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The Role of Artificial Intelligence in Food Processing

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Introduction

The food processing industry has undergone a transformative journey over the years, with technological advancements playing a crucial role in enhancing efficiency, quality, and sustainability. In recent times, Artificial Intelligence (AI) has emerged as a game-changer, revolutionizing various aspects of food processing. This article explores the multifaceted role of AI in the food industry, examining how it contributes to optimizing processes, ensuring quality control, and promoting sustainability.

Enhancing Efficiency in Production

Artificial Intelligence has become an indispensable tool in streamlining and optimizing production processes within the food industry. AI-powered systems can analyze vast amounts of data in real-time, allowing for predictive maintenance and reducing downtime in manufacturing plants. Machine learning algorithms can predict equipment failures before they occur, enabling proactive maintenance and minimizing disruptions in the production line. This results in increased operational efficiency and reduced costs, contributing to a more sustainable and economically viable food processing sector.

Moreover, AI-driven automation has transformed routine tasks in food processing, from sorting and packaging to quality control. Robotics, powered by AI, can handle repetitive tasks with precision and speed, significantly increasing production rates. This not only leads to higher output but also frees up human resources for more complex and creative tasks, fostering innovation in the industry.

Quality Control and Assurance

Maintaining high-quality standards is paramount in the food processing industry. AI technologies play a pivotal role in ensuring the quality and safety of food products. Computer vision systems, integrated with AI algorithms, can inspect and analyze raw materials, intermediate products, and final goods with unparalleled accuracy. These systems can detect defects, contaminants, or irregularities that may not be visible to the human eye, facilitating early intervention and minimizing the risk of compromised product quality. Furthermore, AI contributes to the standardization of processes, ensuring consistency in taste, texture, and appearance of food products. By analyzing data from various stages of production, AI can identify patterns and deviations, allowing for immediate adjustments to maintain product quality. This not only meets regulatory requirements but also builds consumer trust and satisfaction.

Sustainable Practices in Food Processing

The global food industry is increasingly recognizing the importance of sustainability, and AI is playing a crucial role in promoting environmentally friendly practices. AI algorithms can optimize resource utilization, such as energy and water consumption, by dynamically adjusting production schedules based on real-time demand and availability of resources. This not only reduces waste but also minimizes the carbon footprint associated with food processing operations. AI also contributes to sustainability through precision agriculture, optimizing crop yields, and reducing the use of pesticides and fertilizers. By analyzing weather patterns, soil conditions, and crop health, AI-powered systems provide farmers with valuable insights, enabling them to make informed decisions that lead to more efficient and sustainable agricultural practices.

Supply Chain Optimization

Artificial Intelligence plays a pivotal role in optimizing the complex and interconnected web of the food supply chain. From farm to fork, AI technologies help in minimizing inefficiencies and reducing waste. Predictive analytics powered by AI can forecast demand more accurately, allowing for better inventory management and reducing the likelihood of overproduction or stockouts. This not only leads to cost savings for businesses but also contributes to overall sustainability by preventing unnecessary waste.

Additionally, AI-driven logistics and transportation management systems enhance the efficiency of distribution networks. Algorithms can optimize delivery routes, reduce transportation costs, and ensure timely delivery of fresh and perishable goods. Real-time tracking and monitoring enable proactive responses to potential disruptions, further enhancing the reliability and resilience of the entire supply chain.

Personalized Nutrition and Product Innovation

Artificial Intelligence is opening up new frontiers in product innovation and personalized nutrition within the food processing industry. AI algorithms analyze vast datasets related to consumer preferences, dietary restrictions, and health trends to identify emerging patterns and opportunities. This insight enables food manufacturers to develop and introduce products that cater to specific consumer needs, fostering innovation and market differentiation.

Moreover, AI contributes to the creation of personalized nutrition plans based on individual health profiles and preferences. By leveraging machine learning algorithms, food processors can develop customized formulations that align with dietary requirements, allergies, or lifestyle choices. This not only enhances consumer satisfaction but also promotes healthier eating habits.

Regulatory Compliance and Traceability

Ensuring regulatory compliance and traceability are critical aspects of the food processing industry. AI technologies aid in automating and streamlining compliance processes by continuously monitoring and updating protocols in response to evolving regulations. This reduces the risk of non-compliance and helps food processors stay ahead of regulatory changes, ensuring the safety and legality of their products.

Furthermore, AI facilitates traceability throughout the supply chain, enabling quick and precise identification of the source of any issues, such as contamination or product recalls. By implementing blockchain and other distributed ledger technologies, AI ensures transparency and accountability, allowing stakeholders to trace the journey of food products from origin to consumption. This not only enhances food safety but also builds trust among consumers, who are increasingly concerned about the origin and quality of the products they consume.

Conclusion

In conclusion, the role of Artificial Intelligence in food processing is transformative and multifaceted. From enhancing production efficiency to ensuring quality control and promoting sustainable practices, AI has become an integral part of the modern food industry. As technology continues to advance, the synergy between AI and food processing will likely lead to further innovations, creating a more resilient, efficient, and sustainable food supply chain for the future. Embracing these technological advancements will not only benefit manufacturers but will also contribute to meeting the growing global demand for safe, high-quality, and sustainably produced food products.

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Tobacco Caterpillar (*Spodoptera litura*) as a Major Problem in Agriculture Ecosystem and their Management

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Introduction

Spodoptera litura commonly known as tobacco caterpillar, *spodoptera litura* is a polyphagous pest and cause considerable damage to soybean, cotton and vegetables is a widely distributed pest in South-East Asia, feeding on 63 plant species belonging to 22 families. In an outbreak phase, this insect can completely defoliate large area of crops causing the reduction in yield. Heavy use of synthetic insecticides to control this pest resulted in the development of resistance against insecticides of different groups. Although a variety of agrochemicals are used for growing crops, little is known about their direct or indirect effects on non-target organisms including insect pests.

Integrated Pest Management is a strategy to manage pests on the basis of a systems approach that looks at the whole crop ecosystem. This includes understanding how the pests interact with their host plants, with the general climatic conditions, plant health, and nutrition and with each other. When implementing an IPM system, growers should select ways to reduce overall pest levels in their fields and ensure that the management of pests is compatible with their other crop management strategies.

Economic Importance of *Spodoptera litura*

Spodoptera litura is an extremely serious pest the larvae of which can defoliate many economically important crops. It is seasonally common in annual and perennial agricultural systems in tropical and temperate Asia. This noctuid is often found as part of a complex of lepidopteron and non-lepidopteron foliar feeders but may also injure tubers and roots. Hosts include field crops grown for food and fiber, plantation and forestry crops, as well as certain weed species. Most studies on the economic impact of *S. litura* have been conducted in India, where it is a serious pest of a variety of field crops. It has caused 12 to 23% loss to tomatoes in the monsoon season, and 9 to 24% loss in the winter. In potato crop around 40- to 45- day-old crop, damage ranged from 20 to 100% in different parts of the field depending on moisture availability. Larvae also attacked exposed tubers when young succulent leaves were unavailable. On tobacco crop in India, it was estimated that two, four, and eight larvae per plant reduced yield by 23 to 24, 44.2 and 50.4%, respectively. Larvae (2.3 and 1.5) reduced yield of aubergines (eggplant) and Capsicum, respectively in glasshouses by 10%. On Colocasia esculenta (taro), an average of 4.8 4th instar larvae per plant reduced yield by 10%. Aroid tuber crops (including taro) suffered yield losses of up to 29% as a result of infestation by *S. Litura*. Spodoptera litura is also a pest of sugarbeet, with infestations presenting in March and peaking in late March and April. *Spodoptera litura* is also a member of a complex that causes extensive defoliation of soybean defoliation as severe as 48.7% during the pre-bloom stage of growth.

In grapes Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh Spodoptera *litura* appears during November-December feed on the leaves in groups and make the leaf surface papery. Later they feed on the bunches and unripe grape and causes the losses up to 10%.

Identification of *Spodoptera litura*

The young caterpillars are light green with black head or black spots and mine on the leaf tissues. The well grown caterpillars are grey or dark brown with `V' shaped white mark on the front portion of the black head.

Spodoptera litura **larvae and adult**

Damage Symptoms

The first star larvae feed gregariously on the leaf, on which the egg mass is laid by scrapping the epidermal layer, leaving the skeleton of veins. The skeletonized leaf may dry up. Then, the larvae move to other leaves and feed by making small holes. In later stages, they consume most of these leaf tissues and because of severe attack, only the stem and side shoots will be standing in the field without any leaf or bolls. Once squares, flowers and bolls develop, they prefer these better than leaves. They bore into them, feed on the internal content completely and cause shedding of squares and young bolls. This type of feeding is seen only during early morning hours and night, and during hot sunny hours the caterpillars will be hiding in the flowers or in the cracks of the soil. This pest is found to cause damage in all stages of crop growth, but fleshy green leaves should be present for egg laying.

They feed voraciously along the veins of leaves and also cut the stems of small and tender seedlings. Hence, they are also known as cut worms. There will be about 80 to 100% loss due to this pest.

Spodoptera litura **damage Tomato crop**

Spodoptera litura **damage Cauliflower crop**

***Spodoptera litura* damage in grape plant**

Management Options of *Spodoptera litura*

Cultural method: The cultural control method is important component of the *Spodoptera litura* pest management strategy winter kill by exposing larvae and pupae within the upper soil surface lowers the chance of incidence of the pest. Cultural regulation involves preventing for control of insect, collect of *spodoptera litura* egg masses and destroy it is very important for break of lifecycale of *spodoptera litura*.

Physical control: Without effective monitoring activity successful implementation of *Spodoptera litura* management is not possible. Pheromones and light traps are found effective in monitoring of *spodoptera litura*. Commonly used pheromones are Spodo-lure capsule. Light traps can also be used to capture adult moths. Mass trapping of male moths using pheromones, preventing them from mating.

	
Use of Funnel trap	**Use of Solar light trap for adult**

Biological Control

Release egg parasitoids *Trichogramma chilonis* in the crop fields for 6 weeks @ 50000 eggs per ha per week soon after the appearance of moths.

Use of Bio-Pesticides and Entomopathogen

Use of *Metarhizium anisopliae, Bacillus thurigensis variety Kustuki and Beauvaria bassiana* 5.0gm/L spray at 10 days intervals effective against eggs and second – instar larvae of *Spodoptera litura*. Use of *Spodoptera litura* Nucleo Polyhedrosis Virus (SNPV)@2.0ml/L at 15 days intervals for better control of Spodoptera *litura*.

Use of Plant Based Pesticides

Plant based pesticides are better over synthetic chemical pesticides as they are environment friendly, biodegradable, easily available, ecologically sound and sustainable. Use of neem oil@4.0 ml/L, karanja oil 10 ml/L and *Nicotiyana tabacum* extract @4.0 ml/L early spray after detecting of larvae, at 10 days intervals for effective of *Spodoptera litura*.

Chemical Control

Spodoptera litura can be controlled by applying synthetic insecticide. Alternate uses of chemical group for avoid of resistance problems. Spary of Emamectin benzoate 0.4gm/L, chlorantraniprol 0.4ml/L and spinosad 0.5ml/L alternately spray at 10 days intervals for better management of *Spodoptera litura.*

Conclusion

Spodoptera litura is a polyphagous insect damage the several crops and reduce the quality and yields. IPM strategies minimize the loss and increase the marketable value of crops. Cultural practice such as collect of *spodoptera litura* egg masses and destroy. Use of pheromone traps are Spodo-lure capsule. Light traps can also be used to capture adult moths. The uses of egg parasitoids *Trichogramma chilonis, Metarhizium anisopliae, Bacillus thurigensis variety Kustuki and Beauvaria bassiana* , *Spodoptera litura* Nucleo Polyhedrosis Virus (SNPV). Alternate uses of chemical group for avoid of resistance problems use of Emamectin benzoate, Chlorantraniliprole and Spinosad, for better management of *Spodoptera litura.*

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Physiological Perspective of Plant Growth Regulators in Fruit Crops

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Introduction

Plant growth regulators (PGRs) play a crucial role in regulating various physiological processes in fruit crops, influencing their growth, development, and ultimately, yield. From a physiological perspective, PGRs exert their effects by interfering with artifically occurring plant hormones which include NAA, boric acid, Potassium citrate, Putrescine, Calcium nitrate, and Multi micronutrient.

NAA is an organic compound, which is a plant hormone auxin. It suppresses the ABA biosynthesis and increases in the endogenous level of auxin and other metabolites in the plant. It has important role in fruit formation, abscission cell elongation and it increased fruit set percentages and fruit retention. Boric acid has a crucial role in many functions of plant such as increases the pollen germination and pollen tube elongation, hormonal movement, fruit set, it also increased the pollen producing capacity of the anthers and pollen viability, thus finally leads to higher fruit set.

Potassium citrate is key to successful pollination and further fruit setting. High level of potassium is needed for regulating anther dehiscence, pollen imbibition, pollentube growth leading to successful fertilization. It is very positive in enhancing sugar starch translocation, fruit size and quality. Putrescine is polycationic compounds of low molecular weight that have been proposed to be a new category of plant growth regulators or secondary hormonal messenger.

Putrescine implicated in a wide range of plant physiological processes such as cell division, pollen germination and pollen tube growth, pollen viability, somatic embryogenesis, anti-senescence, and biotic/a biotic stress responses also enhanced pollen tube ovule penetration and delayed ovule senescence without effect on flower ethylene production. Recently, putrescine spray at full bloom stage markedly increased fruit set, fruit retention and size of fruits.

Calcium nitrate has crucial role in flowering, pollen germination and fruit set, is also increased the pollen producing capacity of the anthers and pollen viability, thus finally leads to higher fruit set. Multi micronutrient are trace element required in less quantity but play vital role in the plant metabolism process starting from cell wall development to respiration, enzymatic activities, hormone synthesis, carbohydrate synthesis, nitrogen fixation and reduction etc., (Das, 2002). Application of multi micronutrient mixture help in increasing fruit set, fruit retention, avoiding fruit drop and also improve fruit yield.

By understanding the physiological roles of these PGRs, growers can strategically manipulate their application to optimize fruit yield, quality, and post-harvest characteristics. Proper timing and dosage of PGR application can enhance fruit set, size, uniformity, and marketability while minimizing fruit drop, premature ripening, and post-harvest losses.

However, it's crucial to maintain a balance in PGR application, as excessive or improper use can lead to adverse effects such as hormonal imbalances, abnormal growth patterns, or physiological disorders in fruit crops. Furthermore, environmental factors, genetic differences among cultivars, and interactions between PGRs and other cultural practices need consideration for effective and sustainable PGR management strategies in fruit crop production.

Role of Plant Growth Regulators

Calcium nitrate + Boric acid: Kumar *et al.* (2020) recorded maximum fruit set per panicle, number of fruits per tree and fruit yield were recorded under the foliar spray of calcium nitrate @ 0.06% + boric acid @ 0.02% at two stages i.e. 50 per cent flower bloomed per panicle and second spray at the time of fruit set in mango cv. Langra. This might be due to Calcium nitrate serves as a vital nutrient for plant growth, playing a crucial role in cell division, cell wall formation, and overall fruit development. Boric acid, on the other hand, acts as a micronutrient essential for pollen germination, fruit setting, and sugar transport within the plant.

The application of calcium nitrate and boric acid through foliar spray enhances the availability of these nutrients directly to the mango tree, ensuring optimal uptake and utilization. Calcium facilitates the movement of carbohydrates and other essential nutrients towards developing fruits, thereby promoting fruit set and growth. Boric acid aids in the development of healthy pollen grains, improving pollination and subsequent fruit formation. At the grain, pea, and marble stages of mango fruit development, the enhanced availability of calcium and boron promotes cell division, enlargement, and differentiation, leading to the formation of well-developed fruits. This results in an increased number of fruits per tree and ultimately contributes to higher fruit yield.

NAA + Micronutrient mixture Grade - IV: Singh *et al.* (2017) reported that significantly maximum fruit set, numbers of fruits per tree, fruit yield, fruit weight, fruit volume, reducing sugar, non-reducing sugars and total sugars were recorded under the foliar spray of NAA 25 ppm + multi micronutrient mixture Grade-IV (1%) at three stages i.e. first at flower bud initiation, second at full bloom stage and third at pea stage on mango cv. Amrapali. This might be due to NAA is a synthetic auxin that can stimulate fruit development by enhancing cell division and elongation, particularly during the early stages of fruit formation. This could lead to an increased number of fruits per panicle and per tree. The micronutrient mixture, containing essential elements like iron, zinc, copper, manganese, etc., supports various metabolic processes crucial for fruit development, such as photosynthesis, enzyme activation, and carbohydrate metabolism. This ensures optimal physiological functioning within the tree, thereby improving fruit set, yield, and quality.

Furthermore, the combination of NAA and micronutrients likely enhances the translocation of assimilates, including sugars, from source organs (leaves) to sink organs (fruits), leading to increased fruit weight and volume. The regulation of sugar metabolism, including reducing sugars, non-reducing sugars, and total sugars, is vital for fruit sweetness and overall quality. The foliar spray may optimize sugar accumulation in mango fruits, contributing to improved taste and market value. Overall, the foliar application of NAA and micronutrient mixture appears to positively influence mango fruit set, yield, and quality through their synergistic effects on hormonal balance, nutrient assimilation, and sugar metabolism during various stages of fruit development.

Potassium citrate + Putrescine: Abd El-Migeed *et al.* (2013) recorded the maximum reducing sugar, non-reducing sugar, total sugar and shelf life with minimum acidity was recorded by spraying potassium citrate @ 2% + putrescine @ 10 ppm at full bloom stage in date palm cv. Amhat. This might be due to potassium citrate acts as a buffering agent, regulating pH levels within the fruit tissue. By maintaining optimal pH, enzymatic activities responsible for sugar breakdown are moderated, leading to reduced levels of both reducing and non-reducing sugars. Putrescine, a polyamine, complements this action by inhibiting ethylene production, which slows down the ripening process and decreases sugar metabolism.

Additionally, potassium citrate enhances cell membrane stability, reducing water loss and maintaining fruit firmness, thus extending shelf life. The combination of these compounds creates an environment less conducive to microbial growth and enzymatic degradation, further preserving the fruit's quality. By minimizing acidity, the taste profile of the fruit remains balanced and appealing to consumers. The interaction between potassium citrate and putrescine underscores a synergistic effect, enhancing each other's functionality in preserving fruit quality. Through this approach, the physiological processes of ripening, sugar metabolism, and spoilage are effectively regulated, resulting in fruits with improved texture, reduced sugar content, prolonged shelf life, and optimal taste.

NAA + Boric acid: Kumar *et al.* (2022) recorded the maximum fruit weight, pulp weight, diameter, length with minimum peel weight, stone weight and fruit specific gravity when foliar application of boric acid 0.6% + NAA 25ppm combination were done at three interval; first spray on 15th November and second spray on 15th December on bael tree cv. NB-9. This might be due to Boron, an essential micronutrient, plays a crucial role in cell wall formation, pollen tube elongation, and carbohydrate metabolism, thus influencing fruit development and size.

Boron deficiency can lead to poor fruit set and development. Foliar application of boric acid ensures an adequate supply of boron, promoting cell division and enlargement in the fruit, thereby increasing its weight and size. NAA a synthetic auxin, regulates various physiological processes in plants, including cell elongation, division, and fruit development. NAA stimulates cell enlargement, contributing to increased fruit diameter and length. Moreover, the combined application of boric acid and NAA likely enhances hormonal balance within the fruit, leading to optimal growth while minimizing undesirable traits. NAA may regulate the balance between auxins and cytokinins, promoting fruit growth while reducing peel thickness and stone weight.

Boron enhances cell wall integrity, ensuring structural support for fruit growth, while NAA promotes cell division and elongation, maximizing fruit size. The reduction in peel weight could be attributed to enhanced cell expansion and reduced lignification under the influence of these compounds. Synergistic action of boric acid and NAA positively influences fruit development by enhancing cell division, enlargement, and hormonal regulation, resulting in larger fruit size, increased pulp content, and improved fruit quality, while simultaneously reducing undesirable traits such as peel weight, stone weight, and specific gravity.

Boric Acid

Panwar *et al.,* 2017 reported that foliar spray of boric acid gave maximum TSS, reducing sugar, non-reducing sugars, total sugars, shelf life of fruits and minimum acidity in fruit crop. This might be due to act as a micronutrient that plays a crucial role in various physiological processes within the plant. It facilitates the uptake and transport of sugars, which contributes to increased TSS in fruits.

The enhanced TSS levels result from the accumulation of soluble sugars like glucose, fructose, and sucrose. Additionally, boric acid application may influence the activity of enzymes involved in sugar metabolism, leading to changes in both reducing and non-reducing sugar contents. Moreover, boric acid can affect fruit ripening processes and post-harvest characteristics.

By regulating hormonal balance and enzyme activities, it extends the shelf life of fruits by delaying senescence and reducing decay. This preservation effect is further supported by the maintenance of optimal sugar levels, which provide energy for metabolic processes and help combat microbial spoilage. Furthermore, boric acid application tends to minimize fruit acidity by modulating ion uptake and translocation, thereby regulating pH levels. This reduction in acidity can enhance fruit flavour and make them more palatable.

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The Intersection of Climate Change and Organic Farming: Adapting to a Changing World

Article ID: 48803

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Abstract
Climate change and organic farming are two major challenges facing the agriculture industry today. While climate change is causing unprecedented environmental disasters, organic farming is gaining popularity as a sustainable alternative to conventional agriculture. This paper explores the intersection of these two issues and examines how organic farming can help farmers adapt to a changing world. The paper begins by discussing the impact of climate change on agriculture, including rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events. These factors are affecting crop yields, soil health, and water resources, making it increasingly difficult for farmers to maintain their livelihoods. The paper then examines the principles of organic farming and how they can help farmers adapt to a changing world. Organic farming emphasizes soil health, crop rotation, and natural pest control methods, which can help farmers mitigate the impacts of climate change by improving their resilience to extreme weather events and reducing their reliance on synthetic inputs. The paper also explores the challenges facing organic farmers in adapting to a changing world, including limited access to resources and knowledge, lack of government support, and market barriers. These challenges must be addressed in order for organic farming to become a viable option for farmers in a changing climate. Finally, the paper concludes by discussing the potential of organic farming as a solution to both climate change and food security challenges. By promoting sustainable agriculture practices, we can reduce greenhouse gas emissions, conserve water resources, and improve food security for vulnerable populations. However, this will require a significant shift in agricultural policies and practices at both national and international levels.

Keywords: Agriculture, Climate change, Organic farming, Sustainable production.

Introduction
Climate change is one of the most pressing global issues of our time, and its impacts are being felt in every sector, including agriculture. Traditional farming practices are being disrupted by changing weather patterns, rising temperatures, and increased pests and diseases. In response, organic farming has emerged as a sustainable and resilient alternative. This article explores the intersection of climate change and organic farming, examining the ways in which organic farming practices can help farmers adapt to a changing world (Habib-ur-Rahman *et al.*, 2022).

Organic Farming and Climate Change
Organic farming is a production system that relies on natural inputs and processes rather than synthetic chemicals. It is based on three core principles: health, ecology, and fairness. Organic farming practices are designed to promote soil health, conserve water resources, and reduce greenhouse gas emissions. As a result, organic farming has the potential to help farmers adapt to the challenges of climate change. One of the keyways in which organic farming can help farmers adapt to climate change is through soil conservation. Soil erosion is a major problem in many parts of the world, particularly in areas affected by extreme weather events such as floods and droughts. Organic farming practices such as crop rotation, cover cropping, and conservation tillage can help to build soil structure and improve soil health, making it more resilient to erosion. This is important because healthy soil can store large amounts of carbon, helping to mitigate greenhouse gas emissions. Another way in which organic farming can help farmers adapt to climate change is through natural pest control. Pests and diseases are becoming more prevalent in many parts of the world due to changing weather patterns. Organic farmers use natural methods such as crop

rotation, biological control agents, and cultural practices to manage pests and diseases without relying on synthetic chemicals. This is important because synthetic chemicals can have negative impacts on soil health and water quality, making it more difficult for farmers to adapt to the challenges of climate change (Petersen-Rockney, 2022).

Challenges and Opportunities

While organic farming offers many benefits for farmers adapting to climate change, there are also challenges that need to be addressed. One of the main challenges is the need for more research and support for organic farmers in developing countries. Many smallholder farmers in developing countries lack access to the resources they need to adopt organic farming practices, including training, inputs, and markets. This makes it difficult for them to adapt to the challenges of climate change and build resilience in their communities. Another challenge is the need for more policy support for organic farming. Many governments still prioritize conventional agriculture over organic farming, despite the fact that organic farming offers many benefits for farmers adapting to climate change. This needs to change if we are going to build a more sustainable food system that can adapt to the challenges of climate change. Governments need to provide more support for organic farmers through policies such as subsidies, tax breaks, and research funding (Malhi *et al*., 2021).

Conclusion

In conclusion, organic farming offers many benefits for farmers adapting to climate change. From soil conservation and natural pest control to improved water management and reduced greenhouse gas emissions, organic farming practices can help farmers build resilience in the face of climate change. However, there are also challenges that need to be addressed, including the need for more research and support for organic farmers in developing countries and more policy support for organic farming at the national level. By addressing these challenges and promoting sustainable agriculture practices that can adapt to climate change, we can build a more resilient food system that benefits both farmers and consumers alike.

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Success Story of Sesame Farmer

Article ID: 48804

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Abstract

Sesame is an important oilseed crop grown in summer season in Jagtial district of Northern part of Telangana. JCS 1020 variety grown by the progressive farmer in Jagtial district revealed that total cost of cultivation was Rs. 22,117/- per acre. The yield was observed to be 5 q/A. Gross and net returns were observed to be Rs. 85000/- and Rs. 62883/- per acre respectively. Hence cultivation of JCS 1020 variety of sesame is beneficial to the farming community.

Keywords: Staple, irrigation, economics, gross returns and net returns.

Introduction

Agriculture is the backbone for Indian Economy and it provides employment to 60 per cent of labour force. Agriculture contributes to 19.9 per cent of GDP (2020-21). In India, out of the total geographical area of 328.73 million hectares, gross cropped area is 197.32 million hectares. The food grain production has increased from 51 million tonnes in 1950-51 to 308.65 million tonnes during 2020-21. (Agricultural Statistics at a Glance 2021).

Sesame is an important oilseed crop grown in India and grown in an area of 1667650 ha. States like Madhya Pradesh and Uttarpradesh have highest area under sesame cultivation with an average of 340540 and 327327 ha from 2017-18 to 2021-22. Whereas Telangana ranked 10th position in area with an average area of 22176 ha. In Telangana, sesame is grown mainly in the Northern Region because of suitable ago-climatic conditions. Majorly sesame is grown in Turmeric fallows. In addition, sesame is also grown in cotton fallows, groundnut fallows and rice fallows. Among all the districts of Telanagana, Jagtial ranked 1st in area under sesame cultivation with an average of 1038 ha and average productivity of 0/64 tonnes/ha from 2017-18 to 2021-22.

Sesame variety JCS 1020 was released through SVRC on the name of Jagtiala Til 1 during 2019, a white seeded variety with 85-90 days duration. RARS, Polasa, Jagtial conducted awareness programmes to the farmers regarding the yield superiority which amounts to 1050-1100 kg/ha during summer under irrigated and 700- 750 kg/ha during Late kharif with lifesaving irrigations and it is moderately resistant to shattering. Its multi-capsular nature favour to exploit maximum returns under favourable crop management. In addition, the variety also suitable for export with free fatty acids, palmitic acid (10.37%), steric (6.52%), oleic (41.99%), linoleic (40.39%), eicosenoic (0.68%).

Mr. K. Ramkishan (41 years), a progressive farmer from Veldurthi village of Jagtial Rural mandal of Jagtial district cultivated JCS 1020 variety of sesame crop in summer season 0f 2022. He used drip irrigation for cultivation of sesame in his field. He also adopted diversified farming on his land comprising various combinations of field crops such as cereals (paddy), commercial crops (turmeric), Horticulture crops (Mango) and vegetables.

Scientists of Regional Agricultural Research Station, Polasa, Jagtial motivated the farmers for cultivation of the variety and provided technical support. Scientists also conducted field visits and provided need-based suggestions to the farmers.

He has cultivated JCS 1020 variety rop in summer, 2022 through drip irrigation. After harvesting turmeric crops on the 3rd week of January, field was prepared with cultivator (two times) and rotovator (one time). He used 2.5 kg of sesame see for one acre by mixing it with 7.5 kg of sand and broadcasted the seed. Later laterals of drip system were arranged at 80 cm. distance. Within 25 days of sowing, manual weeding was done to maintain a weed free environment. He adopted fertigation method by applying 10 kg of urea and 25 kg of potash for one acre through drip syatem. and yielded 315.5 quintals per acre for which the farmer reaped good results. Later for control of capsule borer, sprayed chloripyriphos @ 2.5 ml/l of water at capsule formation stage and neem oil @ 5ml/l of water for control of sucking pests. He has given 6-8 life saving irrigations to the crop.

The details of cost of cultivation particulars of farmer are attached below.

Table 1: Costs of cultivation of mustard crop (in Rs. per acre):

S.No.	Particulars	Cost (In Rs./A)
I	**Operational costs**	
1	Human labour	12840 (58)
2	Machine power	1900 (9)
3	Fertilizers	520 (2)
4	Plant protection chemicals	810 (4)
5	Miscellaneous expenses	150 (1)
6	Interest on working capital	136 (1)
	Total operational costs	**16356 (74)**
II	**Fixed costs**	
1	Rental value of owned land	5000 (23)
2	Depreciation	450 (2)
3	Interest on fixed capital	311.25 (1)
	Total fixed costs	**5761 (26)**
III	**Total cost**	**22117 (100)**

The perusal of Table 1 depicts that average cost of cultivation per acre was ₹ 22117. The proportion of variable and fixed costs in the total cost of cultivation accounts to 74 and 26 per cent respectively. Among the variable costs, expenditure on human labour was accounting to 58 per cent. This was observed because of increased number of labour during harvesting period due to unseasonal rains and higher labour wages in the village. This was followed by expenses on machine labour (9%). Among the fixed costs, rental value of owned land accounts maximum accounting to 23 per cent.

Table 2: Profitability of paddy cultivation:

S.No.	Particulars	
1	Yield (q/A)	5
2	Gross returns (Rs. /A)	17000
3	Net returns (Rs. /A)	85000
4	Returns per rupee spent	62883
		3.84

It is evident from Table 2 that the average yield per acre was 5 quintals. Whereas gross returns and net returns were observed to be ₹ 85000 and ₹ 62883 respectively. The returns per rupee spent was observed to be 3.84.

Conclusions

Cultivation of JCS 1020 variety of sesame crop in turmeric fallows was beneficial to the farming community and hence the farmers are advised to cultivate the variety to increase the net returns.

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Photos

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Sweeping Away Pests: How Remote Sensing Technology is Revolutionizing Agriculture?

Article ID: 48805

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Introduction

In the age-old battle between farmers and pests, a new weapon has emerged: remote sensing technology. Imagine being able to detect pests lurking in your fields before they even make a move. Picture having the power to precisely target them without dousing your crops in harmful chemicals. Thanks to remote sensing, this futuristic vision is becoming a reality, transforming the way we approach pest management in agriculture.

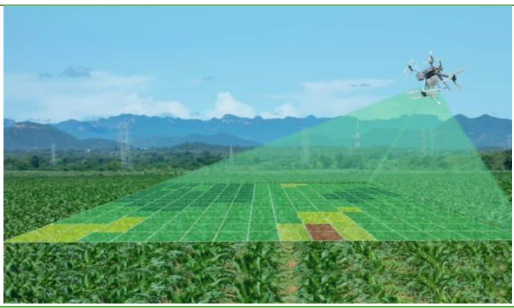

Figure 1: Geospatial Surveying

Figure 2: Internet on Things

What Exactly Remote Sensing is?

At its core, it involves using sensors mounted on satellites, drones, or ground-based platforms to gather data about our environment. In the context of pest management, these sensors capture crucial information like temperature, humidity, soil moisture, and even pest activity. One of the most remarkable aspects of remote sensing is its ability to provide real-time data. This means farmers can monitor their fields continuously, keeping a vigilant eye on any signs of trouble. Whether it's a sudden spike in temperature that attracts a particular pest or a drop in soil moisture that signals potential infestation, remote sensing alerts farmers to take action promptly. But the real magic happens when we combine this real-time data with advanced analytics and algorithms. By crunching the numbers, we can predict pest outbreaks with astonishing accuracy. Imagine receiving a notification on your smartphone warning of an impending armyworm invasion based on data collected from sensors in your fields. Armed with this information, farmers can deploy targeted interventions precisely where they're needed, sparing the rest of the crop from unnecessary pesticide exposure. Speaking of pesticides, remote sensing technology also helps reduce our reliance on these chemical solutions. By pinpointing areas of infestation with surgical precision, farmers can apply pesticides sparingly, minimizing their environmental impact. This not only protects beneficial insects and wildlife but also ensures the long-term health of our soil and water resources.

Figure 3: Scanning infestation due to pest and diseases through satellite imagery.

Figure 4: Areas threatening to pest in a field

But perhaps the most exciting aspect of remote sensing in pest management is its potential to revolutionize the way we farm. By providing insights into pest behaviour and ecosystem dynamics on a scale never before possible, this technology opens the door to a new era of sustainable agriculture. Farmers can adopt integrated pest management strategies that harness the power of nature, using biological controls and habitat management to keep pests in check.

Of course, like any technology, remote sensing comes with its challenges. The upfront costs of implementing these systems can be daunting for small-scale farmers, and there's a learning curve involved in interpreting the data effectively. Plus, there are privacy concerns to consider when collecting and sharing sensitive information about land use and crop health.

Conclusion

However, the benefits far outweigh the challenges. With remote sensing technology, we have the potential to revolutionize pest management in agriculture, making it more precise, efficient, and sustainable than ever before. By harnessing the power of data and analytics, we can protect our crops while safeguarding the environment for future generations. So, here's to a future where pests are no match for the power of technology – and where our fields flourish like never before.

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Electronic Nose Technology for Stored Grain Pest Detection

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Under most climatic conditions and in most countries, farmers store grains in grain bins with the capacity for at least one year's production. However, long-term storage in these structures could provide an ideal environment for population development of common stored-product insects. Furthermore, the presence of insects in the stored-grain facilities can contribute to substantial losses during storage. An important part of insect control in stored grain is the early detection of insects in the bin. Although several methods have been developed to monitor the quality of grain in storage, they lack the sensitivity for early detection of insects. New technologies that can accurately and quickly detect the early insect infestation of grains are needed. Sensor technologies, such as electronic nose (E-nose), might offer numerous advantages over traditional stored product insect detection techniques. The e-nose technology might be used to analyze interstitial gas in stored grain for specific insect-produced volatiles. It receives attention in various application areas including agriculture due to advancement in sensor technology and design, software innovations and improvements. E-nose is an electronic device consisting of an array of sensors and software used for data processing and pattern recognition to recognize. It is a system originally created to mimic the function of a human nose. E-nose has an advantage of detecting odour that cannot be possibly detected by human nose as well.

History

E-nose was first suggested by K. Persaud and George Dodd of Warwick University in 1982. Then afterwards in 1988, another professor of this university named Julian Gardner conducted his research on this E-nose It then came into popular use after 1989. Since then, development of sensor array-based instruments has been actively pursued in Asia, Europe and North America.

Types of E-Nose

Most widely used for the classification of grain use metal oxide semiconductor (MOS) sensors or MOSFET sensors. Most of the existing work uses models like PEN2, PEN3, FOX3000, Cyanose 320 uses MOS sensors. Other models of e-nose may have electro chemical sensor, conducting polymer sensor, optical sensors, and Quartz crystal microbalance sensors. To classify the odour, several classification algorithms and regression are applied on the data such As Artificial Neural Network (ANN), support vector machine (SVM), Linear discriminate analysis (LDA), k-mean clustering analysis, fuzzy c-mean clustering, BPNN, principal component analysis (PCA), etc.

Figure 1: PEN 2, PEN 3

Figure 2: FOX 3000

Figure 3: CYRANOSE 20

Working Principle of E-Nose

1. Sample delivery system: It enables the generation of the headspace (volatile compounds) of a sample. The system then injects this headspace into the detection system.

2. Detection system: It consists of a sensor set is the reactive part of the instrument. The adsorption of volatile compounds on the sensor surface causes a physical change of the sensor; they experience a change of electrical properties. A specific response is recorded by the electronic interface transforming the signal into a digital value and the recorded data are then computed based on statistical models.

3. Computing system: It combines the responses of all sensors to produce a result. These results can be easily analayzed with a database of qualified samples. New samples are identified by comparing those with the samples in database.

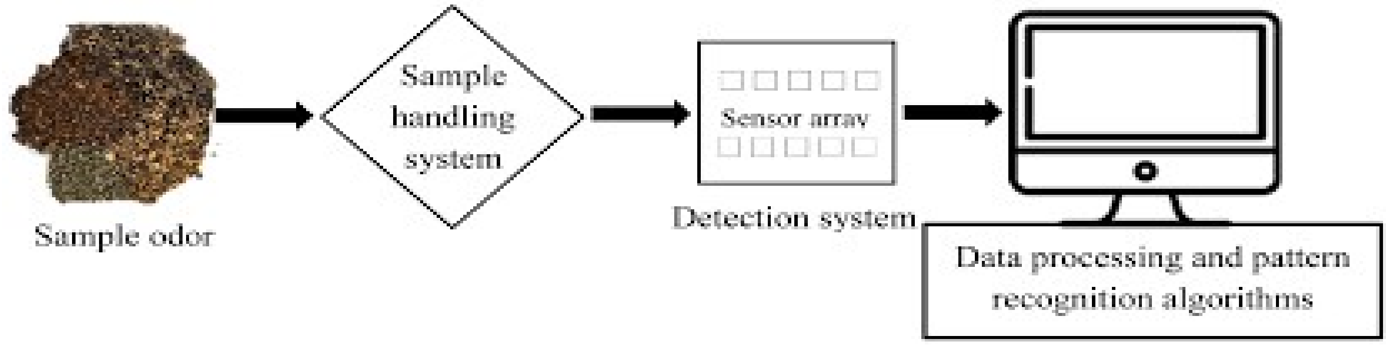

Figure 4: working principle of E- nose

The Alpha MOS FOX-3000 electronic nose sensors were shown to be sensitive to volatile compounds, especially moisture. When wheat moisture was low (14% and 16%), sensors were sensitive to the volatiles and metabolites from red flour beetle (RFB), whereas, when wheat moisture was high (18%), the sensor could not differentiate insect volatiles from other volatiles. Discriminant Factorial Analysis and Partial Least Squares algorithms were effective in the application of e-nose to predict wheat moisture content. The e-nose used in this research could detect the presence of red flour beetle (RFB) in wheat with a high infestation level of 20 insects/kg at 14% and 16% moisture content. However, it did not detect the presence of RFB in wheat at 18% moisture content. The e-nose was able to differentiate 1 RFB/kg infestation level from 20 RFBs/kg infestation level in wheat at 14% and 16% moisture content.

Figure 5: ALPHA MOS 3000

Another case study which reveals that the Storage rice with moisture content of 11.8 ± 0.3% was used for conducting the tests. The rice samples were infested with different numbers of adult insects, including rice weevil (Sitophilus oryzae), lesser grain borer (*Rhyzopertha dominica*) and red flour beetle (*Tribolium castaneum*), in containers containing 1 kg of rice. The samples were stored at temperatures of 15 °C and 30 °C for four weeks. The data were analyzed using the principal component analysis (PCA) method. The results revealed that the E-nose was not able to distinguish the clean rice and infested rice with lesser grain borer. While it had high response ability to the volatile components produced by rice weevil and red flour beetle after four weeks of storage. Consequently, the E-nose could discriminate the clean and infested rice with above insects after four weeks of storage at temperature of 30 °C. The classification accuracy of E-nose for clean and infested rice was low at storage temperature of 15 °C for the tested insects.

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Seed Priming: A Key to Sustainability in Drought Stress

Article ID: 48807

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Abstract

Abiotic stresses spotlights the field crops, vegetable crop at all growth phases and results in significant yield losses in important crops. Numerous physiological, biochemical and molecular practices have been examined by crop researchers to battle drought stress/water limiting stress, but in the current environment, these measures are meager. It is so appealed that plants can be primed by various organic and inorganic stimulants for exceptional toughness under stressful environments. In order to confer tolerance, novel seed priming techniques are hopeful to field of research in stress biology and crop stress management. Seed priming is the active process of carefully hydrating seeds with germination stimulants so that pre- germinative metabolic activity can continue while the radicle's emergence is halted. The terms "hydro-priming," "osmo-priming," "halo-priming," "solid matrix priming," "bio-priming," and "hormonal priming" refer to various priming techniques. Seed priming will speed up and synchronize germination, improve plant growth and stand establishment, raise stress tolerance, improve fertilizer and water use efficiency, and have superior weed suppression effects. This article covers the physiological and biochemical changes through several seed priming techniques, Nano-priming and its significance in sustainable agriculture.

Keywords: Seed priming; water limited stress; seed priming techniques; nano priming.

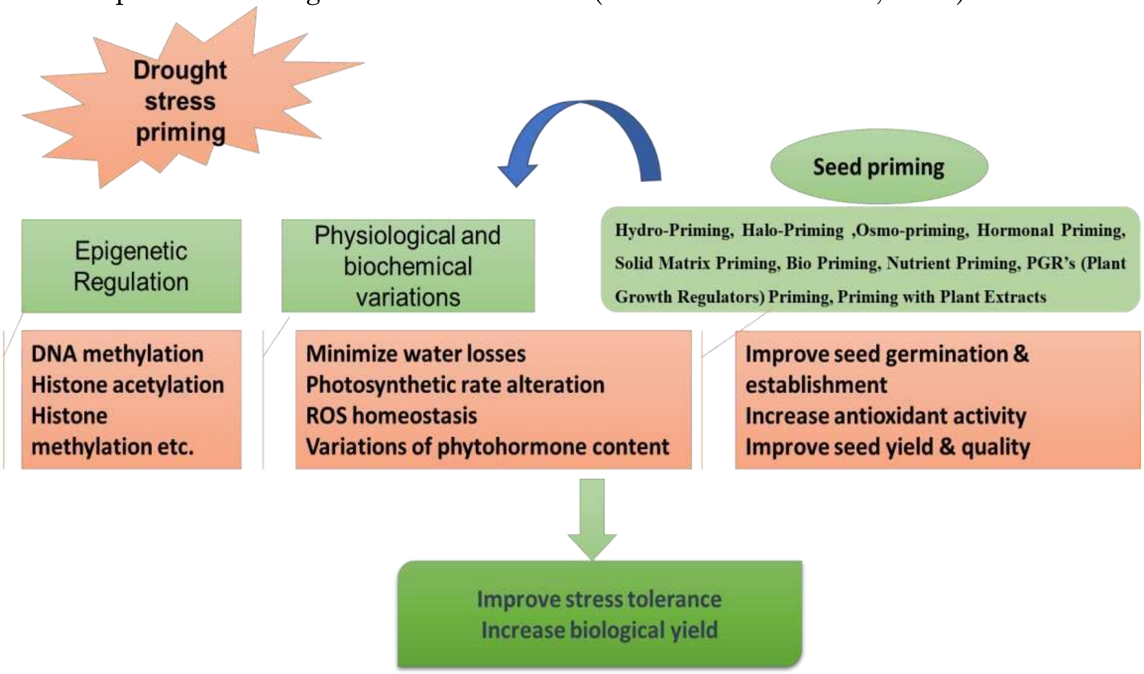
Introduction

For the majority of India's poor and vegetarian people, pulses are a staple food and a significant source of protein in the country. Pulses offer the main combination of high biological value vegetarian protein when combined with cereals. According to the findings of household consumption surveys, there has been a fall in pulse consumption, which has increased malnutrition and decreased protein intake in the country (Shalendra *et. al*., 2013). About 24% of the world's undernourished population still live in India. According to GOI report (2016), a plunge in the country's per capita net availability of pulses from 70.3 to 29.1 g/day/capita was observed in years 1959 to 2003. With the production of pulses in the recent decades, an improvement in availability of pulses in vegetarian population in India. According to GOI report (2016), a plunge in the country's per capita net availability of pulses from 70.3 to 29.1 g/day/capita was observed in years 1959 to 2003. Pulses, as an important source of protein, constitute a basic ingredient in the diet of vast majority of poor and vegetarian population in India. According to projections from the Indian Institute of Pulses Research, Kanpur, the nation's pulses demand will reach 39 million tonnes by 2050, necessitating a 2.2 percent annual growth in production (Kumari *et al.,* 2023). India accounts for about 29% of the global area and 19% of the global production of pulses making it the largest producer and consumer in the world. More significantly, India is the world's largest importer and processor of pulses. Abiotic stress are the atrocious challenges that come forward mainly due to unfavorable climatic change scenario, such challenges are heavy metal toxicity, drought, heat, and high soil salinity, which ultimately decreased crop output across the globe [Gupta and Gupta 2010].

Effect of Drought Stress on Growth and Development of Plant

The main issues impacting seed germination, emergence, seedling vigor and ultimately crop output are abiotic stresses. These unfavorable factors significantly affect many agricultural areas in dry and semi-arid countries. Drought can interfere with a plant's natural functioning at various phases of growth, which decreases the plant's overall production. Plants adjust physiologically, biochemically, and molecularly to these conditions to some extent, but these natural adaptation techniques are insufficient to produce the desired results (Dey *et. al.,* 2022). Low germination percentage and less stand establishment reduces overall growth of seedlings by affecting their morphological (seedling length and biomass), physiological (relative water content), biochemical (amylase, protease, and lipase activities), and molecular (stress proteins, aquaporins, and dehydrins) characteristics (Jyoti *et. al.,* 2017). Reproductive phase the sensitive growth phase of plant determines yield in most crops is also affected by drought stress (Sodani *et. al.,* 2017). Drought stress during the reproductive period affects grain development, grain number, grain weight, and many other yields and yield-attributing features, which leads to a significant decrease in productivity and quality of final production (Kuwayama *et. al.*, 2019). Seed priming is a important and effective way to synchronize seed germination, promote emergence and establish in the farm, among other methods for increasing crop yield. By synchronizing seed germination, the seed priming approach can help farmers reduce the losses by drought stress, increase crop production, and create systemic resilience to drought stress in plants.

Seed Priming: Seed priming is a simple and efficient hydration strategy to promote seed germination. Seeds undergo a physiological process known as regulated hydration and drying during priming, which results in an improved and increased pre- germinative metabolic process for quick germination. Prior to germination, seed treatments cause a physiological state known as the "primed state," which enhances a number of cellular reactions. The prepared seeds produce seedlings that have early, uniform germination and an overall improvement in their lifetime different growth characteristics might be seen. It improves crop production, nutrient uptake, water use effectiveness, release of photo- and thermos-dormancy and activating genes/ proteins that respond to stress, such as late embryogenesis abundant (LEAs), which may result in the development of drought stress resistance (Thomas and Puthur, 2020).



Seed priming effects under drought stress

Techniques of Priming: Every crop needs a unique, optimized priming procedure. Optimization takes into account a number of factors, including the amount of time needed for treatment, the priming or coating material, the Vigor of the seeds, and the storage circumstances (temperature, moisture, oxygen requirement etc.)

Nano Priming under drought stress: Drought is a major environmental condition that has the interest of both environmental and agricultural specialists. Limited moisture content diminishes cell size, disrupts membrane integrity, induces oxidative stress, and causes leaf senescence, all of which reduce crop growth. Si NPs improve plant drought tolerance. Drought resistance, for example, improved in hawthorn plants treated with Si NPs, but defense-related physiological indicators varied according to drought levels and Si NPs concentrations applied. Similarly, Si NPs revealed a high potential for post-drought plant recovery in barley plants through modifying morphophysiological characteristics discovered that Si NPs improved cucumber growth and yield under water-stressed and saline situations (Chauhan *et. al.*, 2023).

Conclusion

A technology known as seed priming increases germination, promotes early flowering and maturity, increases crop resistance to abiotic challenges, and is both safe and effective for the environment. It is also suggested that seed priming is a better solution against germination issues when seeds are grown in unfavorable conditions. However, there are still a number of restrictions on seed priming techniques. Not every priming technique will result in considerable germination and growth. In this aspect, choosing a certain priming technique is crucial to getting greater germination and eventual yield. Therefore, more thorough research is needed to choose appropriate priming techniques for certain crops in order to ensure a higher yield.

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Role of NGOs in Agriculture

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Introduction

The global agriculture landscape is significantly shaped by Non-Governmental Organizations (NGOs), which function as enablers for inclusive agricultural practices, sustainable development, and community empowerment. NGOs have become essential players in bridging gaps, encouraging innovation, and pushing for good change within the agriculture sector in an era where environmental conservation, socioeconomic well-being, and global food security are of utmost importance. In order to foster synergies that improve overall productivity and resilience, NGOs working in the agricultural sector frequently serve as intermediates, bringing together farmers, local communities, and government organizations. Their varied responsibilities include advocating for policies, promoting ecologically friendly farming methods, developing capacity, and disseminating technology. Equipping farmers with the knowledge and abilities needed to implement sustainable and effective farming practices is one of the main roles of non-governmental organizations in the agricultural sector. Non-governmental organizations (NGOs) facilitate the diffusion of cutting-edge technologies, contemporary techniques, and best practices that can maximize agricultural productivity while reducing environmental impact through demonstration projects, workshops, and training programs. NGOs also serve as defenders of the rights and interests of farmers, pushing laws that advance fair trade, market accessibility, and smallholder farmers' protection. Through active participation in policy making, non-governmental organizations (NGOs) facilitate the establishment of favorable conditions for fair agricultural growth, rural livelihoods, and the reduction of poverty. In addition, NGOs frequently work with international organizations, businesses, and research institutes to innovate agriculture. Innovative technologies, environmentally friendly farming practices, and market-driven strategies are developed and put into practice as a result of this partnership, strengthening agricultural systems' long-term resilience.

Definition

Professor Peter Willetts, from the University of London, defines an NGO as "an independent voluntary association of people acting together on a continuous basis for some common purpose other than achieving government office, making money or illegal activities." In this view, two main types of NGOs are recognized according to the activities they pursue: operational NGOs that deliver services and campaigning NGOs.

The World Bank describes NGOs as “private organizations that pursue activities to relieve suffering, promote the interests of the poor, protect the environment, provide basic social services, or undertake community development.”

Role of NGOs in Agriculture

Through a variety of initiatives aimed at addressing major issues facing farmers, rural communities, and the agricultural sector overall, non-governmental organizations (NGOs) play a critical role in the development of agriculture in India. Here are some ways that NGOs support the growth of agriculture in India:

1. Capacity Building and Training: NGOs plan farmer training courses and capacity-building projects. A variety of subjects are covered in these programs, such as crop management, current agricultural techniques, water conservation, and the application of cutting-edge technologies. NGOs enable farmers to embrace more productive and sustainable farming practices by improving their knowledge and abilities.

2. Technology Dissemination: NGOs spread knowledge on enhanced farming methods, crop types, and farming equipment, which helps to accelerate the adoption of new technology. This aids in farmers' productivity gains, input cost reductions, and climate change adaptation.

3. Promoting Sustainable Agriculture: NGOs frequently concentrate on encouraging environmentally conscious farming methods that are sustainable. This entails supporting the use of environmentally friendly inputs, fostering organic farming, and advancing water-efficient irrigation methods. Long-term farming system viability is guaranteed by sustainable agriculture, which also helps the environment.

4. Access to Finance and Markets: NGOs support farmers in gaining access to markets and funding. In order to assist farmers in obtaining loans, gaining access to market data, and negotiating better pricing for their produce, they might help organize farmer cooperatives or self-help groups. Rural areas' economies benefit from this as well.

5. Women Empowerment: The goal of empowering women in agriculture is being pursued by numerous NGOs in India. They encourage gender-inclusive policies, train female farmers, and assist with revenue-generating endeavors. Increasing the status of women in agriculture benefits better household well-being and rural development as a whole.

6. Policy Advocacy: NGOs work to change policies that have an impact on the agriculture industry through advocacy campaigns. Their job includes addressing policy matters as well as issues pertaining to crop insurance, water management, and property rights. NGOs help to create a more hospitable and conducive environment for agriculture by promoting policies that benefit farmers.

7. Disaster Response and Resilience Building: NGOs are essential to resilience building and catastrophe response. In addition to providing emergency assistance in the event of natural disasters like floods or droughts, they also aim to increase resilience by encouraging climate-smart agriculture and implementing risk-reduction strategies.

8. Research and Innovation: NGOs advance agricultural innovation and research by working with research institutes. In order to increase total agricultural output, they support the creation and use of new crop varieties, pest-resistant seeds, and creative farming techniques.

9. Education and Awareness: NGOs try to educate farmers about government programs, their rights, and the resources that are out there. Through this education, farmers are better able to access resources for support, make well-informed decisions, and actively engage in the process of development.

Non-governmental organisations (NGOs) have a diverse function in the advancement of agriculture in India. They tackle issues at the local level and enhance the general sustainability and welfare of rural communities.

NGOs in India

1. Self Employed Women's Association (SEWA): The largest Central Trade Union in India was established on April 12, 1972, and is called the Self-Employed Women's Association (SEWA) With nearly 2.5 million members as of 2023, the majority of them are self-employed, underprivileged women working in 18 states' informal economies. For more than 50 years, SEWA has worked to improve the lives of low-income self-employed women workers from the informal economy, guided by the Gandian principles of Satya (truth), Ahinsa (non-violence), Sarvadharma (integrating all faiths. all people) and Khadi (propagation of local employment and self-reliance). The two goals of Full Employment: SEWA has been accomplished through a range of projects that incorporate technology, technical training, microfinance, market connections natural resource management, etc. across over 125 distinct crafts obtain money and job security.

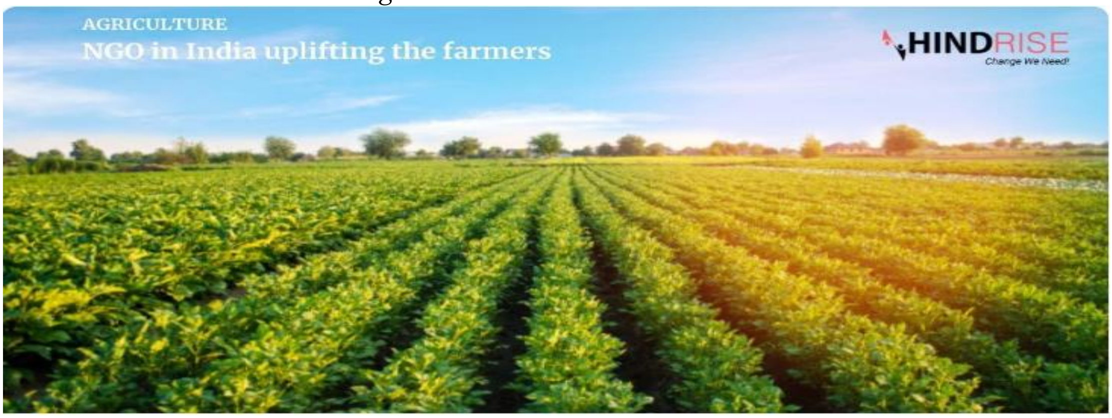
SEWA has an integrated strategy approach which are:

a. Organizing for Collective Strength.
b. Capital formation to reduce risk and combat poverty.
c. Increasing capabilities to remain stable in a cutthroat market.
d. Social security to improve productivity & well-being.

2. DHAN Foundation: October 2, 1997, the Humane Action (DHAN) Foundation was founded as a professional development organization. It attracts educated, highly driven young men and women into the development field. They would implement cutting-edge development strategies to eradicate poverty nationwide, fulfilling the organization's objective. Learn more about DHAN Foundation. The DHAN Foundation is one of the nation's leading development organizations, dedicated to improving the lives of the underprivileged and impoverished. The promotion of the Foundation aims to attract highly educated and motivated young men and women to the development field.

3. Hindrise Foundation: One such organization that has actively worked to improve farmers' lives and serve as their right hand in all aspects of farming is Hindrise Foundation, an agriculture non-governmental organization in India. An agriculture non-governmental organization in India known as Hindrise Foundation is dedicated to resolving both small and big problems in the agriculture sector. The main objective of this NGOs is following:

a. The primary focus of the Hindrise Social Welfare Foundation, an agriculture non-governmental organization in India, is to enhance farmers' productivity by enabling them to fulfill all chores in their particular fields.
b. To give aspiring farmers sufficient opportunities by expanding their knowledge base so they might achieve great things in the future.
c. To organize training sessions and seminars to help the nation's farmers stay up to date on the newest inventions and techniques so they may apply them, gain self-confidence, and improve their farming methods.
d. As an Agriculture Non-Governmental Organization in India, we offer a forum for resolving problems associated with farming in India.



4. National Agro Foundation (NAF): Mr. C. Subramaniam, the architect of India's Green Revolution and recipient of the Bharat Ratna Award, established the National Agro Foundation (NAF) as a Public Charitable Trust in 2000 with the goal of bringing about inclusive growth and a rural revolution that places a special emphasis on agriculture and small and marginal farmers. As the mastermind behind India's "Seed to Grain" Green Revolution, Mr. Subramaniam envisioned the NAF as a sustainable platform for the social and economic advancement of farmers through a "Soil to Market" approach. Before taking over as President of India, Dr. A P J Abdul Kalam led the NAF as its Chairman of the Governing Council.

5. MYRADA: MYRADA is a non-governmental organization that was founded in 1968 and operates in underdeveloped and drought-prone regions. In 18 districts across Karnataka, Andhra Pradesh, and Tamil Nadu, we work with over a million families to establish and strengthen community-based organizations (CBOs), support livelihood initiatives, manage and develop natural resources, enhance the community's health and educational conditions, and increase the community's capacity to raise and manage resources on its own. In order to influence policies that benefit the disadvantaged, we also collaborate with governments and other partners and funders.

6. Watershed Organization Trust: WOTR is a well-established organization in Maharashtra that is engaged in comprehensive rural development initiatives. It focuses on agriculture, allied sector development, climate change adaptation, watersheds, natural resource management, social development, training, and capacity building. The organization says, "We are dedicated to transforming the lives of millions of poor villagers across India through participatory watershed development, ecosystem restoration, and climate-resilient, sustainable agriculture." They enhance farm productivity and profitability; make farming practices climate-resilient and nature-friendly, and work with communities to arrest land degradation. Their climate-resilient agriculture approach helps farmers mitigate the risks of climate change, reduce the cost of cultivation, increase productivity and enhance their adaptive capacities. It also has a special emphasis on building vulnerable communities, farmers, and women.

Conclusion

Especially when considering India, non-governmental organizations (NGOs) have a significant and varied influence on the development of the agricultural environment. NGOs make a substantial contribution to the sustainable development of agriculture by upholding their fundamental values of autonomous, voluntary, and purpose-driven activities. Together, their diverse programs—which range from policy advocacy and disaster response to technology distribution and capacity building—empower farmers, improve agricultural practices, and create resilient rural communities. NGOs equip farmers with the information and abilities required for efficient and sustainable farming techniques through their unwavering efforts. Through the dissemination of innovative technology, the promotion of sustainable farming practices, and the defense of farmer rights, non-governmental organizations (NGOs) enhance livelihoods, lower environmental impact, and boost production. NGOs collaborate with corporations, research institutes, and international organizations to foster agricultural innovation. Through this partnership, new technology, farming techniques, and market-driven strategies are developed and put into practice, strengthening the agricultural systems' long-term resilience. NGOs establish a comprehensive framework for agricultural development by tackling important issues like creating capacity, disseminating technology, sustainable agriculture, market access, women's empowerment, policy advocacy, disaster relief, and research and innovation. NGOs play a crucial role in promoting good change and advancing the goal of a more sustainable and equitable future within the intricate world of global agriculture.

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Advancements of High Hydrostatic Pressure Technology in the Food Industry

Article ID: 48809

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Introduction

In the food industry, food safety and freshness are critical considerations. Traditional heat pasteurisation procedures, while successful in microbial inactivation, frequently cause changes in food quality, such as off-flavours, texture softening and nutritional loss. Non-thermal technologies, such as high-pressure processing (HPP), are gaining traction in response to changing customer needs for minimally processed foods with increased shelf life. HPP includes submitting food to pressures ranging from 100 to 800 MPa, which successfully inactivates bacteria and enzymes while keeping nutritional and sensory properties. This novel process has numerous applications, ranging from decontaminating acidic foods to developing new food ingredients. HPP allows the food business to meet pasteurisation, preservation and processing goals without sacrificing quality. High-pressure technology, which is used in nations such as the United States, Mexico, South Korea, Spain and Japan, has had tremendous sales development, with an annual rise of $10 billion. The National Advisory Committee on Microbiological Criteria for Foods recognises this technology, which has been approved by the United States FDA and USDA, as a supplementary non-thermal pasteurisation method. HPP retains flavour, colour, quality and nutrients while removing harmful germs, so ensuring food safety and extending shelf life without the use of preservatives. As a result, it is set to transform eating habits and daily life, with applications ranging from agricultural products and food items (Wang *et al*., 2016).

Principles of High-Pressure Processing Technology

Food is a complicated three-dimensional structure made up of many elements such as protein, carbohydrates, lipids, enzymes, nucleic acids, and liquids. When exposed to high pressure, the gaps between micro molecules, such as water molecules, close, whereas bigger molecules, such as proteins, stay spherical. This pressure-induced phenomenon influences the permeation, filling, and adhesion of tiny molecules within bigger ones, changing the 3D structure of protein chains and deactivating enzymes. High-pressure processing (HPP) retains the primary structure of proteins by leaving covalent linkages unaltered. However, pressure-induced structural rearrangements, such as hydration alterations, cause enzyme deactivation. HPP damages microbial membranes, hindering reproduction and survival, and so pasteurising food. HPP alters cellular functioning by disrupting microbial membranes, which impacts nutrient delivery and waste disposal. This disturbance is caused by enzyme inactivation and membrane structural alterations, which facilitate microbial inactivation. However, it may speed up product deterioration during storage. Furthermore, HPP influences the structure of important macromolecules such as DNA and enzyme proteins, which contributes to food preservation. Microbial reproduction is influenced by various factors such as liquid quantity, sugar levels, salt concentration, pH value, and dietary components. Combining HPP with pH modification, temperature control, chemical additives, or modified environment packing can improve preservation efficacy (Rendueles *et al*., 2011).

High pressure processing (HPP) is suitable for a wide range of liquid and solid food products, particularly those sensitive to heat and highly acidic meals that inhibit spore formation. HPP operates at 600 MPa, successfully deactivating most vegetative cells, preserving food quality and natural flavours and extending shelf life. Unlike previous sterilisation procedures that rely on chemical additives, HPP-treated foods are additive-free, ensuring food safety while preserving taste. Furthermore, HPP's controllability and low susceptibility to external influences make it superior to traditional procedures that are influenced by moisture, temperature, pH and organic environments, which can promote microbe resistance. Thus, HPP offers a viable solution for improving food safety and prolonging product shelf life while maintaining product quality and consumer satisfaction and its components are shown in fig.1. (Kovac *et al*., 2010).

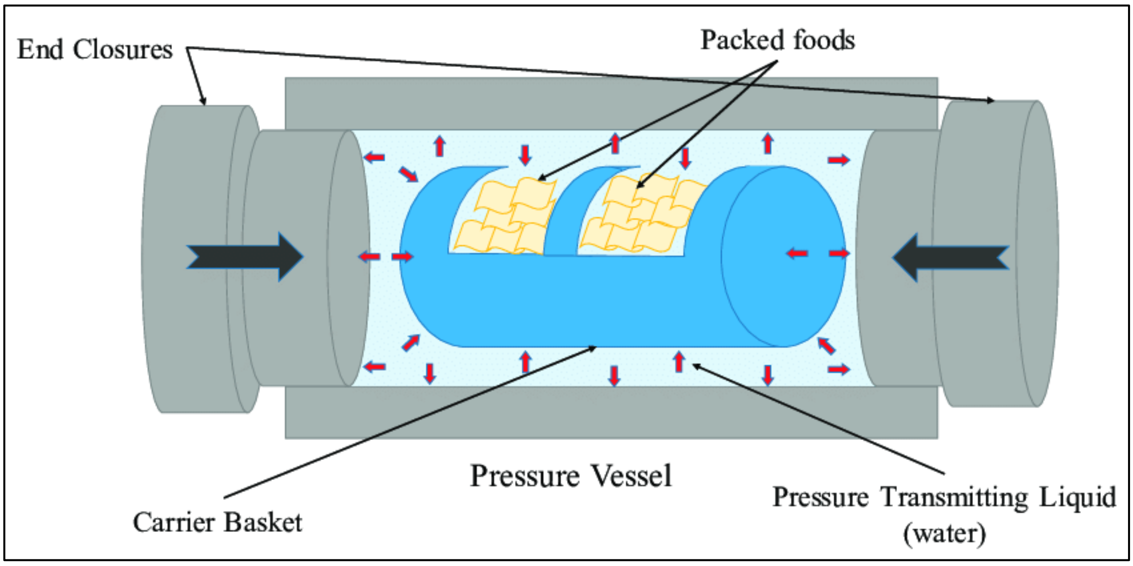

Fig.1. Components of high-pressure processing

Application of High-Pressure Processing in Food Industry

High pressure processing (HPP) demonstrates significant potential in deactivating food pathogens while preserving sensory, nutritional and functional attributes, offering substantial benefits to the food industry. This promising technology has witnessed rapid industrial adoption, particularly in stabilizing ready-to-eat meats and cured products. HPP's evolution traces back to 1899 when American scientist Hite discovered its ability to extend milk's storage period at 450 MPa. Subsequent advancements include solidifying egg whites under 500 MPa pressure and producing the first high-pressure jam in Japan in 1991. Fujichiku's introduction of pork ham under HPP in 1992 marked a transformative breakthrough, enhancing softness, moisture retention, and preservation while reducing saltiness. Some of the applications of HPP as follows:

1. Fruit and vegetable-derived products: High pressure processing (HPP) improves fruit and vegetable products by keeping greater nutrition, fresh-like flavour, and a longer shelf life than thermal pasteurisation. HPP applications intelligently combine pressure, temperature, and time to optimise texture, colour, and flavour. Studies show that HPP is efficient at preserving bioactive components in Aloe vera gel and controlling enzyme activity in orange juice. HPP-treated items include salsa, pre-chopped vegetables, organic juices and jams, which meet high requirements for colour, freshness, flavour and food safety. The expected broad availability of HPP-treated fruits and vegetables in supermarkets, restaurants and homes reflects increasing customer demand for healthier, less processed meals (Wang *et al*., 2016).

2. Egg products: High pressure processing (HPP) provides potential options for increasing the shelf life and quality of liquid egg products. HPP treatments increase foaming capability and microbiological safety while retaining qualities similar to fresh liquid eggs. Furthermore, HPP improves egg protein functions and emulsification quality, albeit the benefits differ depending on pressure level. Investigating structural and physicochemical changes during HPP is critical for optimising the functional characteristics and bioactivities of egg proteins, which have the potential to yield high-quality, microbiology-safe products (Wang *et al*., 2016).

3. Dairy products: High pressure processing (HPP) is a viable alternative for dairy product processing that preserves flavour, texture, and nutrition while minimising negative consequences. HPP-treated milk keeps its original components and has higher quantities of free amino acids than thermally processed milk. Fonterra Cooperative Group Ltd. uses HPP for milk production, which ensures active ingredient retention. HPP also shows promise in cheese manufacture by lowering bacteria populations and increasing proteolysis. Furthermore, HPP-induced alterations in milk proteins create prospects for hypoallergenic hydrolysates. Overall, HPP offers a viable method to improve dairy product safety and quality while addressing consumer demand for fresh-like goods (Wang *et al*., 2016).

4. Seafood: High pressure processing (HPP) is revolutionising seafood preservation by retaining flavour and texture while reducing infections. Unlike heat techniques, HPP enhances shelf life while maintaining quality. Research shows that it is efficient in lowering microbial development in seafood items, hence improving safety and freshness. According to studies, HPP has the capacity to maintain sensory features while preventing spoiling, resulting in a longer shelf life and higher consumer satisfaction. With applications ranging from yellowfin tuna to raw oysters, HPP is a promising alternative for seafood producers looking to improve the quality, safety, and marketability of their goods, thereby benefiting both the seafood industry and consumers (Wang *et al*., 2016).

5. Meat products: Recent improvements in high pressure processing (HPP) for meat and meat products have centred on increasing microbiological safety while maintaining qualitative features. HPP is rapidly being used globally for products such as cured gammon and precooked meals, providing increased safety without sacrificing sensory qualities. Studies are being conducted to reduce sodium level in meats by combining HPP with other procedures, hence enhancing shelf life and attractiveness. HPP also improves the freshness of poultry, with potential applications in fresh chicken breast fillets. Additionally, HPP improves the functional characteristics of muscle proteins, which benefits product texture and binding. Its ability to permeate packaging allows equal pressure treatment, which is suitable for pathogen-prone products such as sliced cooked meats (Wang *et al*., 2016).

6. Alcoholic beverages: High pressure processing (HPP) holds potential for enhancing the quality of alcoholic beverages, particularly wine and beer. In winemaking, HPP effectively inhibits spoilage microorganisms such as Brettanomyces while maintaining polyphenol components. HPP treatments in beer maintain microbiological stability while improving organoleptic characteristics without changing critical factors such as ethanol concentration. According to studies, HPP could be a viable alternative to existing procedures such as pasteurisation, decreasing the requirement for chemical preservatives like SO2. Although research on HPP in alcoholic beverages is limited, its potential to improve product quality and provide ecologically friendly solutions is clear, requiring greater investigation in the sector (Wang *et al*., 2016).

Conclusion

New non-thermal technologies offer the potential to provide safe and high-quality food. HPP can inactivate harmful bacteria and enzymes while modifying food structures without affecting nutritional or sensory quality. HPP technology combines heat pasteurisation for food safety with consumer demand for minimally processed, fresh foods. UHP processing systems have challenges such as high investment costs, limited control over process variables and lack of regulatory approval, hindering their widespread industrial application. However, high-pressure treated food can meet future demands for easy, safe, natural and nutritious food. As a result, HPP technology offers vast commercial potential.

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Nano Particles in Storage Pest Management

Article ID: 48810

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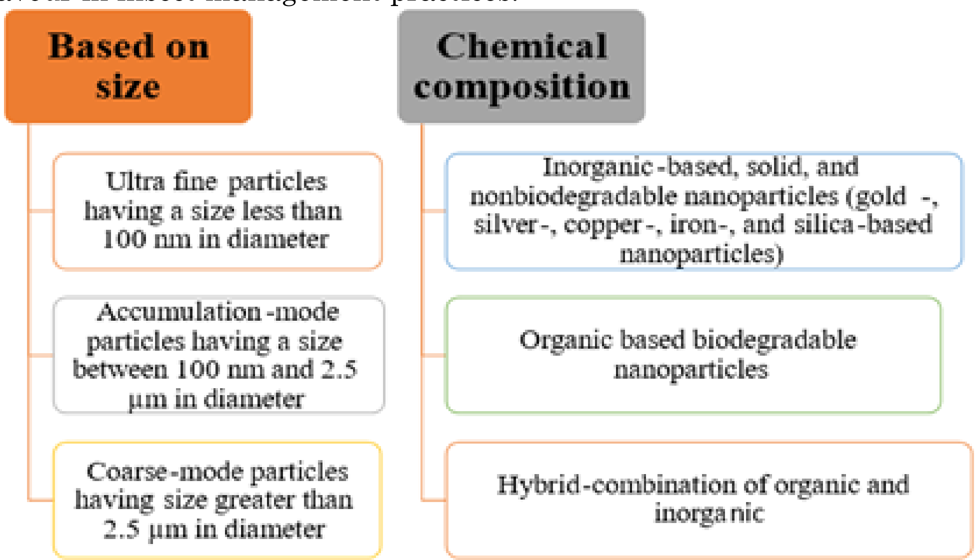
Introduction

Grain crops form a crucial component of our diet as they are rich in proteins, carbohydrates, fats, vitamins, minerals, and oils. Due to the presence of these nutrient elements, the grains of these crops are prone to infestation by insect pests during storage. Losses due to storage insect infestation can go up to **50 to 60%** under extreme situations. Sometimes, the postharvest losses can surpass the losses that crops suffer in the field. Direct losses occur in the form of direct consumption of kernels, while indirect losses include formation of webbing, exuviae, frass, and insect cadavers that significantly hamper seed quality and leave grains unfit for human consumption. Changes in the grain storage environment due to insect infestation result in the formation of warm and moist "**hotspots**" which further lead to the development of storage fungi. Rodents also cause significant storage losses. Rodents not only eat grains, but also contaminate more than 20% of their diet with faeces, urine and hair. Eventually, insects are a larger proportion in stored grain pests. Hence, it is very vital to optimize proper management practices for storage pests. Today when agriculture is facing major challenges of environmental contamination, pest resistance, bioaccumulation, and health hazards, nanotechnology is emanating as a highly attractive tool to achieve the target of lowering the quantity of pesticide used by offering new methods for the formulation and delivery of pesticide active ingredients, as well as novel active ingredients, collectively referred to as nano pesticides. Nanotechnology will overcome the limitations associated with conventional pesticides by enhancing pesticide efficacy, improving stability of active ingredients. Metal based nano pesticides are gaining notable stance in pest management. Nano science can be used extensively in controlling stored product pests.

Nanoparticles

It is a particle of matter 1 to 100 nanometers (nm) in diameter. Word "nano" emerged from the Greek word "dwarf". This kind of particle size has benefits like slow-release technology, long persistence in environment etc., which can favour in insect management practices.



Classification of Nanoparticles

Nanoparticles for stored pest management: Inorganic-based nano pesticides are tested more in pest management and plant-based nanoparticles are more effective for stored pest management as they are environmentally safe and are easy to develop.

Types of Nanoparticles

1. Silver nanoparticles - (AgNPs): Used as carriers for delivering agrochemicals to the targeted site. Exhibit insecticidal, bactericidal, antifungal, and antiviral properties. They possess high chemical stability, electrical conductivity. Used against rice weevil-*Sitophilus oryzae.*

2. Aluminium Oxide Nanoparticles- (Al2O3NPs): Nanostructured alumina (NSA) dust or aluminum nanoparticles are used. Nano alumina can be a **good alternative** to harmful dust formulations based on diatomaceous earth. **Entomotoxins** made from aluminium nanoparticles were effective against *Rhizopertha dominica.*

3. Titanium Dioxide Nanoparticles- (TiO2NPs): These nanoparticles have low toxicity and minimal non-target biological effects. The main advantage of using titanium dioxide formulations in storage is **less ecological harm** to non-target species. Effective against *Tribolium castaneum*.

4. Zinc Oxide Nanoparticles -(ZnONPs): Zinc oxide nanoparticles have been used for because of their remarkable **antimicrobial**, physical, and optical properties. Zinc oxide nanoparticles reduces **fecundity, total development period**, and causes 100% mortality of **pulse beetle**-*Callosobruchus chinensis.*

5. Silicon Dioxide Nanoparticles -(SiO2NPs): These are also known as silica nanoparticles and have higher thermal stability, low toxicity, and excellent biocompatibility with a range of molecules and polymers. These can act as excellent nanocarriers. They have the capacity to attach to plant surfaces and hair of insects through which they enter into the insect body and affect their body functions. Effective against *Tribolium castaneum*.

6. Nano emulsions: These nano emulsion formulations can improve the effectiveness of botanical insecticide. It is cheaper as it requires **less active ingredient** as water solubility is high. Storage stability is quite high under a broad range of temperatures (−10–55° C). Effective against *Sitophilus oryzae.*

7. Polymer-based nano pesticide formulations: Used for controlled release formulations of insecticides, herbicides. Polymers deployed for nano pesticide formulations consist mainly of polysaccharides and polyesters. Polyethylene glycol is mostly used. When loaded with essential oil, they effectively control *Tribolium castaneum.*

Conclusion

Nanoparticles have many advantages like small size, slow release, long persistence in environment action and they also reduce usage of chemicals. Even their long persistence is benefit in pest management, their effect should be considered as storage confined environment. Also, the biodegradability of nanoparticles and toxicity is a major concern which has to be investigated.

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Diabetes Mellitus: An Overview

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Abstract

Diabetes, a chronic health condition marked by elevated blood sugar levels (glucose), occurs due to insufficient insulin production or ineffective insulin utilization in the body. Managing the distinct causes and treatments of various diabetes types, including Type 1, Type 2, and Gestational diabetes, is crucial for successful management. Long-term complications associated with diabetes, such as cardiovascular diseases, neuropathy, and kidney dysfunction, highlight the importance of proactive management to mitigate their impact on overall well-being. Effective diabetes care involves close collaboration with healthcare providers, adherence to prescribed medications, and regular monitoring of blood sugar levels. Addressing diabetes requires a comprehensive approach that considers both medical interventions and lifestyle adjustments. By diligently managing the condition and adhering to preventive measures, individuals with diabetes can lead fulfilling lives while minimizing the risk of complications and improving their overall health. Continued research efforts and public health initiatives are essential for advancing understanding and management of this complex condition.

Introduction

Diabetes is a prevalent chronic health condition in India, characterized by elevated levels of blood sugar (glucose) in the body. It occurs when the body either doesn't produce enough insulin or can't effectively use the insulin it produces affecting around 77 million adults aged 18 and above with Type 2 diabetes. Additionally, there are approximately 25 million individuals classified as prediabetic, indicating a heightened risk of developing diabetes soon. The overall prevalence of diabetes in India is reported to be 11.4%, with a notable increase in new cases recorded between 2019 and 2021. This surge in diabetes cases can be attributed to various lifestyle factors such as easy access to abundant food, frequent consumption of fast food, inadequate sleep, reduced physical activity, and heightened stress levels. Economically and epidemiologically developed states like Tamil Nadu and Kerala exhibit particularly high rates of diabetes prevalence.

Diabetes can lead to severe health risks if not managed effectively. Type 2 diabetes is the most common type globally and poses risks of heart disease, nerve damage, and eye complications. Comprehensive management strategies involving medication, lifestyle modifications, and personalized care plans are essential for managing diabetes effectively. Preventive measures include maintaining a balanced diet, staying physically active, and addressing risk factors such as obesity and family history. Recognizing symptoms like increased thirst and frequent urination and seeking regular medical supervision are crucial for improving outcomes and enhancing the quality of life for individuals with diabetes.

Types of Diabetes

Diabetes manifests in several forms, including Type 1, Type 2, and Gestational diabetes, each with distinct causes and treatments. Type 1 diabetes results from an autoimmune attack on insulin-producing pancreatic cells, while Type 2 diabetes stems from insulin resistance leading to decreased insulin production.

Gestational diabetes arises during pregnancy due to hormone-induced insulin blockage. Other rarer types include Maturity Onset Diabetes of the Young (MODY), Neonatal diabetes, and syndromic forms like Wolfram and Alström Syndromes. Differentiating between Type 1 and Type 2 diabetes hinges on their etiology and therapeutic approaches. While Type 1 necessitates insulin injections owing to impaired insulin production, Type 2 is managed through lifestyle modifications, medications like Metformin, and occasionally, insulin therapy.

Etiology of Diabetes

The etiology of Type 1 diabetes involves an autoimmune reaction targeting pancreatic beta cells, culminating in reduced insulin production and elevated blood sugar levels. Although its precise triggers remain elusive, genetic predisposition, family history, and environmental factors such as viral infections are implicated. Genetic predisposition, familial history, geographical influences, and age peaks in children also contribute to Type 1 diabetes risk. Environmental factors like viral infections further exacerbate this autoimmune response.

Type 2 diabetes is chiefly driven by factors such as excess weight, sedentary lifestyle, insulin resistance, and genetic susceptibilities. Inadequate response to insulin or diminished insulin secretion leads to impaired glucose utilization and subsequent hyperglycemia. Lifestyle modifications, including dietary adjustments, physical activity, and medication adherence, are essential for effective Type 2 diabetes management. Collaborating with healthcare providers to craft personalized care plans ensures comprehensive control of blood glucose, blood pressure, and cholesterol levels. Timely diagnosis and vigilant monitoring of symptoms like thirst, urination, fatigue, and unexplained weight changes facilitate early intervention and disease management.

Complications of Type 2 Diabetes

Long-term complications of Type 2 diabetes encompass a spectrum of health issues that significantly compromise well-being and overall health. These include cardiovascular ailments like heart disease and stroke, vision impairments, foot ulcers, neuropathy, kidney dysfunction, and microvascular complications affecting small blood vessels. Proactive management through lifestyle modifications, medication compliance, and regular medical assessments is pivotal in mitigating these complications' impact.

Preventive Strategies

While preventive strategies for Type 1 diabetes remain under exploration, current efforts focus on averting environmental triggers and antigen-specific interventions to arrest or reverse the autoimmune process. Despite strides in diabetes management technologies, Type 1 diabetes remains incurable, with considerable long-term complications. Identification of at-risk individuals and vigilance in monitoring symptoms aid in timely intervention, although preventive measures for Type 1 diabetes await further advancements.

Dietary Recommendations for Managing Diabetes

Foods to Avoid:

a. **Processed Meats:** Bacon, ham, and salami are high in harmful chemicals and linked to diseases like cancer and heart disease. Opt for lean proteins such as chicken, turkey, tuna, or hard-boiled eggs.

b. **Full-Fat Dairy:** High in saturated fats, full-fat dairy products increase the risk of heart disease and obesity. Replace them with low-fat or non-fat options, or try non-dairy alternatives like almond or soy milk.

c. **Packaged Snacks and Processed Baked Goods:** These often contain refined sugar, unhealthy fats, and additives. Choose healthier alternatives like hummus with veggies, almonds, or apple slices with nut butter.

d. **White Carbohydrates:** White bread, rice, and pasta cause blood sugar spikes and weight gain. Opt for whole grain alternatives like brown rice, quinoa, and whole grain bread and pasta.

e. **Sweetened Breakfast Cereals:** High in added sugars, many breakfast cereals lead to blood sugar spikes. Choose oatmeal, homemade granola, or low-sugar cereals instead.

f. **Dried Fruits:** While they offer fiber, dried fruits are high in sugar. Opt for fresh fruits like apples or bananas for a healthier snack.

g. **French Fries:** Deep-fried in unhealthy fats, French fries are high in calories and detrimental to diabetes management.

Foods to Include:

a. **Fiber-Rich Foods:** Non-starchy vegetables, whole grains, and legumes help stabilize blood sugar levels and keep you feeling full. They also have a low glycemic index.

b. Protein-Rich Foods: Lean proteins like chicken, turkey, fish, and plant-based sources provide essential energy and promote satiety.
c. Fruits: Choose low to medium glycemic index fruits for their vitamins, minerals, antioxidants, and fiber.
d. Healthy Fats: Incorporate sources like olive oil and avocado for essential fats that support heart health.
e. Unsweetened Drink: Opt for unsweetened beverages like tea, coffee, or flavored sparkling waters to avoid added sugars and maintain stable blood glucose levels.

By prioritizing nutrient-dense, low glycemic index foods and avoiding processed, sugary, and high-fat options, individuals with diabetes can better manage their condition and reduce the risk of complications.

Conclusion

Diabetes poses a significant global health challenge, particularly with Type 2 diabetes being the most widespread form, carrying substantial risks of complications if left unaddressed. Managing diabetes effectively demands a comprehensive strategy involving medication, lifestyle adjustments, and personalized care plans tailored to each patient's unique needs. Vital preventive measures, including maintaining a balanced diet, staying physically active, and addressing risk factors like obesity and family history, play a pivotal role in mitigating the disease's onset and progression.

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Understanding the Postharvest Management of *Khasi* Mandarin (*Citrus reticulata*)

Article ID: 48812

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Khasi mandarin is one of the most important commercial fruit crops of Northeast India. Most of the mandarin orchards of the region are 20-50 years old and the fruits produced become crucial for fetching premium prices, moreover this existing tress needs either replanting or rejuvenation. And due to absence of proper pre and postharvest management practices, a bulk quantity of mandarin gets damaged during the process of handling, transportation, marketing and storage. The mandarins of the region are somewhat larger than a tennis ball, are bright orange in color, while on the inside, there is a sweet, aromatic juice. The fruits are traditionally harvested between November and February, and the villagers use a woven bamboo tool for collecting the mandarins, allowing them to gently pick the fruit without any damage. Interestingly, according to a local belief, *Khasi* mandarin possesses the ability to calm angry people, so it is often given as a present to make up for past offenses.

An approximate postharvest loss in orange in India is reported to be 13.95% which is approximately Rs.4.33 crores, mainly due to losses during handling and marketing (Table 1). Postharvest losses of orange at various stages of handling is categorized as mentioned below-

Table 1. Stages of postharvest losses of mandarin:

Stage Loss	(in %)
Harvesting	3.25
Grading	0.75
Transportation	1.25
Marketing/Storage	
Wholesaler	1.20
Retailer	7.50
Total loss	**13.95**

Harvesting

Harvesting of the produce in time reduces the postharvest losses to maximum extent and harvesting at proper maturity allows handlers to begin their work with the best possible quality produce. Harvesting at immature/improper stage results sub-standard qualities of the fruits and harvesting at over ripe stage reduces the sensory quality and shelf life of the fruits remarkably. Besides, it reduces the yield in subsequent years and in extreme cases alternate bearing of the plants is also observed. Pickers can be trained in methods of identifying produce that is ready for harvest. A proper time of harvesting provides better quality and more shelf life of crops. Maturity indices play a significant role in judging the appropriate stages for harvesting *Khasi* mandarin for its market value, shelf life, nutritional and sensory qualities. The following indices may be taken into consideration while harvesting *Khasi* mandarin.

Table 2. Maturity indices of *Khasi* mandarin.
1. Rind colour (visual): Yellow orange
2. Juice content (%): >49.00
3. Days from flowering to harvesting: 230-250
4. TSS (°B), total soluble solids: 9.5-10.0
5. Titrable acidity (% as citric acid): 0.75-.081
6. TSS: Acid: 12.38-12.97

Fruit harvesting by fruit clipper reaching to individual fruits in tree canopy by standing on ladders, collection of fruits in cloth bags tied around the waist of the picker are suggested as improved harvesting methods. Trails conducted at NRC for Citrus, Nagpur, showed that by following improved harvesting methods, 158 fruits could be harvested in one hour time and clipping fruit peduncle close to fruit helps in avoiding puncture injury to other fruits. Attempts have also been made to use PVC (polyvinyl chloride) tubes through which harvested fruits are rolled down to the ground.

Postharvest Handling for Shelf-Life Extension

The shelf life of the fruits could be increased up to 25-30 days when the fruits harvested at optimum maturity are treated with stay fresh wax (1 part wax + 2 parts water). The treated fruits will have minimum weight loss (5-7%) and higher retention of ascorbic acid during storage.

Two pre harvest sprays with 0.1% Bavistan during August and September

↓

Harvest fruits at optimum maturity (yellow orange/orange colour stage)

↓

Sorting and grading

↓

Washing the fruits with chlorinated (100 ppm) water

↓

Drying (removal of surface moisture)

↓

Treatment of fruits with stay fresh wax (1 part wax + 2 parts water)

↓

Drying (removal of surface moisture)

Fig.1. Pre and postharvest handling for shelf-life extension

Packaging

Improved corrugated fibre board (CFB) boxes have been developed by Assam Agricultural University, Jorhat for long distance transportation of *Khasi* mandarin. The post-harvest loss during transportation by truck (1000 km) was less than 15 in CFB boxes as against 10.82% in wooden boxes. The cost of each box with an accommodation capacity of 128 fruits is Rs. 40-45 only.

Table 3. Specification of CFB boxes:

Parameters	Corrugated fibre board (CFB) box
Internal dimension (L x W x H) in mm	420x300x320
No to ply	5
Breathing holes	12 Nos. of circular holes (2 cm diameter)
Capacity	128 nos. of mandarin
Stock load	120 kg

Table 4. Loss reduction during transportation by using CFB boxes:

Type of boxes	Loss during transportation (1000 km by truck)		
	Bruising loss (%)	**Decay loss (%)**	**Total loss (%)**
CFB box	Nil	0.78	0.78
Wooden box	6.66	4.16	10.82
Bamboo box	3.00	4.22	7.22
Plastic crates	5.33	3.11	8.44

Degreening

Degreening is sometimes done to improve fruit colour by removing green chlorophyll using ethephon, an ethylene releasing compound, as post-harvest treatment. Degreening should be done only when it is a must as degreening normally shortens shelf-life of mandarins. ICAR-NRC for Citrus, Nagpur, has developed degreening unit using polyurethane foam insulated steel panels and fitted with humidifying, cooling and heating units having suitable control measure.

Control of Postharvest Diseases

The stem-end rot caused by *Botryodiplodia* sp. and *Alternaria citri* is commonly experienced. Post-harvest decay of mandarin oranges due to infection of various pathogens (*Botryodiplodia theobrommae*, *Colletotrichun gloeosporioides* and *Alternaria citri* as pre-harvest pathogens) can be controlled to a great extent by the measures mentioned below.

1. Three pre-harvest sprayings (45, 30 and 15 days before harvesting with benzimidazole covering the whole canopy controls stem-end rot disease effectively.
2. The post-harvest diseases caused by *Penicillium*, *Aspergillus* and *Geotrichum* spp. can be controlled by (a) washing fruits with chlorine water and (b) dipping them for 5 minutes in benzimidazole fungicides.

Table 5. Post-harvest treatments of citrus fruits for their storability:

Mandarin orange	Treatments	Storage temperature & RH	Storage period(d)
Nagpur	Wax 2.5% + Carbendazim (2,000 ppm) + vented PE	20-35°C, 50-60% RH	21
Khasi	Wax 3% + Benlate 350 ppm + PE	11-19°C	24
Coorg	Wax 3% + 2,4-D 100 ppm + PE	20-16°C	21
Darjeeling	2% Phenol	40°F	20
Kinnow	Wax 6% + Polyethylene	1-3°C, 85-90%	90
Kinnow	Wax 6% + diphenyl paper wrapping	19±8°C	90

Storage

Khasi mandarin could be kept in marketable condition for 12-15 days at ambient condition if they are harvested at optimum maturity (i.e., 230-250 days after flowering). The shelf life of the fruits could be extended up to 25-30 days if they are treated to stay fresh. At evaporative cool storage, the fruits of optimum maturity could be kept for 30-31 days with a cumulative decay loss of 27.49%. Likewise at cold storage (7-8°C) the shelf life of the fruits is about 40-45 days. For marketing of cold stored mandarin, cold chain must be maintained throughout the distribution system.

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Automated Oasis: Enhancing Agriculture with Drip Irrigation Automation

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Abstract

Automated Oasis is a groundbreaking technological advancement poised to revolutionize modern agriculture through its innovative implementation of drip irrigation automation. This system represents a paradigm shift in agricultural practices, seamlessly integrating automation technology with traditional irrigation methods to maximize efficiency and sustainability. By employing sophisticated sensors and algorithms, Automated Oasis optimizes water usage by precisely delivering water directly to the roots of plants, minimizing wastage and ensuring optimal hydration levels for crops. This not only conserves water resources but also enhances crop yields and quality. Furthermore, the automation feature eliminates the need for manual intervention, saving farmers valuable time and labour costs. With Automated Oasis, agriculture enters a new era of precision and productivity, paving the way for a more sustainable and prosperous future in food production.

Keywords: Automated, Sensors, Enhanced, Hydration

Introduction

By 2050, experts predict that the global population will reach 9.15 billion, with 24.5% of that number residing in South Asia. Forecasts indicate that cereal output will rise from 2.1 billion tons to 3 billion tons, reflecting the importance of cereals in the human diet. Twenty percent of the world's wheat and thirty-one percent of its rice are grown in the South Asian area, making it a vital breadbasket. Total global grain output would have climbed by 50.1% from 2010 levels by 2050, while South Asian cereal production will have increased by 62.7% under the no-climate-change scenario.

The social and environmental effects of changing populations and climate, as well as their consequences for long-term sustainability, are linked to water supply. One of the world's most pressing problems, water shortage results from an imbalance between supply and demand for water. From 3500 to 5425 km3—a 55% increase—is predicted to be the global water consumption from 2000 to 2050. Water and food production throughout the globe will be negatively affected by climate change, with severe regional unpredictability and shortage. Given that 94% of arable land is already in use and 58% of agricultural regions are confronting several climate dangers, including water scarcity and severe heat stress, meeting this anticipated demand in South Asia is doubly difficult. Although roughly a quarter of the world's population resides in South Asia, the region's nations and river basins provide an unequal 4.6% of the world's renewable water resources every year. Despite rising populations, South Asia's per capita water availability remains below the global average. Crops grown for grain need a disproportionate amount of water compared to other agricultural inputs, and this is true across the board in the area.

The region's water resources are highly variable over time, there is a significant disparity between the amount of water available and the amount needed for various purposes, and surface and groundwater resources are being used at an unsustainable rate to satisfy this demand. Agricultural water usage accounts for an extremely high 91% of total water consumption in South Asian nations, with a range of 90% to 98%.

Importance in Agriculture

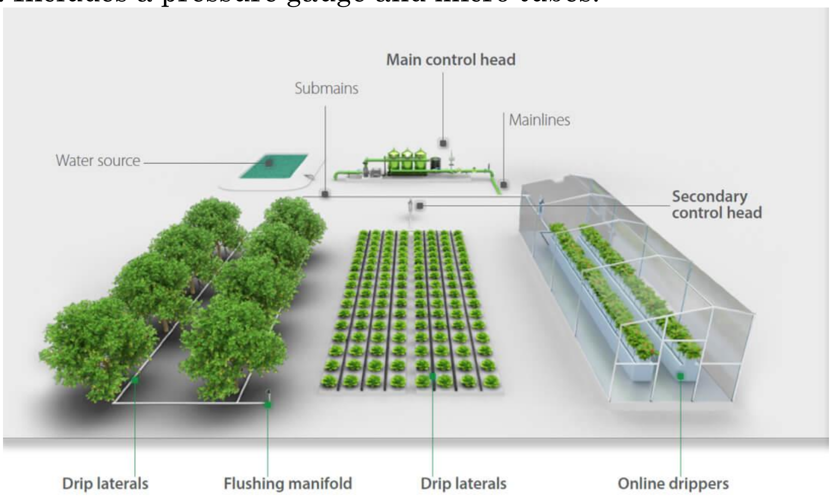
An innovative and cost-effective irrigation technique, drip irrigation (or micro-irrigation) reduces water loss and evaporation by delivering water directly to plant root zones. It guarantees efficient water distribution while using half as much water as conventional systems. Because of the fine control it provides over the supply of fertilizer and nutrients, drip irrigation also helps to save nutrients. Because it's automatable, farmers will have more freedom and less need for human labour. In addition to lowering labour requirements and helping to sustainable agriculture, the effectiveness of drip irrigation has made it a popular choice among farmers and homeowners throughout the globe.

1. Micro-irrigation minimizes water loss due to evaporation and runoff by directing water directly to the plant's root zone.
2. It makes plants healthier by lowering their vulnerability to pests and diseases and maximizing their uptake of water.
3. It helps plants absorb more water, which reduces weed growth.
4. It allows for more accurate administration of fertilizers and other nutrients that are water-soluble, leading to better nutrient absorption.
5. It can be readily adjusted to various soil types, topographies, and crop varieties because to its versatility.
6. It saves energy compared to conventional sprinkler systems since it uses less pressure and flow.
7. Micro-irrigation solves several problems associated with agricultural expansion and is therefore a technique that allows for sustainable agriculture. With the right knowledge and efficient subsidy programs, governments can boost the use of this new technology.

Parts of Drip Irrigation System

Drip Irrigation System Components-

1. Pump station: Provides water from the source and maintains the right pressure for delivery into the pipe system.
2. Control valves: Control the discharge and pressure in the entire system.
3. Filtration system: Cleans the water using screen filters and graded sand filters.
4. Fertilizer tank/venturi: Slowly adds a measured dose of fertilizer during irrigation.
5. Mainlines, submains, and laterals: Supply water from the control head into the fields.
6. Emitters or drippers: Control the discharge of water from the lateral to the plants.
7. By-pass assembly: Includes a pressure gauge and micro tubes.



Crops Suitable for Drip Irrigation

1.	Orchard Crops	Grapes, Banana, Pomegranate, Orange, Citrus, Mango, Lemon, Custard Apple, Sapota, Guava, Pineapple, Coconut, Cashewnut, Papaya, Aonla, Litchi, Watermelon, Muskmelon etc.
2.	Vegetables	Tomato, Chilly, Capsicum, Cabbage, Cauliflower, Onion, Okra, Brinjal, Bitter Gourd, Ridge Gourd, Cucumber, Peas, Spinach, Pumpkin etc.
3.	Cash Crops	Sugarcane, Cotton. Arecanut, Strawberry etc.
4.	Flowers	Rose, Carnation, Gerbera, Anthurium, Orchids, Jasmine, Dahilia, Marigold etc.
5.	Plantation	Tea, Rubber, Coffee, Coconut etc.
6.	Spices	Turmeric, Cloves, Mint etc,
7.	Oil Seed	Sunflower, Oil palm, Groundnut etc.
8.	Forest Crops	Teakwood, Bamboo etc.

Wetting Patterns in Drip Irrigation

When compared to other approaches, drip irrigation may only soak a small fraction of the soil's root zone—as little as 30 percent. The patterns of wetness are affected by factors like as discharge and soil type. Even if just a tiny area of the root zone gets wet, it is essential to satisfy the crop's total water need. Drip irrigation decreases soil evaporation, surface runoff, and deep percolation, but it does not decrease crop water usage. Both the equipment and its user determine the extent to which these savings are possible. While there are alternative techniques that may be used instead of drip irrigation, it is most effective in locations where the water quality is poor, on ground that is very hilly or undulating, when water or labour is costly, or when growing valuable crops that need to be watered often.

Futuristic Technologies Implementation

There are a number of new technologies on the horizon that have the potential to make smart irrigation systems even more efficient and successful in the future.

By analyzing meteorological data and projecting future water demands, smart irrigation systems are already making use of artificial intelligence (AI). By anticipating plant growth patterns and modifying watering schedules appropriately, this technology has the potential to optimize water consumption even more as it develops.

Drones: Drones are now finding usage in farming as a means to monitor crop development and identify damage. Drones have the potential to aid smart irrigation systems in the future by providing real-time data on soil moisture levels.

The term "Internet of Things" (IoT) refers to a system of interconnected computing devices that may exchange data both locally and remotely. Future smart irrigation systems may be able to optimize water consumption even further by connecting to other Internet of Thing's devices like weather sensors and soil moisture sensors.

Machine Learning: This branch of artificial intelligence enables computers to acquire new skills and knowledge by analyzing existing data. Further optimization of water consumption and improvement of crop yields might be achieved with the application of machine learning algorithms as more data is gathered from smart irrigation systems.

Conclusion

In conclusion, the implementation of a Drip Irrigation Automation system marks a significant advancement in agricultural technology, offering a myriad of benefits for farmers and the environment alike. Through the precise delivery of water directly to plant roots, this system optimizes water usage, reduces wastage, and enhances crop yields and quality. Furthermore, the integration of automation technology eliminates the need for manual intervention, saving farmers valuable time and labour costs. Overall, Drip Irrigation Automation represents a crucial step towards sustainable and efficient agriculture, enabling farmers to produce more with fewer resources while minimizing environmental impact. As we continue to innovate and refine such systems, the future of farming looks increasingly promising, with the potential to meet the growing demands for food production while preserving our precious natural resources for generations to come.

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Smartphone Usage During Meals and its Impact on Caloric Intake in People: An Overview

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Abstract

In recent years, smartphones have become ubiquitous in our daily lives, influencing various aspects of our behavior, including eating habits. While smartphones offer convenience and entertainment, emerging research suggests a potential link between smartphone usage during meals and increased caloric intake, particularly among young people. This overview aims to synthesize the relationship between smartphone usage and caloric intake, shedding light on the potential implications for health and well-being.

Introduction

In today's modern world, smartphones have become indispensable tools for billions of individuals, seamlessly integrating into various aspects of daily life. However, despite their undeniable advantages, concerns have arisen regarding the adverse effects of excessive smartphone usage, particularly on dietary habits and overall lifestyles. With an estimated 6.4 billion smartphone users worldwide, these devices have become ubiquitous, often being the first thing individuals interact with upon waking up. On average, users spend approximately 3–4 hours per day on their smartphones, engaging with a multitude of applications. This constant connectivity throughout the day has revolutionized how we interact with technology, even extending to mealtime routines. The incorporation of smartphones into mealtime activities has raised concerns about their potential to disrupt healthy eating habits. Similar to the distractions posed by television, using smartphones while eating can lead to mindless consumption and a subsequent increase in calorie intake, especially from high-fat foods. Research has shown that engaging in distracting activities, such as smartphone use during meals, can hamper individuals' ability to monitor their food intake, thereby contributing to overeating. Furthermore, studies have explored the correlation between excessive smartphone use and the heightened risk of obesity, particularly among younger demographics who tend to multitask with media. This phenomenon underscores the need to address the impact of smartphone addiction on dietary behaviors and overall health. In essence, while smartphones offer myriad benefits, their overuse can have detrimental effects on dietary choices and lifestyle habits. Recognizing and tackling these issues is paramount for promoting healthier behaviors in an increasingly digital-centric society. Conversely, some argue that the convenience offered by smartphone apps may serve as a significant societal driver of unhealthy eating. Notably, the popularity of phone-based food delivery apps has surged over the past decade. While certain apps may facilitate a healthy diet, the majority of those offering delivery services disproportionately provide access to "junk" food. Consequently, frequent users of such apps may experience an increase in weight as a result of their dietary choices.

Impact of Smartphone Usage on Eating Behavior

Numerous studies have delved into the impact of smartphone usage on eating behavior, providing valuable insights into how digital distractions can influence food consumption. Evidence suggests that individuals tend to consume larger portions and eat more rapidly when using smartphones during meals, resulting in heightened caloric intake. Furthermore, the diversion caused by smartphone usage may disrupt satiety signals, diminishing individuals' awareness of their food intake and increasing the likelihood of overeating. Smartphones have the potential to alter appetite regulation and elevate the risk of weight gain. However, it's important to note that changes in eating behavior attributed to smartphones may not solely be due to the technology itself. These effects may align with well-established psychological processes such as social facilitation or attentional limitations, which can also impact appetite control and memory encoding.

Research by Tebar *et al*. 2021 during the COVID-19 pandemic revealed that increased smartphone use was associated with a higher likelihood of consuming sweetened foods. This trend was also observed among individuals who watched more television but not among those who reported increased computer use. However, given the multitude of factors influencing dietary behavior, the direction of these effects may not always be straightforward. Engaging with highly distracting content could lead to both overeating and undereating, with variations across different groups. Moreover, studies have shown a positive correlation between the frequency of media multitasking and body mass index (BMI), suggesting that screen time technologies may divert attention from internal.

Psychological Mechanisms

The relationship between smartphone usage and increased caloric intake is underpinned by several psychological mechanisms. One such mechanism is cognitive distraction, which arises from the attentional demands of smartphone activities. This distraction diverts focus away from the sensory experience of eating, thereby impairing the ability to regulate food intake effectively. Additionally, the rewarding nature of smartphone interactions, such as engaging in social media or gaming, can create a conditioned response that reinforces eating behaviors. This can lead to mindless snacking and excessive consumption as individuals seek gratification through their smartphone use.

Implications for Health

The consequences of heightened caloric intake linked to smartphone use during meals reach beyond immediate dietary impacts. Persistent overeating can fuel weight gain and obesity, elevating the risk of developing associated health complications such as cardiovascular disease, type 2 diabetes, and metabolic disorders. Moreover, excessive smartphone use during meals may encourage sedentary behavior and undermine mindful eating practices, thereby compromising overall dietary quality and nutritional intake.

Recommendations for Behavior Modification

Addressing the detrimental effects of smartphone usage on eating behavior requires multifaceted interventions aimed at promoting mindful eating and reducing digital distractions during meals. Strategies may include establishing designated "phone-free" mealtimes, creating awareness of smartphone usage patterns, and fostering mindful eating practices through sensory engagement and portion control. Additionally, raising awareness among young people about the potential health consequences of excessive smartphone use during meals is essential for promoting healthier eating habits and lifestyle choices.

Conclusion

In summary, the correlation between smartphone usage and caloric intake in young individuals highlights the necessity for heightened awareness and proactive steps to alleviate the negative impacts of digital distractions on eating behavior. Encouraging mindfulness and limiting smartphone use during meals can foster healthier dietary practices and improve overall well-being. Researchers emphasize the significance of implementing robust nutrition education and awareness initiatives to instill healthy lifestyle habits among students and counteract the detrimental effects of smartphone addiction. These interventions play a critical role in guiding students towards healthier dietary decisions, enhancing sleep quality, boosting physical activity levels, and ultimately promoting holistic well-being.

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Preventive Weed Management Strategies in Direct Seeded Rice

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Abstract
Direct-seeded rice (DSR) is gaining popularity in Asia as a resource-efficient alternative to puddled transplanted rice (PTR), however, weed management poses a significant challenge in DSR systems. In this context, preventive approaches, focusing on restricting weed propagule dispersal and persistence, emerge as crucial complements to curative tactics like herbicide use. It includes minimizing weed seed production in fields and adjacent areas, practical methods for seed dispersal prevention, and the potential of seed predation and decay. Successful integration of preventive measures necessitates interdisciplinary approaches that balance biological effectiveness, economic feasibility, and social acceptability.

Introduction
Rice cultivation in Asia traditionally relies on puddled transplanted rice, which offers benefits like weed control and improved nutrient availability but poses challenges such as soil degradation, high water usage, and labor intensity. Direct seeding of rice (DSR) emerges as an alternative, avoiding nursery raising and water inundation, yet faces weed competition due to the absence of size disparity between rice and weeds and limited water availability. The critical period for weed competition in DSR is up to 41 days after sowing, but a weed-free situation until 70 DAS is preferable for higher productivity. Weeds, if not controlled during this period, can reduce yields by 15 to 100 per cent. Therefore, the development of an effective weed management program for DSR is needed such as prevention, cultural, mechanical, chemical, and biological. Out of which, prevention is the most basic of all weed control methods which restricts the introduction and spread of weeds, therefore it is essential to understand different preventive weed management strategies.

Preventive Weed Management
Preventive weed management techniques are carried outside of the agricultural production area (in neighbouring bunds, irrigation canals, or seed distribution channels) or before the crop is planted (during fallow times or in rotating crops).

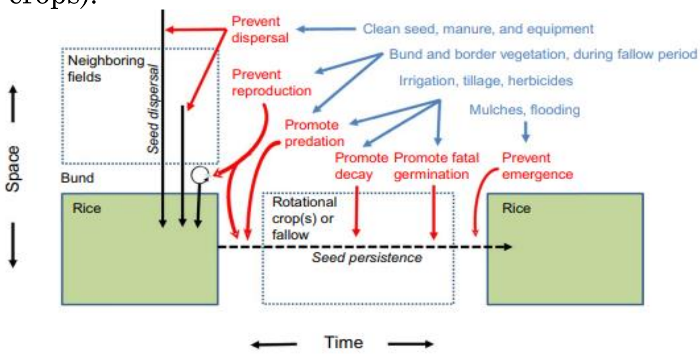

Fig.1. Conceptual Framework of preventive weed management in direct seeded rice

The important strategies involve to limiting the time and space at which weed propagules can disperse and survive as well as establishing barriers that stop weeds from emerging within the crop. These strategies include:

1. Preventing Reproduction: Effective control of weed seedbanks over the long run, stopping weed reproduction is essential. If seed production is stopped for a few years, weed seedbank densities can be drastically decreased; if seed production is permitted, however, weed densities can rise quickly. A major objective in DSR is to minimize seed rain. Propagules of important weeds in DSR are produced in fallow fields or in field borders, bunds, or fallow fields outside of the rice field itself. Preventing the formation of weed seeds in fields and irrigation channels adjacent to DSR production zones can pose significant logistical and cost challenges. This is mainly because the ownership and management of these areas typically differ from those of the DSR fields. Apart from that rice farmers might hesitate to clear weeds from bunds because they perceive them as valuable sources of green fodder, a method of safeguarding bunds against erosion, or as habitats for beneficial insects. To control weeds,

a. Rotate crops strategically,
b. Use cover crops or green manure crops
c. Apply mulches,
d. Use mechanical methods
e. Use selective herbicides.

2. Prevent Dispersal: The movement of weed seeds via crop contamination is an important mechanism of dispersal in DSR systems, since high seeding rates are used, and the seeds are sown directly into the main field. Weeds which mature at the same time as rice are often harvested and threshed with the rice, resulting in contamination. The control measures are:

a. Screening and using certified rice seeds.
b. Sanitizing planting and harvesting equipment between infected and non-infected fields.
c. Filtering irrigation water flow at field entry points with nylon nets or collecting and removing floating weed seeds from the water surface.
d. Providing cattle with certified feeds or feeding with fodder devoid of weed seeds would reduce weed seed dissemination by cattle.

3. Promoting seed decay: Decay of weed seeds in the soil may occur due to microbes or aging and senescence. The strategies to promote decay are:

a. Adopting tillage methods such as shallow tillage or reduced tillage can promote conditions conducive to faster decomposition of weed seeds by enhancing microbial activity and soil oxygenation.
b. Use of organic amendments such as compost or crop residues can enhance microbial activity and promote the breakdown of weed seeds through microbial degradation.
c. Proper irrigation strategies can create conditions that promote faster decomposition of weed seeds, ultimately reducing their viability and potential for germination.

4. Promoting Predation: Promoting predation as a means to manage weed seeds in direct-seeded rice involves:

a. Encouraging natural predators that feed on weed seeds such as birds, insects, and small mammals that consume weed seeds as part of their diet.
b. Creating habitats that attract and support these predator populations, such as providing shelter and food sources, can help enhance their presence in rice fields.
c. Minimizing disturbance to these habitats and adopting conservation-friendly farming practices can further encourage predation of weed seeds.
d. By harnessing the natural predation potential, farmers can reduce weed seed populations in direct-seeded rice fields, contributing to sustainable weed management practices and improved crop yields.

5. Promoting Fatal Germination: Managing weeds is challenging due to their ability to persist in the soil seedbank for extended periods, coupled with considerable variability in germination timing among and within species. To effectively control weeds, one approach is to permit their germination and eliminate emerged weeds before planting the crop, or to prevent weed seed germination during the crop establishment phase. These strategies encompass various methods as follows:

a. Practicing stale seedbed: Tillage and irrigation are strong candidates for promoting weed germination in stale seedbeds. Tillage is known to stimulate the germination of many weed species through the combined effects of soil aeration, exposure of seeds to light, and increased N mineralization and soil temperature.
b. Combining stale seedbeds with floating row covers which can stimulate weed germination through higher soil temperature and moisture.

c. Nutrients are known to stimulate the germination of many weed species, hence changing the timing or rate of N fertilizer applications or adjustments in the timing of practices.

d. Rotational crops (including cover crops) often entail the application of practices which stimulate germination by their allelopathic or competitive effects.

6. Inhibiting Germination and Emergence: Seed germination ability varies by species, with larger seeds having greater carbohydrate reserves able to emerge from deeper soil depths. Small seeded species, like *Amaranthus spp*. have limited carbohydrate reserves, limiting their emergence depth. The size of propagules also influences weed emergence and establishment. Techniques to inhibit weed seed germination and emergence include:

a. Deep tillage- Is an effective approach for weed species with small and short-lived seeds as deep burying will reduce their emergence and the likelihood of losing seed viability is high by the time seeds again reach the soil surface in the germination zone.

b. Surface mulches prevent seeds from germinating or sprouting by making shoots grow longer to reach sunlight. They also hinder the growth of small-seeded plants as they lack enough stored energy to penetrate through the mulch. Additionally, mulches can impede germination by affecting soil conditions such as temperature, moisture, and light, as well as through allelopathic effects.

c. Rice cultivars which can tolerate anaerobic condition/flooding at germination phase are referred to as anaerobic germination (AG) tolerant rice can also facilitate the advantage of early flooding for weed control in DSR systems.

Integrating Preventive Strategies

1. Integrating Stale Seedbeds and Crop Rotations During Fallows:

a. Stale seedbeds stimulate weed seed germination before crop planting, allowing for targeted weed control measures to be applied, thus reducing the overall weed seed bank.

b. Additionally, rotating crops during fallow periods can introduce competitive species or crops with allelopathic properties, suppressing weed emergence and growth while also diversifying weed management tactics, ultimately leading to a decline in weed seed populations over time.

2. Reduced Tillage with Residue Retention:

a. Crop residues on the soil surface acts as a physical barrier, hindering weed seed germination and emergence by blocking light and impeding seed-soil contact.

b. The improved water retention capacity of soils under reduced tillage and residue retention creates conditions unfavourable for weed seed germination, as many weed species require moist soil for successful germination.

3. Rotational Tillage and Establishment Methods:

a. By employing different tillage techniques and establishment methods, like alternating between traditional ploughing and no-till or minimal tillage, farmers can efficiently disrupt weed seeds in the soil layers and generate unfavourable environments for their development.

b. Rotating crop establishment methods, *i.e.* by rotating DSR with transplanting, the buildup of problematic weeds may be delayed or eliminated.

4. Integrated Bund Management:

a. Integrated bund management in direct-seeded rice involves holistic approaches such as maintaining vegetative cover, mulching, or intercropping on bunds.

b. These practices serve as physical barriers to weed encroachment, disrupt weed seed germination habitats, and promote competition from cover crops or intercrops, collectively reducing weed seed presence in the direct-seeded system while improving soil health and overall sustainability.

Conclusion

Weed control in direct-seeded rice (DSR) is notably more challenging and poses greater risks of yield loss compared to transplanted rice, leading to increased reliance on herbicides for control purposes. However, depending solely on herbicides is not sustainable and raises concerns for both environmental and health impacts. This underscores the pressing need for adaptable integrated weed management approaches in DSR systems. Prioritizing preventive and cultural methods to decrease reliance on herbicides is vital for effective and sustainable weed management in DSR. Nevertheless, there is a lack of accessible information on preventive weed management in DSR, highlighting the necessity for further research and adoption of alternative strategies to ensure the long-term success of DSR systems.

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Mango Stone, Kernel and MKF

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Introduction

Mango is grown worldwide and Mango (*Mangifera indica* L.) is the main fruit of Asia and has developed its own importance all over the world. It is called the king of fruits. The world production of mangoes is estimated at 42 million tons per year. India accounts for 44% of world production, followed by China, Kenya, Thailand, Indonesia, Pakistan, and Mexico. Mango pulp has a sweet taste and exotic flavor due to which it is liked by one and all. During consumption and processing of mango, a large quantity of by-products in the form of peel and seeds are generated which, mostly, are discarded as waste. Mango seed kernels and peel have nutritional and pharmaceutical importance and hence have received much attention in recent times. They contain a significant number of proteins, fats, carbohydrates, and some specific bioactive compounds.

Mango Kernel

The fruit has 85% skin and pulp. The stone (seed) which is thrown away constitutes around 3-25% of total fruit. The kernel inside constitutes 54-85% of the stone which is kidney shaped and contains 9-14% oil which is called mango kernel fat (MKF). India has a potential for production of 35,000 tonnes of MKF annually. The mango seed kernel contains 50 to 70% carbohydrates, 5 to 10 % proteins, 10 to 18.0% fat/oil, and 1 to 10 % crude fiber. Minerals constitute around 4%. Soluble sugars and tannins are present in small quantities. Protein and starch are easily digestible. The ash portion consists of mainly Ca, Mg and P. Mango kernels are used in making pickles, fluor and starch. Mango kernel starch is used in textile, paper and jute industries.

Mango seed kernel is a remarkable source of phytochemicals like phytosterols, carotenoids, tocopherol, polyphenols (mangiferin, hesperidin, vanillin, penta-o-galloyl-glucoside, rutin, quercetin, kaempferol, etc.), and phenolic acids (gallic acid, caffeic acid, ellagic acid, ferulic acid etc.). These phytochemicals have the potential to improve human health and prevent the growth of pathogenic microorganisms. They are also known for their high antioxidant, anticancer, antimicrobial, antidiabetic, and antiplatelet aggregation properties.

Mango Fruit and its Byproducts

Processing of ripe mango fruit generates its peel and seed as waste, which is approximately 40-50 % of the total fruit weight. As mango is seasonal fruit, about 20 per cent of fruits are processed for products such as puree, nectar, leather, canned slice and chutney, juices, ice cream, fruit bars and pies. Food powders (prepared with a reduction of antinutritional factors) can be obtained from seeds, and these powders can include premium-grade fats or extracts with high functional power.

The kernel has medicinal value mostly as anthelminthic. Collection and decortication are being attempted, in view of the importance of mango kernel fat as tallow and cocoa butter substitutes. Mango stones are dried in the sun to a moisture content of 13%. They are decorated by hand. A mechanical decorticator is useful in handling large quantities. The kernels are edible and consumed in some parts of India, especially during scarcity times. It can easily be stored for a year. It is slightly astringent and eaten after roasting, boiling or leaching with water.

Processing Mango Stone for Fat

From the point of view of processing, mango is an important fruit providing large amounts of waste material in the form of peels and stones. Mango seed kernel is comparable to cereals such as rice, wheat, maize and barley with respect to its content of carbohydrates, proteins, fat, calcium and phosphorus. It is a rich source of starch and fat. Because of their size and shape, and toughness of the shell wall, mango stones are difficult to decorate for separating the inner kernel. Development of a mango stone decorticator is an important breakthrough in the utilization of mango kernels. The degree of decortication attained in the mechanical decorticator is almost 100%, and the yields are quantitative. Dry mango kernels can be stored without deterioration for a period of more than a year.

The air-dried stones yield kernels which can be sun dried to a moisture content of 10%. The cooked kernels are passed through an expeller, and the resulting cake can be extracted with hexane. The fat from the kernels is extracted mostly by solvent extraction. The kernels are broken into small pieces, flanked by beating after steam treatment. Very thin flakes with 10-12% moisture is then extracted in continuous type extraction mills using hexane at 40 - 50^{0}C. Later the hexane is removed at 110^{0}C to obtain the fat. The deoiled meal also is desolventized. Mango kernel fat is obtained in 11% yield. Mango kernels are rich in antioxidants and have a role in protecting against breast cancer. They are beneficial for diabetics and effective in controlling diarrhea. Mango kernels also aid in weight loss in addition to reducing skin problems.

Mango Kernel Fat (MKF)

Blandness, plasticity and absence of toxic substances make MKF a potential edible fat. The fat characteristics are as follows; acid value 2.1-6.2; iodine value 31.6-59.1(indicates saturation); saponification value 189.9-194.7; unsaponifiable matter, 1.0-2.5% and melting point, 35.0-49.0^{o}C (solid at room temperature). MKF contains 96.1% neutral lipids and 3.9% polar lipids with 2.9% glycolipids and 1% phospholipids. MKF contains 52% oleopalmitostearin and 19% oleodistearin. MKF is rich in saturated fatty acids namely palmitic and stearic acids. The oleic acid content is around 45%. The fatty acid composition is as follows: palmitic acid (16:0) = 3.5-17.8%; stearic acid (18:0) = 24.0-56.9%; oleic acid (18:1) = 33.3-52.6%; linoleic acid (18:2) = 1.3-13.4% and arachidic acid (20:0) = 0.4-2.6%. Mango kernel oil is solid at room temperature with a melting point of 35–49 °C. Mango fat can be used as a substitute for cocoa butter in chocolate manufacturing.

Mango oil, mango kernel fat, or mango butter, is an oil fraction obtained during the processing of mango butter. It is a soft yellow colour. The oil is semi-solid at room temperatures, but melts on contact with warm skin, making it appealing for baby creams, suncare balms, hair products, and other moisturizing products.

MKF as CBS (Coco Butter Substitute)

MKF and mango fat stearin are refined through phosphoric acid treatment to remove gums, and alkali treatment to reduce FFA (free fatty acids). The oil is then dried under vacuum at 100^{0}C and bleached using bleaching earth and carbon. MKF when utilized as CBS does not show any differences in taste, texture and odour of the ice cream, butter scotch and toffees. MKF with a M.P. of 36^0 C can easily be blended with cocoa butter without any change in the properties. MKF is utilized mainly as CBS. As MKF is softer, its quality as CBS is improved by selective solvent fractionation and partial hydrogenation. Mango fat stearin is almost similar to cocoa fat. Mango stearin obtained by solvent fractionation appears more suitable as a cocoa butter substitute. MKF is also utilized as an ointment base. It is better than paraffin base in releasing the drugs quickly. Mango fat when randomized and fractionated or co-randomized with coconut oil becomes a useful raw material for ointment base and its stearin fraction is a good suppository base.

Utilization of Mango Kernel

Mango stone, like pulp, finds many uses. The stony portion is used as a fuel in India, while the kernel is utilized for making such products as pickle, flour, starch, and cattle feed. It is estimated that about 1,40,000 tonnes of starch can be obtained annually from kernels alone, together with the tannins and fats as by-products. This starch can be used in textile, jute and paper industries. Dried kernels with less than 10% moisture content can be used as animal feed, because of a balanced proportion of amino acids present in them. Feeding experiments conducted on poultry have shown that a mixture of maize meat and mango kernel flour to the extent of 20% has no detrimental effect on the development of chickens. Dried kernels can be fed as such to animals without any further treatment or processing. Mango kernel serves as a good manure for plants. Application of powdered mango kernel compost at half the dose of FYM has given better crop response and yields.

Defatted Meal

The proximate composition of defatted mango kernel meal is as follows: fat 0.41%, protein 6.2%, ash 3.6% and crude fibre 4.5%. The defatted meal is rich in starch and thus is a source of industrial starch. It is edible and can be eaten after drying, though slightly astringent. Since it is poor in nitrogen, it is not very useful as animal feed. However, it is free from toxic constituents and hence it is normally utilized as cattle feed.

Conclusion

Mango (*Mangifera indica* L.) is grown worldwide. The fruit is called the king of fruits. During consumption and processing of mango, a large quantity of by-products in the form of peel and seeds are generated which, mostly, are discarded as waste. Mango seed kernels and peel have nutritional and pharmaceutical importance. They contain a significant number of proteins, fats, carbohydrates, and some bioactive compounds.

Mango seed is a potential source of nutritional food ingredients due to the high quality of its fat and protein and the high content of antioxidants and compounds that have antimicrobial activity. Mango seed kernels which represent about 9 per cent of total fruit weight and treated as processing waste, can be processed into flour which can be used to incorporate into food products. The mango seed kernel contains 50 to 70% carbohydrates, 5 to 10 % proteins, 10 to 18.0% fat/oil, and 1 to 10 % crude fiber. Minerals constitute around 4%. Soluble sugars and tannins are present in small quantities. Mango seed kernel is a remarkable source of phytochemicals like phytosterols, carotenoids, tocopherol, polyphenols and phenolic acids.

Mango kernel fat (MKF) or mango butter, is an oil fraction obtained during the processing of mango kernel. The oil is semi-solid at room temperatures, but melts on contact with warm skin, making it appealing for baby creams, suncare balms, hair products, and other moisturizing products. It is also used as coco butter substitute (CBS). Mango stone, like pulp, finds many uses. The stony portion is used as a fuel in India, while the kernel is utilized for making such products as pickle, flour, starch, and cattle feed. The defatted meal is rich in starch and is a source of industrial starch. Mango seed and kernel have highly useful phytochemicals which need to be utilized profitably.

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Cold Storage in Stored Produces

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Introduction

Cold storage for stored grains is a sophisticated preservation method designed to mitigate spoilage and maintain the quality of harvested crops over extended periods. This process involves storing grains in controlled environments with regulated low temperatures, depending on the specific type of grain. The primary objective of cold storage is to inhibit the activity of microorganisms, which can contribute to the deterioration of grains. It not only safeguards the nutritional integrity of grains but also plays a pivotal role in addressing post-harvest challenges, contributing to food security, and promoting sustainable agriculture practices.

Types of Cold Storages

Refrigerated Warehouses: These are large-scale storage facilities equipped with refrigeration systems to maintain a consistent low temperature. Refrigerated warehouses are suitable for bulk storage of grains and offer precise temperature control. Ideal for long-term storage.

Fig 1: Refrigerated Warehouse

Controlled Atmosphere Storage: This method involves modifying the atmospheric composition within storage facilities to slow down the aging process of grains. Oxygen, carbon dioxide, and humidity levels are controlled to extend storage life.

Fig 2: Controlled Atmosphere Storage

Grain Silos with Aeration Systems: Silos equipped with aeration systems facilitate temperature control by circulating air through the stored grains. This helps manage temperature differentials and prevent localized heating. Ideal for bulk storage.

Fig 3: Grain Silos with Aeration System

Deep Freezing Storage: Utilizes freezing temperatures to halt microbial and enzymatic activity, ensuring the preservation of grain quality. Commonly employed for specific grains sensitive to higher temperatures.

Fig 5: Solar-Powered Cold Storage

Bulk Container Refrigeration: Refrigerated containers designed for transporting bulk quantities of grains. These containers are equipped with temperature control systems to preserve grain quality during transportation. Preventing deterioration of grains and preserving quality upon arrival at the destination.

Fig 6: Bulk Container Refrigeration

Cold Rooms: Large, insulated rooms with controlled temperature and humidity. Bulk storage with moderate energy consumption. Large scale grain elevators equipped with insulated storage silos to house vast quantities of grains under controlled conditions.

Fig 7: Cold Rooms

Advantages

1. Preservation of Quality: Cold storage slows down biological and chemical processes, preserving the nutritional quality, flavour, and texture of stored grains.

2. Insect and Pest Control: Lower temperatures help deter insect infestations, protecting grains from damage and contamination.

3. Extended Shelf Life: Cold storage inhibits microbial growth, allowing grains to maintain freshness and remain viable for longer periods.

4. Reduced Oxidation: Lower temperatures reduce oxidation, preventing rancidity and maintaining the integrity of oils present in grains.

5. Reduced Spoilage: Cold storage minimizes the risk of spoilage due to factors like heat and humidity, ensuring a higher percentage of grains remain usable.

6. Improved Marketability: Grains stored in cold conditions tend to have better visual appeal, making them more marketable and attractive to consumers.

Disadvantages

1. High Initial Capital Investment: Establishing cold storage facilities requires significant upfront costs for infrastructure, refrigeration systems, and technology implementation.

2. Risk of Pest and Disease Persistence: Without proper pest management strategies, there is a risk of infestations or quality issues in stored grains.

3. Limited Accessibility in Remote Areas: Establishing cold storage facilities may be impractical or economically unfeasible in remote or underdeveloped regions.

4. Technological Complexity: Implementing and maintaining advanced cold storage technologies, such as controlled atmosphere systems, requires specialized knowledge and expertise.

5. Space Requirements: Cold storage facilities, especially larger ones, often demand considerable space, limiting their feasibility in densely populated or urban areas where land is scarce.

Conclusion

The adoption of cold storage facilities for stored grains presents a multifaceted solution addressing several critical aspects of agricultural and food management. This not only safeguards food safety but also enhances market value and consumer satisfaction. The role of cold storage remains pivotal, safeguarding the essence of our harvests and sustaining the delicate balance between abundance and scarcity in our ever-changing world.

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Rabbit Farming - A Lucrative Avenue

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Introduction

Rabbit farming offers high profits with low investment and also takes less space compared to other livestock activities. Apart from meat production they can also be raised for hide and fur. For landless people, uneducated youth and women, rabbit farming gives an additional income as a part time job. With the growing human population and increased demand for animal protein, rabbits are becoming an increasingly appealing alternative. According to 2019 livestock census, the total population of rabbits in India is 0.55 million. The per capita availability of meat is 6.82 kg/year whereas ICMR recommendation is 11 kg/ year. The recent surge in popularity of rabbit raising can be attributed to their high productivity, early maturation, shorter generation interval, and effective feed utilization.

Advantages of Rabbit Farming

1. The initial investment cost for rabbit farming is low along with quick returns (about six months after the establishment of the farm).

2. When compared to the other meats rabbit meat contain high protein (21%) and less fat (8%), making it suitable for people with heart disease. So, this meat is suitable for all age groups from adults to children.

3. Besides, rabbit meat is rich in calcium and phosphorus levels and comparatively low sodium levels

4. Rabbits can be fed with easily available leaves, waste vegetables, and grains. Growth rate in broiler rabbits is very high and they attain 2 kg at the age of three months.

5. The litter size (Number of young ones born/ kindling) in rabbits is high (around 2-12). They are highly prolific with some females producing 25 to 50 kits (young ones of rabbit) per year.

6. Rabbit dung is rich in nitrogen and phosphorus, so it can be used as an organic fertilizer for growing flowers, fruits and vegetables in backyard gardens.

7. The meat of the rabbit is rich in poly-unsaturated fatty acids (PUFA) which comes under the category of white meat. Besides, rabbit meat is high in sodium and potassium.

8. Small groups (up to 50 numbers) of rabbits can be reared in the backyard of the house with kitchen waste as feed.

9. Rabbits are small sized animals. So, they require less space, feed, care and management.

Methods of Rearing Rabbits

Rabbits can be reared at the backyard within a small shed which can be constructed with a small investment. To protect rabbits from the climatic conditions such as in hot summer, rain and to protect them from dogs and cats, construction of shed is necessary.

Rabbits can be reared in two system of housing:

1. Deep litter system: This method is suitable for rearing small number of rabbits and not suitable for intensive system of rearing. To prevent rabbits from digging burrows, the floor should be made up of concrete. Litter materials such as paddy husk, paddy straw or wood shavings can be filled up to 4-6 inches from the floor. Deep litter system is not suitable for rearing more than 30 rabbits. Male rabbits should be housed separately. Rabbits reared in deep litter system are more susceptible to diseases. Management of bunnies also very difficult in deep litter system. A shed measuring 95 feet long and 20 feet wide can accommodate approximately 200 breeder rabbits and their young. A total of 500 rabbits can be reared in a shed 150 feet long and 25 feet wide.

2. Cage system: The shed should be built in east and west direction. Rabbits in cages require 3 square feet per male rabbit, 6 square feet per female rabbit, and 1 square foot per growing rabbit.

Adult rabbit cage should have 1.5 feet length, 1.5 feet breadth and 1.5 feet height. This cage is suitable for one adult rabbit or two growing rabbits. Growing rabbit cage should have 3 feet length, 1.5 feet breadth and 1.5 feet height. This sized cage is suitable for 4-5 rabbits up to 3 months age.The cage size for growing rabbits is sufficient for the rabbits going to be kindled. But the bottom and sides of the cage should be made up of weld mesh of 1.5 X 1.5 inches. This used to prevent the young bunnies to come out of the cage.

Generally, the temperature in the shed should be maintained between 25 to 30^{o} C. Similarly, measures should be taken to ensure that the humidity in the air is within 50 per cent. Also, the light in the shed is to be maintained for 12 to 14 hours per day.

Breeding Management of Rabbits

1. The average age at first mating is about 5-7 months and it varies with the physical maturity of individual rabbit and also breed.
2. Male rabbits at 1 year of age should be used for breeding purpose. Male rabbits can be used for mating until they are about three years.
3. Mating should be done either early in the morning or in the evening. The adult female (doe) is to be taken to the adult male (buck) cage and never vice-versa.
4. Female rabbit does not have an oestrus cycle and she is considered to be in heat when her vulva is red and when she accepts male. Female rabbit when provided good environment will remain in heat throughout the year unless become pregnant.
5. Ovulation occurs only after mating after 12-14 hours.
6. Maximum number of mating per buck is 4/day and 12/week.
7. Male to female ratio is 1: 10 -15
8. During the first time mating, rabbit should be handled with one hand over ears and shoulder and other support the body, raising the hind quarters making suitable mating position.
9. For pregnancy diagnosis, abdominal palpation is done at between 14-16 days.
10. The gestation period is 30-32 days.
11. Kindling often takes place at night and lasts from 15-30 minutes according to size of the litter. The number of babies are 2 to 12. The average number of kittens are 6.
12. The nest box is kept in the cage around 25th day of pregnancy with loosened jute wool or wood shavings.
13. The breeding should be planned in such a way that about 3 to 4 litters per doe are obtained per year during multiplicative stage.
14. In order to prevent inbreeding depression rabbits from the same family should not be bred. Therefore, replace male rabbit about once every year. After three years, the full grown female rabbits should be replaced either by new purchases or females of own farm.

Care of Young Ones

The nest box should be removed after 5 weeks of kindling. Kits should be examined, and dead ones should be removed daily. If the bedding becomes wet, it should be replaced by a fresh and clean one. Weaning should be done at 5th or 6th week after kindling.

Feeding of Rabbits

Feed and water troughs for rabbits usually made up of galvanized iron. The feed trough should be designed in the shape of "J" and they are usually fit outside the cages. To reduce the investment cost the feed and water can also be provided in cups.

1. Feeding of baby rabbits: During first 3 weeks, doe's milk is only its feed. After 3 weeks, the baby will start to eat the grass and concentrates as well suckling the doe. At the time of suckling, the doe should be provided good quality feed. A doe nursing 8 or more young should get 250 g concentrates/day and water 3-5 liters/day. All vegetable rations should be supplemented with salt and a source of calcium like bone meal.

2. Feeding of adult rabbits: Adult rabbits should be provided green bulky roughage's (grasses, green vegetables, leaves and hay). Generally, rabbits can eat and consume all types of grains, legumes and green fodders like Lucerne, Agathi, Desmanthus and various types of kitchen wastes including carrots, cabbage leaves, and other vegetable wastes. They should be provided concentrate feeds too (<18% CF, >60% TDN). For 1 kg body weight of rabbit, 40 grams of concentrate food and 40 grams of green fodder has to be fed. Coprophagy is most important source of nutrients for rabbit which include partially digested feed, containing adequate protein, energy and vitamins. They should be provided adequate amount of clean drinking water. Rabbits dislike dusty and gritty feeds and prefer pellet feed. A dietary supply of vitamins A, D, E is necessary whereas vitamin B and K are synthesized by bacteria in the gut.

Return of Investment in Rabbit Farming

Rabbit farm is a good source of profit and offers good returns. When a pair of rabbit reproduces, a total of 4-10 rabbits can be expected including the parents. These bunnies will probably reproduce after six months as it takes around 6 months for them to fully mature. In a span of a year, a total of around 40-50 rabbits can be expected from one pair of parents.

Rabbits that are less than a month old are called bunnies. These are the ones that sell the most. They weigh between 200 to 250 grams. Rabbits that are over a month old are called growers. Breeders are those which are ready to reproduce. They weigh 2 to 2.5 kg. If it is for meat production, it is usually sold after three months.

Conclusion

A major concern for rabbit farming in India is the marketing and supply chain management. But as it is a good supplement for protein and the management expense is minimal, there is lot of scope in the future.

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Significance of Small Interfering Ribonucleic Acid (siRNA)

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Abstract

Small interfering RNA has gradually developed as an influential RNA dependent gene which is a double stranded RNA molecule and is also known as silencing due to its property that it prevents the expression of a particular gene. Some of its common applications are as follows - It helps in the defense mechanism of the cell and prevents viral infections as well, it can be used to study the function of a particular gene which makes it useful in research, it helps in identifying complex cellular pathways, it has been clinically proven that siRNA can be used to treat several neurodegenerative diseases and even some types of cancer, but the problem arises during the drug delivery as it should only affect the target site that also while not getting degenerated. There are several studies going on the same.

Small interfering RNA is a gene which comes under nanoparticles and indicates that it comes under nanotechnology and works on the similar principle as of gene therapy and helps in detecting/identifying and curing several kinds of diseases, further work on the siRNA in the medical field would be beneficial for future generation as people are getting least bother of their health and themselves are using devices that would affect their health and even may be fatal, introducing this technique will help people to overcome the diseases.

Introduction

Short interfering RNA (siRNA) is also known as silencing RNA or a short interfering RNA which is a kind of RNA molecule and plays an important role in gene regulation and silencing of genes. It is an important tool in molecular biology and plays several roles in drug delivery, cancer therapy, silencing of genes, and many more.

Biological Functions of siRNA

The biological function short interfering RNA is RNA interference (RNAi). It is an evolutionary ancient process in eukaryotic organisms including plants, animals, and fungi. It plays a crucial role in gene silencing.

One of the primary functions of siRNA is to regulate gene expression. Cell uses siRNA to fine-tune the levels of specific proteins produced from their genes. SiRNA is obtained from the double stranded RNA (dsRNA)formed by the action of enzyme called dicer or dicer-like protein. As soon as the siRNA molecules enter the cell, they guide the production of a protein complex called RISC (RNA- induced silencing complex) to their targeted mRNA molecules. SiRNA, known as 'guided strand,' gets attached to the complementary genes present in the targeted mRNA molecule. The complex RISC contains an endonuclease enzyme called Argonaute, which breaks the mRNA leading to its degradation. The degradation mRNA proteins help prevent it from getting converted into functional proteins. SiRNA- mediated gene silencing occurs at post-transcriptional level, which means it affects the mRNA after it has been transcribed from DNA. It allows rapid and reversible regulation of gene expression as cells can quickly degrade or produce more siRNAs in response to changing conditions.

In nature, siRNA plays a vital role in cells defense invading against viruses and mobile genetic elements such as transposons. When a virus infects a cell, transposons get active and often produce dsRNA, which is recognized by cellular machinery. The cell processes this dsRNA to siRNA which can target or degrade viral transposon mRNAs, thereby inhibiting their inhibition or transposition. In some cases, siRNAs can also be involved in transcriptional gene silencing, where they affect the expression of genes at the DNA level. In this scenario, siRNAs can guide epigenetic modifications to the chromatin structure, making the gene less accessible for transcription. siRNA mediated gene regulation plays a crucial role in development and differentiation of multicellular organisms, it helps to ensure the proper expression of genes while developing different organs in the multicellular organisms and allows the formation and differentiation of organs. Researchers are working on siRNA to find its potential to treat various diseases such as cancer, viral infections, genetic disorders using targeted drug delivery.

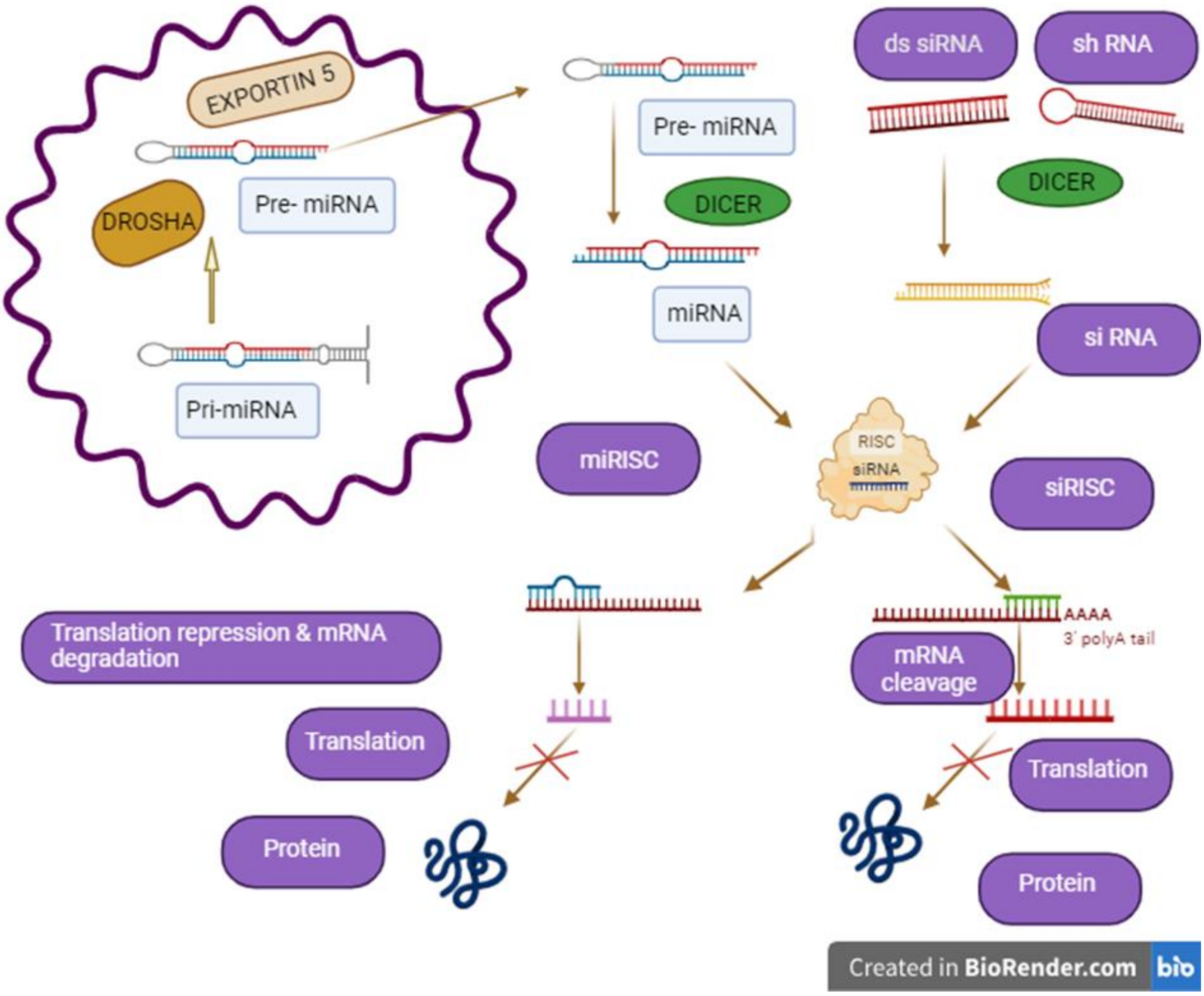

Figure.1

Structure of SiRNA

SiRNA molecules are composed of double stranded RNA which means that it is made up of two strands of RNA which are complementary to each other. This double stranded structure is important for RNAi (RNA interference). They are usually short in length, around 20-25 base pairs but may vary slightly. SiRNA usually has characteristic two- nucleotide overhangs at the 3' end of each strand. These overhangs are unpaired and severe recognition sites for the RNA-induced silencing complex (RISC), a protein complex that guides the siRNA to its target mRNA.

Mechanism of Action

SiRNA can be introduced into the cell using various methods such as transfection or viral delivery. Once inside the cell, siRNA molecules are typically processed to form an active siRNA duplex complex. SiRNA molecules are made up of double stranded RNA with two strands namely guide strand and passenger strand. One of the two strands (guide strand) is chosen based on thermodynamic stability and sequence preferences for incorporation into the RISC (RNA- induced silencing complex). The guide strand of the siRNA is loaded to the RISC complex, which facilitates the unwinding of siRNA duplex to expose the guide strand. Now, siRNA molecule pair with the complementary base pairs of mRNA molecule which is highly specific relying on the Watson-crick base pair rule. Once bound to the RISC complex, which contains argonaute, acts as an endonuclease and cleaves the target mRNA and disrupts the integrity of mRNA rendering it nonfunctional. The cleaved mRNA is rapidly degraded by cellular exonucleases, preventing its translation to functional protein. The ultimate result of siRNA gene silencing is degradation or loss of protein function. This process is reversible; the siRNA and RISC complex can be recycled by allowing for transient gene regulation based on the cell's need.

Applications of SiRNA

There are mainly two applications of siRNA

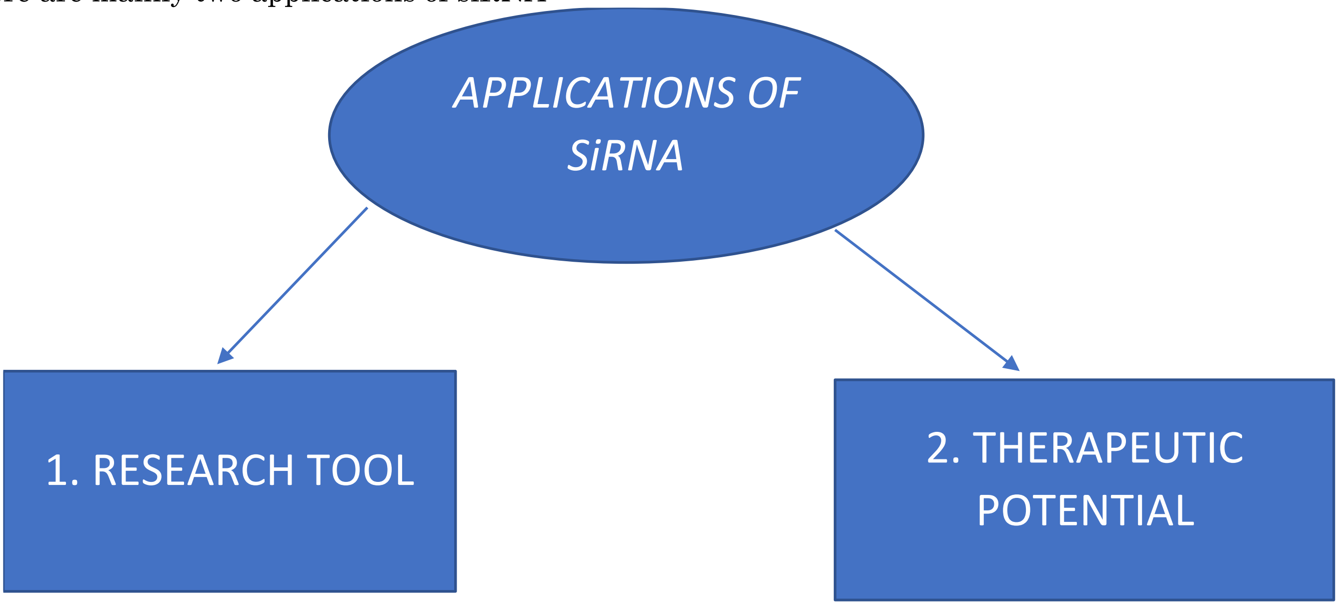

Figure.2

1. Research Tool - siRNA is a valuable tool for studying gene function by allowing researchers to selectively silence genes of interest. This helps in understanding the roles genes play in cellular processes, development and diseases.

2. Therapeutic Applications - siRNA holds significant promise for treating various diseases. It can be used to target and inhibit the expression of disease- related genes, including those involved in cancer, genetic disorders and viral infections. Some of the therapies are - Cancer Therapy- siRNA can target oncogenes (gene promoting cancer growth) or genes involved in tumor progression, offering a potential treatment option for various types of cancer. This approach is often referred to as RNAi- based cancer therapy.

Viral infections- SiRNA can be used to target and silence viral genes, making it a potential therapy for viral infections, including HIV, hepatitis and respiratory viruses. Genetic Disorders- SiRNA can be employed to down regulate the expression of genes responsible for genetic disorders such as muscular dystrophy, potentially alleviating disease symptoms.

Neurological Disorders- In the context of neurological diseases such as Alzheimer's and Parkison's, siRNA can be designed to target genes associated with disease pathology. Opthalmic Diseases- SiRNA can be used to treat ocular diseases like age- related macular degeneration (AMD) and diabetic retinopathy by inhibiting the expression of genes involved in disease progression. Immune Modulation- SiRNA can modulate the immune response by targeting the specific immune- related genes.

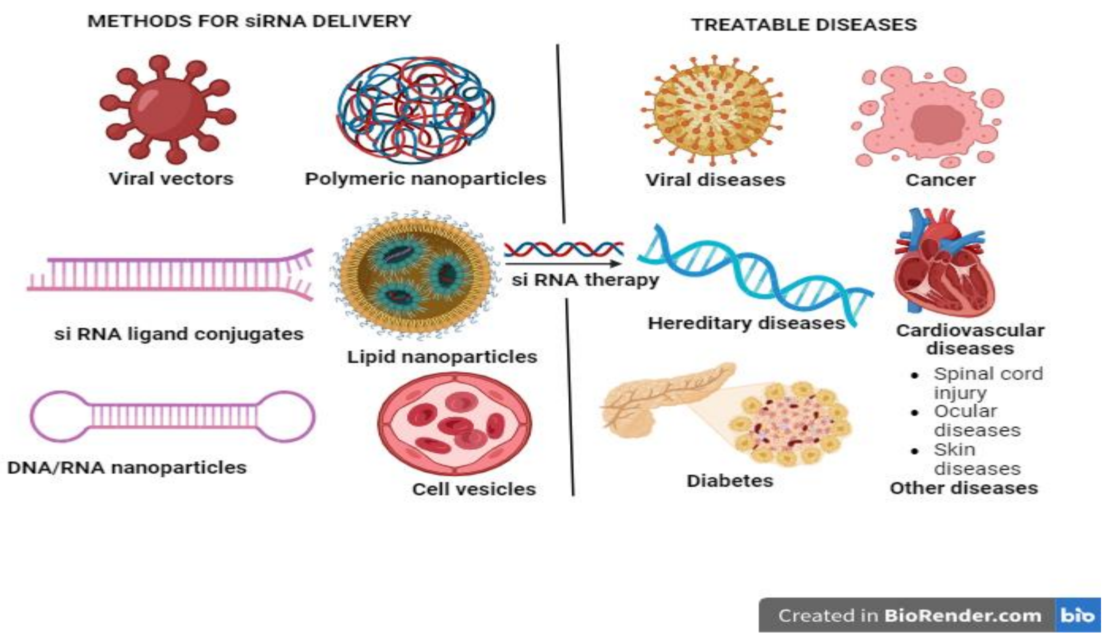

Figure.3

Role of sRNA in Plant Growth

Small, non-coding RNA (sRNA) is generally classified into two types based on their generation:

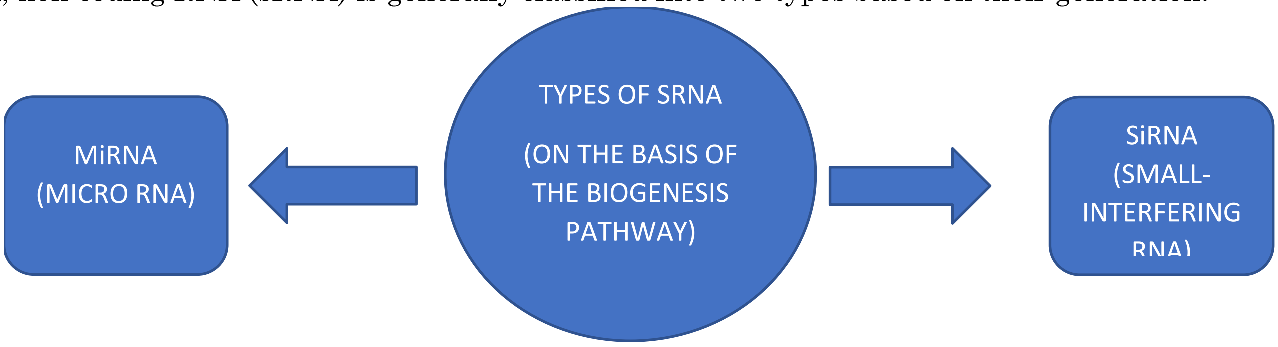

Figure.4

MiRNA (micro-RNA): They are small RNA molecules generally made up of about 21-25 nucleotides in length and play a crucial role in regulating gene expression in plants. They are non-coding RNA and are responsible for various factors affecting growth through the following mechanism-It is started with the transcription of miRNA with the help of RNA polymerase II, and these are known as primary RNA (pri-mRNAs) which are further processed by an enzyme called dicer like 1 (DCL 1) which cleaves the pri-mRNA to release a short-stem- loop structure known as precursor mRNA(pre-mRNA), typically made up of around 70 nucleotides. This pre-mRNA is then exported from the nucleus to the cytoplasm by the action of exportin 5, now it is further processed in the cytoplasm to form the double stranded RNA approximately made up of 21-26 nucleotides whereas there is one strand of mature miRNA or guide strand, and the other strand is the complementary strand or the passenger strand. Eventually the mature miRNA is incorporated into argonaute(AGO) to form RISC (RNA-induced silencing complex), AGO along with miRNA act as an effector in gene silencing. Furthermore, the miRNA loaded RISC is bonded to the target site and finally triggers the degradation of the mRNA ultimately reducing the expression of targeted gene. It also regulates the genes related to the leaf development, root growth, blooming of flowers etc.

SiRNA (Smal interfering RNA): siRNAs are involved in the regulation of gene expression by targeting specific mRNA (messenger RNA) for degradation or translational repression. Plants are constantly exposed to viral infections where siRNA plays a crucial role in the defense mechanism of plants against viruses. When the virus enters the plant these siRNA guides or directs the RISC (RNA induced silencing complex) to degrade the viral RNA so that it won't spread and cause viral infection in the whole plant and thus, protects the plant. SiRNA is also involved in the silencing of transposons which are also known as jumping genes as their uncontrollable growth can cause mutations and growth abnormalities. They also help in the growth of several plant structures such as leaves, roots, and flowers. It also helps in transportation of minerals and nutrition to various parts of the plant and provides response to external stress by releasing stress related genes.

Conclusion

SiRNA is obtained from the double stranded RNA which has diversly applicable in therapeutics to treat several diseases which is useful for mankind and will be highly recommended and used techniques in future to diagnose and treat disease. It also widely being used as a research tool as it may perform several functions which may be unknown to us for the time being. It also plays important roles in plants as it protects them from viral infections, responds to environmental stress and helps in growth, providing minerals and nutrition to the plants and keeps growth regulation by altering certain genes like transposons as their uncontrollable growth can lead to genetic disorders and mutations.

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Soil Conservation: Ways to Maintain Soil Health

Article ID: 48820

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Soil is the surface material that covers the land, containing inorganic particles and organic matter and supplying structural support to agricultural plants, being thus their source of nutrients and water. Agriculture today faces a double-sided challenge—on the one hand, the urgent need to provide food to a growing population, and on the other hand, to do so in a sustainable way. Soil health is the state of the soil in relation to its potential ability to maintain its biological productiveness, strengthen environmental quality, and foster plant and animal health. Soil health is a term used to describe the general state or quality of soil, and in an agroecosystem, soil health can be defined as the ability of the soil to respond to agricultural practices in a way that sustainably supports both agricultural production and the provision of other ecosystem services. Conventional agricultural practices cause deterioration in soil quality, increasing its compaction, water erosion, and salinization and decreasing soil organic matter, nutrient content, and soil biodiversity, which negatively influences the productivity and long-term sustainability of the soil. For this purpose, there is a need of soil conservation. It is the prevention of loss of the uppermost layer of the soil from erosion or prevention of reduced fertility caused by over usage, acidification, salinization or other chemical soil contamination. Soil conservation is a combination of practices which is used to protect the soil from degradation. Unsustainable method like slash and burn are practiced in some lesser developed areas. A consequence of such method and deforestation causes large-scale erosion, loss of soil nutrients and sometimes total desertification. There are certain techniques that are used for soil conservation like crop rotation, cover crops, natural fertilizers, conservation tillage, strip cropping and planted windbreaks, that affect both erosion and fertility.

The Methods of Soil Conservation

1. Crop Rotation is an alternative to planting a field in the same crop year after year. Instead, the main crop is rotated, ideally with cereal crops like winter wheat or forages such as clover and alfalfa. Crop rotation provides several benefits. Rotation reduces the risk of insect and disease problems, thus decreasing a pesticide dependency. Because the crop is changed each year, pests do not have enough time to become established in damaging numbers. Forage crops or legumes such as clover and alfalfa are often used as green fertilizers or plow-down crops, meaning they are planted and later mixed in with the soil as a natural fertilizer and soil builder. Legumes have the special ability to take in atmospheric nitrogen and convert it to forms usable by other plants. For this reason, they are also referred to as nitrogen fixing plants. When used as a green fertilizer, legumes return a significant amount of organic matter to the soil. Their deep roots create tunnels for air and water to enter the soil. All these characteristics in turn guard the surface against water and wind erosion.

2. Cover crops are crops planted to reduce the impact of wind and water on bare soil. They absorb the impact of rain, reduce the speed of runoff, hold the soil in place, and encourage greater infiltration; and hence less runoff. Sweet clover, alfalfa, rye, and winter wheat are common cover crops. They are planted on areas susceptible to erosion like steep slopes; stream and river banks, grassed waterways or around wells to protect ground water supplies from contamination. Cover crops manage soil erosion, soil fertility, soil quality, water, weeds, pests and diseases. Cover crops can increase microbial activity in the soil, which has a positive effect on nitrogen availability, nitrogen uptake in target crops, and crop yields. Cover crops may be an off-season crop planted after harvesting the cash crop. These are nurse crops in that they increase the survival of the main crop being harvested, and are often grown over the winter.

3. Natural fertilizers include livestock manure, mulch, municipal sludge, and legume plants such as alfalfa or clover. Legumes such as clover or alfalfa are grown and then tilled into the soil as "green fertilizer". Like chemical fertilizers, natural fertilizer replenishes the soil with essential nutrients like nitrogen, phosphorus, and potassium. However, they have the added benefit of providing the soil with organic matter.

4. Conservation tillage- It leaves crop residue on the soil surface. This slows water movement, which reduces the amount of soil erosion. Additionally, conservation tillage has been found to benefit predatory arthropods that can enhance pest control. Conservation tillage also benefits farmers by reducing fuel consumption and soil compaction. Conservation tillage consists of a variety of practices used in agriculture to reduce wind and water erosion. Bare soil is highly susceptible to erosion. Excess tillage destroys soil structure and organic matter. In conservation tillage, at least 20 to 30 percent of the soil surface is covered in the previous year's crop residue after planting. The residue reduces wind velocity at the soil surface and breaks the impact of raindrops and the root systems hold the soil in place.

5. Strip cropping involves alternating strips of small grain like rye or forage crops like clover with row crops like corn. It is used to control erosion by reducing the velocity of wind and water. The forage and cereal grain rows tend to trap sediment that may otherwise end up in watercourses. Strip cropping is most effective in controlling erosion on a slope when it is placed along the contour of the land. To control wind erosion, it works best if the strips are placed at right angles to the direction of the prevailing winds**.** Another benefit of strip cropping is the organic matter added from the forage or cereal crop rows.

6. Windbreaks are sufficiently dense rows of trees at the windward exposure of an agricultural field subject to wind erosion. Evergreen species provide year-round protection; however, as long as foliage is present in the seasons of bare soil surfaces, the effect of deciduous trees may be adequate. A windbreak or shelterbelts is a planting usually made up of one or more rows of trees or shrubs planted in such a manner as to provide shelter from the wind and to protect soil from erosion. windbreaks around a home can reduce the cost of heating and cooling and save energy.

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Mulberry Herbal Tea: A Natural Approach to Wellness

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Introduction

Mulberry (*Morus* sp.) belongs to the Moraceae family and is often grown in tropical and subtropical climates across the world. It is used for many incredible purposes, for which it is called **Kalpavriksha**, regardless of mulberry leaves as the sole food for silkworm (*Bombyx mori*). Beyond their role in silk production, mulberry leaves hold a surprising secret their potential for promoting health and well-being. Mulberry leaves have a strong antioxidant impact. The polyphenolic chemicals found in the leaves contribute to their antioxidant properties. The majority of polyphenolic substances found in mulberry leaves are flavonoids such as quercetin, kaempferol, and morin (Frank and Orwell, 2013). It exhibits a great impact against illnesses including diabetes, cardiovascular disease, and viral activity because of the presence of bioactive components (Afzal et al., 2021).

Tea is a popular beverage among people of all ages. Tea has a larger global consumption than soft drinks, coffee, and alcoholic beverages. Using mulberry leaves as tea can be an option to extract polyphenol content from mulberry leaves, allowing individuals to benefit from its favorable health effects. Furthermore, additional bioactive components present in mulberry leaves can be quickly absorbed by the body via drinks such as tea (Aisyah and Issutarti, 2017). Because of its medicinal properties, for centuries, particularly in Asian cultures, mulberry leaves have been brewed into tea, offering a delicious and natural way to support the body.

Nutritional Composition of Mulberry Leaves

Mulberry leaves are highly nutritious, containing a range of vitamins and minerals. Mulberry leaves include polyphenol antioxidants, vitamin C, zinc, calcium, iron, potassium, phosphorus, and magnesium. They also contain 1- deoxynojirimycin (DNG), which may help reduce high blood sugar levels and insulin. Mulberry leaves contain 2.09-7.92% fat, 27.60- 43.6% neutral dietary fiber (NDF), 15.31-30.91% protein, 11.3-17.24% ash and 9.9-13.85% crude fiber. The leaves are also rich in minerals such as (2.42-4.71% Ca, 0.23-0.97% P, 1130- 2240 kcal/kg metabolizable energy).

Herbal Tea

Herbal teas (which are also called 'tisanes') are simple, effective, inexpensive, caffeine- and drug-free ways to enjoy the taste and benefits of herbs and spices. It is a tea brewed from leaves, flowers, fruits, stems, etc, of plant species other than the leaves of *Camilla sinensis* L. (Zhao et al., 2013). They are generally consumed as a refreshing drink for its health benefits and potential therapeutic properties. (Manikant et al., 2023). Herbal tea of mulberry leaf has an antioxidant effect and can address the problem of diabetes mellitus.

Mulberry Herbal Tea Preparation

1. Boil fresh water. Water temperature just below the boiling point is excellent around 160 to 200 ° F (71°C to 93°C) (Killedar et al., 2017).

2. Add one to two tablespoons of dried leaves per cup of hot water. Steep for 5–10 minutes, depending on the desired strength.
3. Strain the tea and enjoy the delicate flavor and potential health benefits.
4. Enhance tea with honey, lemon or ginger for a personalized touch of flavour.

If available, fresh mulberry leaves can be used to make mulberry leaf tea. Simply add four cups of cold water to a saucepan with fresh mulberry leaves and gently cook for 10-15 minutes on the burner.

Health Benefits of Mulberry Tea

Mulberry tea has received attention for its possible health advantages, making it both a delicious beverage and a nourishing elixir. Some significant advantages are.

Blood Glucose Regulation

1. Mulberry tea contains gallic acid, which may help lower blood glucose levels. It's particularly beneficial for individuals with type 2 diabetes but monitoring blood sugar levels is essential.
2. It aids in blood sugar control by inhibiting enzymes responsible for breaking down carbohydrates. This property makes it a potentially beneficial beverage for individuals managing diabetes or those concerned about blood sugar levels.
3. The herb works quickly after a meal.

Cholesterol Management

1. Mulberries have been linked to reducing LDL (bad cholesterol) levels. Lowering cholesterol helps prevent heart disease and related health issues.
2. The compounds in mulberry leaves, such as phytosterols, may play a role in managing cholesterol and promoting heart health.

Antioxidant Power and Mineral Powerhouse

1. Mulberry leaves are high in antioxidants, including flavonoids like quercetin and chlorogenic acid. These chemicals help battle oxidative stress, potentially lowering the risk of chronic illness.
2. Antioxidants found in mulberry tea protect against cellular damage and may even play a role in cancer prevention.
3. Antioxidants help remove free radicals from bodily cells (Kojima et al., 2010).

Digestive Support

Mulberry tea is believed to possess mild laxative properties, promoting healthy digestion and relieving occasional constipation.

Weight Management

Some studies propose that mulberry tea could assist in weight management by inhibiting the absorption of sugars and promoting a feeling of fullness. This potential effect on metabolism makes it an intriguing option for those aiming to maintain a healthy weight.

Anti-Inflammatory Properties

1. The anti-inflammatory qualities of mulberry tea have been explored for their potential to alleviate inflammation and associated health issues. This makes it a beverage with benefits that extend beyond simple refreshments.
2. Mulberry leaf, according to scientists and researchers, helps limit the body's reaction to inflammation-causing substances.

3. Mulberry leaf tea can help prevent and cure arthritis.

Conclusion

Mulberry tea, with its rich history, subtle flavour and potential health benefits, stands as a testament to the harmonious relationship between nature and our well-being. It is more than just a beverage; it is a holistic wellness tonic that nourishes the body and delights the senses. By incorporating mulberry tea into a routine, one may be providing their body with valuable tools to combat oxidative stress and promote overall health. Research on mulberry tea is still ongoing, with promising results suggesting its potential for supporting overall health. With its delicious taste and array of potential benefits, mulberry tea offers a natural approach to support well-being.

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Harnessing the Power of Geothermal Energy in Irrigation: A Sustainable Solution for Agriculture

Article ID: 48822

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Introduction

In a world where the agricultural sector faces increasing pressure to produce more food while minimizing environmental impact, the utilization of renewable energy sources such as geothermal energy holds significant promise. Geothermal energy, derived from the Earth's internal heat, offers a sustainable alternative to conventional energy sources for powering irrigation systems. This article explores the multifaceted benefits of integrating geothermal energy into agricultural irrigation practices, delving into its technological applications, environmental advantages, economic feasibility, and the challenges associated with its adoption.

Understanding Geothermal Energy

Geothermal energy harnesses the heat stored beneath the Earth's surface, originating from the planet's core and the decay of radioactive isotopes. This natural heat manifests in various forms, including hot water reservoirs, steam vents, and hot rocks. Geothermal power plants leverage this heat to generate electricity or provide direct heating for various applications, including agricultural irrigation.

Application in Irrigation: Advantages and Benefits

1. Soil warming: Establishing optimal temperatures conducive to plant growth is paramount for achieving high agricultural yields and robust crop health. Suboptimal temperatures, particularly cold soil conditions, pose significant impediments to the germination and growth phases, thereby constraining agricultural productivity. Leveraging geothermal water represents a viable solution for maintaining consistent soil temperatures in open fields. By strategically deploying irrigation pipes beneath the soil surface, farmers can simultaneously supply water and harness the thermal energy of geothermal water to foster optimal growing conditions for crops. The utilization of geothermal water for irrigation purposes not only extends the growing season but also enhances crop yields, thereby augmenting profitability(Omenikolo et al., 2020).

2. Soil sterilization: Farmers often encounter challenges stemming from pests and detrimental fungi infestations in proximity to their crops. Geothermal water offers a multifaceted solution by serving as an effective soil sterilizer, capable of eliminating pests, fungi, and diseases that jeopardize crop health. Achieving sterilization necessitates the application of high temperatures, typically through the use of hot water to generate steam directly within the soil. Implementation methods commonly involve heating the soil through subterranean pipes or applying steam onto the soil surface, subsequently covering it with a plastic sheet to retain heat(Omenikolo et al., 2020).

3. Geothermal-powered irrigation: In many regions, access to water for irrigation purposes can be challenging. Geothermal power offers a solution, enabling efficient irrigation methods even in arid or remote areas. By utilizing geothermal energy, farmers can generate electricity to power pumps, providing a reliable water supply for their crops. This leads to advantages like water conservation, independence from the grids, and improved crop yield by reliable access to water(Anonymous, 2024).

4. Providing additional nutrients: Geothermal fluids, known for their mineral and nutrient content, offer a valuable resource for enriching soil fertility when incorporated into irrigation systems. This practice enhances the nutritional profile of crops, thereby contributing to their overall health and productivity(Okoroafor et al., 2023).

5. Energy efficiency: Geothermal pumps utilize heat from underground sources to power turbines or directly heat water, eliminating the need for fossil fuels. This results in higher energy efficiency compared to conventional irrigation systems, translating to lower operational costs, and reduced environmental impact.

6. Cost savings: While initial installation costs for geothermal systems may be higher, they offer long-term savings through reduced energy bills and lower maintenance requirements. Additionally, geothermal energy prices are more stable, avoiding the volatility associated with fossil fuels.

7. Environment sustainability: Geothermal energy is clean, renewable, and emits minimal greenhouse gases and pollutants during operation. By replacing fossil fuel-powered pumps, it helps mitigate climate change and reduces air and water pollution, contributing to environmental sustainability and conservation efforts.

8. Reliability and Resilience: Unlike solar or wind energy, which are intermittent, geothermal energy provides a continuous and consistent heat source, ensuring uninterrupted operation of irrigation systems regardless of weather conditions or time of day. This reliability enhances agricultural productivity and resilience in the face of climate variability.

Case Studies and Success Stories

Numerous regions worldwide have successfully implemented geothermal energy in irrigation, demonstrating its effectiveness and viability:

1. Turkey: The Denizli Province in Turkey has embraced geothermal energy for agricultural purposes, utilizing it for greenhouse heating and soil heating in winter. This has enabled year-round cultivation of crops and increased agricultural productivity, contributing to food security and economic development in the region.

2. Kenya: In the Kenyan Rift Valley, geothermal energy powers irrigation pumps, providing reliable water supply to farmers and improving crop yields. The Olkaria geothermal power plant supports irrigation projects in the region, enhancing food security and livelihoods for local communities.

Challenges and Considerations

Despite its numerous benefits, the widespread adoption of geothermal energy in irrigation faces several challenges:

1. Initial Investment: The upfront costs of installing geothermal systems, including drilling wells and implementing infrastructure, can be substantial, posing a barrier to entry for small-scale farmers or developing regions. Access to financing and incentives is crucial to overcome this hurdle.

2. Site Suitability: Not all locations have suitable geothermal resources for energy extraction. Assessing the geothermal potential of an area requires geological surveys and feasibility studies, which can be time-consuming and costly. Targeted research and collaboration between stakeholders are needed to identify suitable sites for geothermal projects.

3. Technical Expertise: Designing, installing, and maintaining geothermal systems require specialized knowledge and skills. Training programs and technical support are essential to ensure successful implementation and operation, particularly in regions with limited capacity and resources.

4. Policy and Regulatory Framework: Clear policies and regulatory frameworks are needed to incentivize investment in geothermal energy and facilitate its integration into existing agricultural systems. Governments can offer subsidies, tax incentives, or feed-in tariffs to promote adoption and offset initial costs, fostering an enabling environment for sustainable agriculture.

Future Outlook

Despite these challenges, the prospects for the use of geothermal energy in irrigation are promising. Advances in technology, coupled with increasing awareness of environmental issues and the need for sustainable energy solutions, are driving interest and investment in geothermal projects worldwide. With supportive policies, innovative financing mechanisms, and collaborative efforts between governments, private sector entities, and local communities, geothermal energy can play a significant role in transforming agriculture towards a more sustainable and resilient future.

Conclusion

Geothermal energy offers a sustainable and environmentally friendly solution for powering irrigation systems in agriculture, with numerous benefits including energy efficiency, cost savings, environmental sustainability, and reliability. While challenges exist, ongoing research, technological innovation, and supportive policies are paving the way for wider adoption of geothermal energy in irrigation, ultimately contributing to global food security, economic development, and environmental conservation. By harnessing the Earth's natural heat, farmers can enhance agricultural productivity while reducing reliance on fossil fuels and mitigating climate change impacts, forging a path towards a more sustainable and resilient agricultural sector.

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Plant MicroProteins: Small but Powerful Modulators of Plant Development

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Summary

The demand for crop-based products is increasing due to population growth, leading to a focus on optimizing crop productivity while minimizing environmental impact. Various molecular methods have been developed, such as RNA interference and genome-engineering technologies like CRISPR-Cas9, to regulate trait-specific genes. However, these methods have drawbacks like off-target effects and complete loss of gene function. MicroProteins (miPs) have emerged as a promising alternative for trait regulation at the posttranslational level. MiPs are small proteins with a single protein-protein interaction domain, akin to microRNAs, and they regulate larger proteins by forming complexes that disrupt normal protein functions. They can be classified into cis-microProteins (derived from the same gene) and trans-microProteins (paralogous to their targets). MiPs inhibit protein complex formation through homotypic or heterotypic interactions, leading to non-functional complexes or sequestering target proteins into inactive states. Synthetic miPs can be designed to target specific protein-protein interaction domains, offering potential for precise and diversified effects.

Introduction

The rising demand for crop-based products is directly linked to population growth. Modern agriculture emphasizes optimizing crop performance while minimizing environmental impacts. To achieve these goals, various molecular methods have been developed for controlling specific genes at the transcriptional and translational levels. RNA interference, for example, can selectively reduce gene expression post-transcriptionally, but it is plagued by off-target effects and lacks transgenerational stability. Genome-engineering technologies such as zinc-finger nucleases, transcription activator-like effector nucleases, and CRISPR-Cas9 have emerged as powerful tools for precise genome modifications. However, they also face challenges such as off-target effects and the risk of completely disrupting gene function, which could be harmful to organisms. A potential solution lies in targeted posttranslational modifications to regulate traits. This approach allows fine-tuning of protein activity without altering the overall plant structure or metabolism. Many biological processes rely on protein complexes formed through protein–protein interactions (PPIs). The formation, stability, and disruption of protein complexes are dependent on various cellular factors, such as regulatory proteins and post-translational modifications. One important means by which complex formation is regulated by miP-mediated inhibition of complex formation (Eguen *et al*., 2015).

MicroProtein

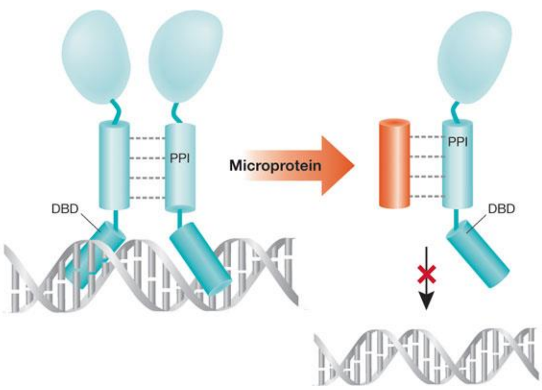

Figure1: Model of microprotein interference

A microProtein (miP) is a small protein, that is typically less than 20 kDa in size and possesses single protein-protein interaction domain (PPI). These miPs belong to a class of proteins that regulate larger multidomain proteins post-translationally. They are analogous to microRNAs (miRNAs) and heterodimerize with their targets causing dominant and negative effects (Figure 1), (Staudt and Wenkel, 2011).

History

The initial discovery of a microProtein (miP) dates back to the early 1990s during research on genes encoding basic helix–loop–helix (bHLH) transcription factors. This miP, identified from a murine erythroleukemia cell cDNA library, was characterized as an inhibitor of DNA binding (ID protein) that exerted negative regulation on the transcription factor complex. The ID protein, measuring 16 kDa, featured a helix-loop-helix (HLH) domain. The microprotein formed bHLH/HLH heterodimers which disrupted the functional basic helix–loop–helix (bHLH) homodimers.

The first microprotein identified in plants was the LITTLE ZIPPER (ZPR) protein. It contains a leucine zipper domain and lacks the necessary domains for DNA binding and transcription activation. Consequently, the LITTLE ZIPPER protein shares similarities with the ID protein. While not all microproteins are physically small, they were termed "microproteins" in 2011 due to negative regulatory actions are similar to those of miRNAs (Staudt and Wenkel, 2011).

Origin

MicroProteins (miPs) fall into two primary categories: cis-microProteins and trans-microProteins. Cis-microProteins originate from the same gene as their target protein and are generated through mechanisms such as, alternative splicing, proteolytic cleavage, alternative polyadenylation, or alternative translation start sites. In contrast, trans-microProteins are paralogous to their targets, emerging from genes that have undergone duplication and subsequent evolutionary refinement via domain loss (Bhati et al., 2020).

Types of Microprotein Inhibition

MicroProteins are capable of interfering with the assembly of heterodimeric, homodimeric, or multimeric complexes. Moreover, they can interact with any protein that relies on functional dimers for normal function. MicroProteins predominantly target transcription factors that form DNA-binding dimers. They regulate these complexes by forming homotypic dimers with the targets, thereby inhibiting the function of the protein complex.

There are two forms of miP inhibition: homotypic miP inhibition and heterotypic miP inhibition. In homotypic miP inhibition, microproteins interact with proteins possessing comparable protein-protein interaction (PPI) domains. Conversely, in heterotypic miP inhibition, microproteins interact with proteins having different yet compatible PPI domains. In both types of inhibition, microproteins interfere and prevent the PPI domains from interacting with their normal proteins (Eguen *et al*., 2015).

Modes of Microprotein Regulation

The primary mechanism of action for microProteins involves the formation of non-functional homo/heterodimeric complexes. For instance, microProteins like Id-like proteins and ZPRs operate in this manner. Nevertheless, certain microProteins have the ability to interact with more complex protein assemblies, thereby enhancing the functional diversity of their targets.

MicroProteins exert their effects through various mechanisms, such as:

1. Sequestering their targets into non-functional complexes.
2. Recruiting chromatin repressor proteins (R).
3. Sequestering the target in a subcellular compartment where it is inactive.
4. Interacting with ion channel subunits to disrupt their transport capacity (Figure 2), (Bhati *et al.,* 2018).

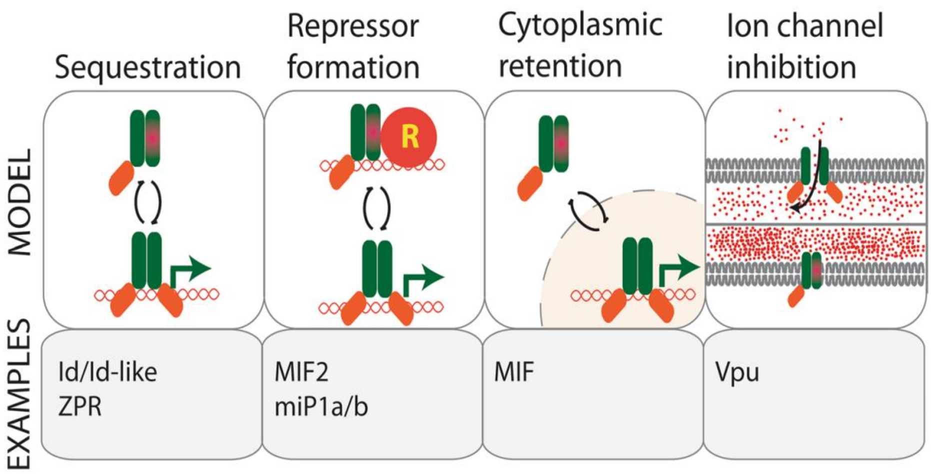

Figure 2. Different modes of microProtein regulation

Functional Role of Microproteins in Plants

A variety of microProteins from diverse families have been discovered in plants, notably in Arabidopsis. Progress in genomic and molecular tools has facilitated the identification and characterization of microProteins in economically significant plant species as well. These microProteins have been studied extensively for their roles in a broad array of physiological functions, including epidermal cell patterning during root hair and trichome development, responses to light signals, leaf development, pigment production, and floral development (Bhati *et al.,* 2018).

Synthetic Microproteins in Plants

Given that microProteins regulate target proteins through compatible protein-protein interaction (PPI) domains, there is potential for designing synthetic microProteins by targeting the PPI domains of critical proteins in physiological pathways. Designing synthetic microProteins with single or multiple functional domains could result in more precise or varied effects.

Dolde *et al,* (2018) employed this strategy by creating transgenic Arabidopsis plants that ectopically expressed protein-protein interaction (PPI) domains derived from DICER-LIKE1 (DCL1), BRASSINOSTEROID INSENSITIVE1 (BRI1), and CRYPTOCHROME1 (CRY1). These proteins play roles in miRNA biogenesis, brassinosteroid response, and light signalling. Remarkably, the expression of these PPI domains led to the disruption of normal physiological processes regulated by DCL1, BRI1, and CRY1 in all three cases.

Expanding on this concept to the commercially significant monocot model rice, Eguen *et al.,* (2020) engineered a microProtein (miP) derived from HEADING DATE 1 (Hd1). Hd1, a rice ortholog of CO in Arabidopsis, plays a pivotal role in flowering regulation by modulating the expression of HEADING DATE 3A (Hd3a) and RICE FLOWERING LOCUS T 1 (RFT1). A synthetic miP was constructed by truncating the CCT domain of Hd1, resulting in Hd1miP. Remarkably, Hd1miP interacted with Hd1, leading to an early flowering phenotype in transgenic plants in a dose-dependent manner, independent of photoperiod. Additionally, the presence of Hd1miP affected yield traits like grain size and also counteracted Hd1-mediated suppression of Hd3a and RFT1 expression levels.

Conclusion

The increase in anthropogenic activity worldwide is creating increasingly stressful environments for plant growth. The combined impacts of climate change and unsustainable agricultural practices pose significant challenges to food security, underscoring the urgency of seeking sustainable and innovative solutions. Traditionally, scientific inquiry has focused on a defined set of large protein-coding genes in biology. However, advancements in technology have revealed the existence of hundreds of thousands of potential genes encoding smaller microProteins. Given their pivotal roles in regulating various physiological processes in plants, microProteins represent promising candidates for the development of synthetic counterparts aimed at bolstering plant stress resilience and thereby enhancing productivity. Harnessing the regulatory potential of these diminutive yet potent microProteins, along with the application of gene editing tools such as CRISPR-Cas9, holds immense promise for crop engineering endeavors.

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Cercospora ricinella: A Phytopathogenic Fungus and its Impact on Castor Cultivation

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Abstract

Cercospora leaf spot is a common disease in castor. It is the most devastating foliar disease in the castor plantations. It is one of the major problems encountered in the cultivation of castor in India, causing substantial injury to leaves intended as feed for eri silkworms. This review examines the biology and epidemiology of Cercospora leaf spot of castor, highlighting its impact on castor cultivation.

Keywords: Castor, *Cercospora ricinella*, Cercospora leaf spot, Epidemiology, Silkworms, Disease incidence.

Introduction

The nomenclature "Cercospora" derives its etymology from the Greek words "kerkos," denoting a tail, and "spora," signifying a spore. This appellation was initially proposed by Johann Bapost Georg Wolfgang Fresenius in the year 1863 to designate cercosporoid fungi, a dematiaceous hyphomycete characterized by filiform, pigmented, and hyaline conidia (Pons and Sutton, 1988). Spegazzini, a prominent figure in mycological taxonomy, described a multitude of novel genera and species across various fungal groups, encompassing 71 species within the genera Cercospora and Cercosporina (Phengsintham et al., 2013). Chupp (1954) published a seminal monograph, which stood as the first comprehensive treatise on the genus Cercospora.

The genus Cercospora (Mycosphaerellaceae, Ascomycota) belongs to the hyphomycete fungi, in which the morphological traits often prove inadequate for precise identification (Welles, 1924), necessitating advanced multi-gene phylogenetic studies to delineate species boundaries. Numerous Cercospora species are recognized as phytopathogenic agents associated with foliar diseases affecting economically significant vegetable and field crops (Groenewald et al., 2013). The Cercospora leaf spot (CLS) disease, also known as frogeye leaf spot, was initially reported by Saccardo in 1876. Adhering to the "One host species, genus or family equals one Cercospora species" concept proposed by Chupp (1954), Pollack (1987) compiled a comprehensive list encompassing more than 3000 Cercospora species. However, subsequent revisions led to the recognition of 659 Cercospora species, with an additional 281 being subsumed as synonyms under the compound species *Cercospora apiis* (Crous and Braun, 2003). In a monographic study of cercosporoid fungi occurring in India, Kamal (2010) deemed only 261 forms of Cercospora out of 935 to be validly recognizable. Furthermore, a total of 483 forms (including 480 species and 3 varieties) were transferred to other taxa on substantiated grounds, with 182 forms being subsumed under *C. apii*s (Kamal, 2010).

Cercospora ricinella

Cercospora leaf spot of castor is a significant fungal disease that affects the productivity and quality of castor crops. It is characterized by the appearance of small, circular or irregularly-shaped dark brown lesions on the leaves, which gradually enlarge and coalesce.These lesions are caused by the fungus *Cercosporaricinella* and can lead to defoliation, reduced photosynthetic activity, and ultimately yield loss. To effectively manage and control Cercospora leaf spot of castor, it is important to have a comprehensive understanding of its epidemiological dynamics.

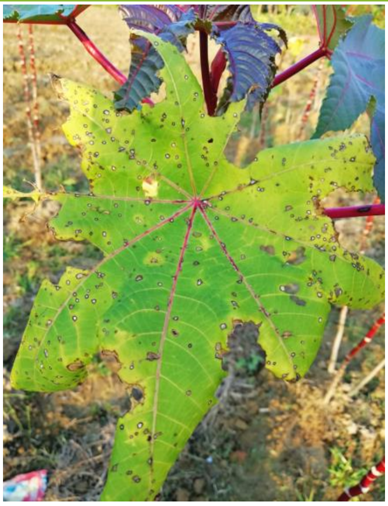

Figure 1. Cercospora infected castor leaf

History and Host Range

The precise origins of the initial isolation and documentation of the fungal pathogen *Cercosporaricinella* remain elusive. Within the Indian subcontinent, the disease has been reported from various locales, including Pusa and Muzaffarpur in Bihar, Hyderabad in Andhra Pradesh, and Kokilamukh in Assam, indicative of its probable widespread distribution across numerous regions of the country. This foliar disease is recognized as one of the most prevalent afflictions impacting a diverse array of sericultural host plants. The pathogen exhibits a remarkable host range, encompassing vegetable crops as well as sericulturally significant plants such as mulberry, som, tapioca, coffee, groundnut, lettuce, sugarbeet, and numerous others. The nomenclatural attribution "*Cercospora ricinella*" was initially bestowed by Saccardo and Berlese in 1885. Notable synonyms of this species include *Cercosporina ricinella* (Sacc. and Berl.) Speg., designated in 1910, *Cercospora ricini* Spegazzini, assigned in 1899, and *Cercospora albidomaculans* G. Winter, designated in 1885.

Biology

The fungal pathogen *Cercospora ricinella* Sacc. and Berl. Belongs to the family Mycosphaerellaceae and exhibits distinct morphological characteristics. The fungal hyphae aggregate beneath the epidermal layer, forming a hymenial stratum. Conidiophore clusters emerge through stomatal apertures or directly penetrate the epidermis. These conidiophores are septate, unbranched, and exhibit a deep brown coloration at the base, gradually transitioning to a lighter brown hue towards the apex. The conidia are elongated, hyaline, straight or slightly curved, truncate at the base, and tapered towards the apex, possessing 2-7 septa. The 76 onidiogen (conidiophore fascicles) are amphigenous, predominantly hypophyllous. The mycelium is internal (Braun et al., 2012). The stromata are poorly developed, ranging from pale brown to brown in color, and are situated substomatally or intra-epidermally, measuring 14-50 µm. The conidiophores exhibit a pale brown hue, gradually becoming paler towards the apex, with a conical tip and occasional constrictions at the proliferation points, measuring 35-140 × 4.5-5.5 µm and bearing 2-4 septa. The conidiogenous cells are integrated, terminal, and intercalary, with multi-locular apices and distinct loci, primarily apical and lateral, measuring 2-3 µm in diameter. The conidia are solitary, rarely catenate, hyaline, cylindrical to cylindro-obclavate or truncate, and distinctly thickened at the base, acute to sub-acute at the apex, measuring 20-130 × 2.5-5.5 µm, with 1-8 septa and thin-walled (Groenewald et al., 2013).

Sporulation

The conidial germination process of the fungus *Cercospora ricinella* commences 9 hours post-inoculation, with the production of an appressorium directly from the conidial apex or at the terminus of a short germ tube. Foliar lesions become apparent 7 days after inoculation, and after 12 days, conidial clusters emerge from both abaxial and adaxial leaf surfaces, breaching the epidermis or emerging through stomatal apertures. Despite the multicellular nature of *C. ricinella* conidia, only a single germ tube is produced from each conidium, invariably originating from the terminal cell (Babu et al., 2007). In contrast, the multicellular conidia of *C. moricola* (Gupta et al., 1995) produce one or more germ tubes per conidium on

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mulberry leaves, facilitating direct entry into the leaf through stomata. Conversely, in *C. henningsii*(Ayesu-Offei and Antwi-Boasiako, 1996), mature conidia undergo budding and fragmentation, generating numerous microconidia that subsequently germinate through germ tubes, some of which produce appressoria. In *C. ricinella*, leaf penetration is exclusively facilitated by appressoria, whereas the germ tubes of *C. moricola* (Gupta et al., 1995) and *C. caricus* (Neto et al., 1998) penetrate host leaves directly through stomatal openings without the formation of appressoria.

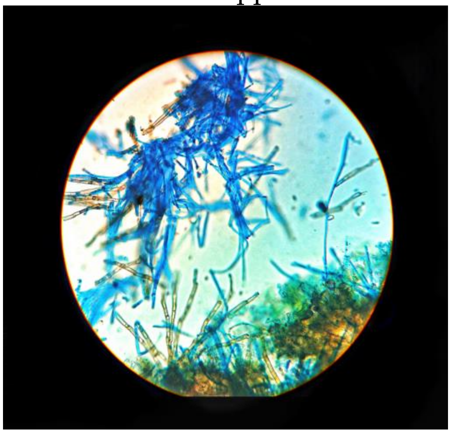

Figure 2. *Cercospra ricinella* spores

Epidemiology

The foliar disease affecting the castor plant (*Ricinus communis* L.) is incited by the fungal pathogen *Cercospora ricinella*. The asexual spores (conidia) of Cercospora initiate infection by directly penetrating the leaf tissues or gaining entry through stomatal apertures. The fungal mycelium proliferates within the leaves, causing tissue damage that manifests as circular or irregularly shaped brownish lesions with light whitish centers, resembling a "frogeye" pattern (Jain, 2019). The pathogen produces a photo-sensitizing toxin, cercosporin, which induces the generation of reactive oxygen species (ROS), disrupting cellular membranes. Through this mechanism, Cercospora infects the plant and exploits its nutrients for sustenance and propagation. While foliar infection is the most prevalent, stems, bracts, or fruits can also be affected in some instances. Souza and Maffia (2011) reported the occurrence of *Cercospora coffeicola*, the causal agent of Cercospora leaf spot in coffee (*Coffea arabica*), infecting castor plants growing as weeds on a coffee farm in Brazil. This represented the first report of castor as a host for *Cercospora coffeicola* in Brazil. Previous reports from Costa Rica (Central America) and Malawi (East Africa) had also documented *Cercospora coffeicola* as a pathogen of castor plants. The disease inflicts considerable damage to the leaves, resulting in a loss of forage for the Eri-silkworm, which is reared on castor plants. Yield losses ranging from 80% to 100% have been attributed to this fungal disease in India (Mamza et al., 2021), adversely impacting the foreign exchange earnings of farmers. Lakshmi et al. (2010) reported that the damage to castor leaves caused a reduction in seed yield, with a loss of 1 m^2 leaf area resulting in a respective decrease of 37.83 g and 24.4 g in seed yield and seed oil yield per hectare.

Perpetuation of *C. ricinella*

According to Agrios (2005), the conidia of Cercospora species are easily detached and can often be dispersed over long distances by wind currents. The fungus thrives under high temperature conditions and is most destructive during the summer months and in warmer climates. Heavy dew formation appears to be sufficient for infection initiation, although Cercospora spores require the presence of free water to germinate and penetrate the host tissues. The pathogen can over-season in seed or as black stromata on previously infected leaf debris. Furthermore, the pathogen can persist as dormant mycelium in plant debris (Parthasarathy et al., 2020). The primary mode of disease dissemination is through wind-dispersed conidia. The disease cycle of Cercospora leaf spot commences in spring, with conidia produced from the surviving pathogen in lesions on crop debris remaining on the soil surface or as dormant mycelia in seeds. These conidia germinate on leaves, penetrate through stomata, and produce hyphae. The hyphae aggregate beneath the epidermis and form stromata. Philip and Qadri (2010) investigated the physiological and biochemical changes induced by the attack of *C. ricinella* on two commonly cultivated castor varieties in South India, Kranthi and GCH-4. They observed a gradual reduction in relative pigment values (SPAD), transpiration rate, and relative water content in both varieties, which was proportional to the intensity of infection. The relative pigment value ranged from 60.24 in healthy leaves to 26.47 in highly infected leaves in the Kranthi variety. In GCH-4, it ranged from 44.77 to 26.67. The effect of the disease on transpiration rate was more pronounced in the Kranthi variety, where it was reduced to 1.58 mol/m^{2}s^{-1}, whereas in healthy leaves it was 15.03 mol/m^{2}s^{-1}. In highly infected leaves of Kranthi and GCH-4, the moisture content was reduced by 7.55 and 24.88 percentages, respectively (Philip and Qadri, 2010). Similarly, the levels of chlorophyll, carotenoids, proteins, and total sugars were adversely affected due to the infection, thereby diminishing the nutritional value of castor leaves.

Disease Incidence in Relation to Weather

In an investigation conducted by Borgohain et al. (2014) on the seasonal occurrence of fungal diversity associated with castor plants in Assam, it was observed that eight fungal species, namely, *Alternaria ricini*, *Aspergillus fumigatus*, *Cercospora ricinella*, *Curvularia clavata*, and *Fusarium* sp., were prevalent during the summer season. Conversely, three fungal species, *Emericella nidulans*, *Leveillula taurica*, and *Melampsora ricini*, were exclusively isolated during the winter season. The study reported a higher number of fungal species isolated during the summer season compared to the winter season. A positive correlation was established between temperature and fungal colony abundance during the summer, as well as between rainfall and fungal colony abundance during the winter season. Contrarily, a negative correlation was observed between relative humidity and fungal colony assemblages, temperature and fungal colony abundance in the winter season, and rainfall and fungal colony abundance in the summer seasons. The Cercospora leaf spot disease inflicts substantial injury to the leaves, consequently diminishing the availability of forage for the Eri-silkworm, which is reared on castor plants.

In Karnataka, it was reported that in severe conditions, infection by Cercospora leaf spot in castor reduced the yield, production and germination up to 30-50% (Dange *et al.*, 2005). The leaf spot caused by Cercospora to mulberry is reported to cause 10-12 % leaf yield loss even up to 20% -35% in severe conditions (Sikdar and Krishnaswamy, 1980; Sikdar, 1987).

Conclusion

Most of the research on this disease has tend to concentrate on technical aspects of fungicide development with significantly less work done on understanding their basic ecology or epidemiology. This limits our ability to employ them successfully for smart host plant disease management. Knowledge on the basic ecology of the biocontrol agents, botanicals or chemicals is very necessary in order to include them in biological control or IDM (Integrated Disease Management). No doubt, works have been done using various chemical fungicides to control this disease. But since we are working with the delicate and sensitive silkworms and we will be feeding these castor leaves to them; it becomes very important for us to improve our understanding of the compatibility and residual effect of the management approaches for the utilization of the control measure in a more efficient way.

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Scientific Poultry Housing

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1. System of poultry housing
2. Availability of land
3. Cost of land
4. Type of farming activity
5. Climatic condition
6. Labor availability.

Broadly Poultry Housing System are Classified into 3 Systems

1. Backyard poultry keeping
2. Free range or extensive system
3. Semi intensive system
4. Intensive system
    a. Deep litter system
    b. Slatted floor system
    c. Slat cum litter system
    d. Cage system.

Backyard Poultry Keeping

1. Traditional Method
2. In which in which few numbers of native chickens are kept on free scavenging system in backyard or surroundings of the human dwelling.
3. Fed by free scavenging around with one- or two-time supplementation with wet rice bran with or without other available feed stuffs of kitchen wastes.
4. Growth and production under this system are generally low.
5. The ability run and fly away from predators.

Free Range Systems

1. Adopted only when adequate land is available to ensure desired stocking density avoiding by avoiding overcrowding. Rear about 250 adults' birds per hectare.

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2. A range provides shelter, greens feed water and shade. Foraging is the major source of feeding for birds.
3. Fields are generally used on rotational basis after harvesting of crops by moving of birds from one field to another of on cropping programme. All categories of birds reared in this system.
4. Mostly preffered foe organic egg production.

Advantages

1. Less capital investment
2. Increases the fertility of soil
3. Cost of housing is least
4. Feed requirements are less.

Disadvantages

1. The scientific management practices cannot be adopted
2. Eggs are lost when laid inside the dense grasses unless special nests are provided
3. Losses due to predatory animals are more.
4. Wild birds may bring diseases unless proper care is taken.

Semi Intensive System

1. Indicates birds are halfway reared in houses and halfway on ground or range.
2. Birds are confined to houses at night or as per need and they are also given access to runs.
3. The houses with solid floors while runs are fields only.
4. The success of rearing depends on maintenance of condition of runs are fields only.
5. The stocking density rate on average for adult birds 750 per hectare.
6. Mainly adopted for duck rearing. Feeding and watering provided in the pen.

Advantages

1. More economic use compared to free range system
2. Protection of birds from extreme climatic conditions
3. Control over scientific operation is some extent possible.

Disadvantages

1. High cost for fencing
2. Need for routine cleaning and removal of litter material from the pen.

Intensive System

1. Confined to houses either ground/floor or on wire-netting floor in cages or on slats.
2. It is the most efficient, convenient and economical system for modern poultry production with huge numbers.

Advantages

1. Minimum land is required for farming. Farms can be located near market areas.
2. Day-to-day management is easier. Scientific management is practiced.
3. The production performance is higher as more energy is saved due to restricted movements.
4. The sick birds can be detected isolated and treated.

Disadvantages

1. Bird's welfare is affected.
2. Chances for spreading of diseases are more.
3. All nutrients should be provided in a balanced manner to avoid nutritionally deficient diseases.

Deep Litter System

1. Birds are kept inside the house all the time
2. Arrangement for feed water and nest are made inside the house
3. The birds are kept on suitable litter material of about 3–5-inch depth
4. The litter is used for fresh litter material spread on the floor.
5. Usually paddy husk, chopped paddy straw or wood shaving are used as litter materials. Saves labour. litter spread on the floor in layers of 2" height.

Advantages

1. Vitamin B2 and vitamin B12 are made available to birds from the litter material by the bacterial action. Deep litter manure used as a fertilizer.
2. Lesser nuisance from flies when compared to cage system.

Disadvantages

1. Diseases outbreak is more prominent.
2. Respiratory problems due to dust from the litter.
3. Litter cost is an additional expenditure.

Slatted Floor System

1. In this iron rod or wood reapers are used as floor usually 2-3 feet above the ground level to facilitate fall of dropping through slats.
2. Wooden reapers /iron rods of 2” diameter can be used on lengthwise of the house with interspace of 1” between rods.

Advantages

1. Saving on labour. Increase sanitation.
2. Bedding is eliminated
3. Manure handling is avoided
4. Less floor space per bird is needed
5. Soil borne diseases is controlled

Disadvantages

1. Higher initial cost

2. More fly problem
3. Feed waste is more
4. Less flexibility in use of the building.

Slat Cum Litter System

1. Commonly practiced in birds for rearing hatching eggs production particularly meat type breeders.
2. A part of the floor area is covered with slats; 60% of the area is covered with slats and the rest is litter.
3. Waterer and feeder are arranged in both salt and litter area.
4. For breeder flocks next boxes are kept.

Advantages

1. Fertility better
2. More eggs per unit area.

Disadvantages

1. More fly problems
2. Housing investment is higher.

Cage System

1. Raising on wire netting floor in smaller compartment, called cages
2. Fitted with stands on floor or hanged from the roof
3. Efficient for laying operations right from day old to till disposal
4. At present 90% of commercial layers in India are kept in cages
5. Waterer and feeder attached to cages from outside except nipples waterers (pipeline installed above the cages)
6. Dropping collected underneath cages or deep pit under cages.

Advantages

1. Clean eggs production. Better feed efficiency
2. Less feed wastage. No need of litter material
3. Minimum floor space. More number of eggs per hen. No need of litter material
4. Vices like pecking and egg eating is minimum.

Disadvantages

1. Handling of manure may be problem
2. Initial investment is high
3. Greater nuisance of flies
4. Cage layer fatigue is main problem (deficiency of ca and p).

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Innovative Techniques in Fruit Nursery Production

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Innovation in Fruit Nursery Production: A Glimpse

The fruit nursery industry plays a pivotal role in supplying high-quality, disease-free planting materials essential for fruit crop production worldwide. To meet the increasing demand for diverse fruit varieties, improve crop resilience, and address environmental challenges, the industry is continually evolving and embracing innovative techniques. These advancements encompass various aspects of nursery management, from propagation methods and environmental control to pest management and technology integration. By adopting these innovative techniques, fruit nurseries can enhance efficiency, productivity, and sustainability while ensuring the supply of healthy planting materials to growers. Innovative techniques in fruit nursery production are essential for improving efficiency, quality, and sustainability in fruit crop cultivation.

Different Innovative Techniques Used in Fruit Nursery Industry: A Brief Overview

1. Tissue Culture Propagation: Tissue culture techniques allow for mass propagation of elite fruit tree varieties under sterile conditions. Example: Tissue culture has been successfully used for the propagation of banana (*Musa spp.*) (Kema *et al.,* 2021), citrus (*Citrus spp.*), and grapes (*Vitis vinifera*).

2. High-Density Nursery Systems: High-density nursery systems optimize space and resources by growing fruit tree seedlings in closely spaced containers or trays. Example: The use of high-density nursery systems has been demonstrated in the production of apple and mango seedlings.

3. Biodegradable Containers: Biodegradable containers made from organic materials reduce plastic waste and minimize transplant shock when planting fruit tree seedlings. Example: Biodegradable containers made from materials such as coconut coir and rice husks have been used for growing citrus and pomegranate (*Punica granatum*) seedlings.

4. Precision Irrigation and Fertilization: Precision irrigation and fertilization techniques optimize water and nutrient management in fruit nurseries, improving plant health and reducing environmental impact. Example: Drip irrigation systems combined with fertigation have been used to efficiently deliver water and nutrients to fruit tree seedlings in nurseries.

5. Greenhouse and Controlled Environment Production: Greenhouse and controlled environment production systems provide ideal growing conditions for fruit tree seedlings, allowing year-round propagation and improved plant quality. Example: Controlled environment chambers equipped with supplemental lighting and climate control are used for producing high-quality cherry (*Prunus avium*) and peach (*Prunus persica*) seedlings.

6. Hydroponic Nursery Systems: Hydroponic systems enable the cultivation of fruit tree seedlings in nutrient-rich water solutions, providing optimal conditions for root development and growth. Example: Hydroponic systems have been utilized for growing strawberry (*Fragaria × ananassa*) seedlings in controlled environments, leading to improved plant vigor and productivity (Chow *et al.,* 2002).

7. Vertical Nursery Systems: Vertical nursery systems optimize space utilization by stacking growing trays vertically, allowing for high-density cultivation and efficient use of resources. Example: Vertical nursery systems have been implemented for the production of tree seedlings such as mango and avocado, maximizing nursery capacity and minimizing land footprint.

8. Automated Nursery Operations: Automation technologies such as robotic seedling transplanters and automated irrigation systems streamline nursery operations, reducing labor costs and improving efficiency. Example: Automated transplanting machines have been developed for the rapid and precise planting of seedlings in nursery containers, increasing productivity in tree nurseries.

9. Remote Sensing and Precision Management: Remote sensing technologies, including drones and satellite imagery, are employed for monitoring nursery conditions and optimizing plant management practices. Example: Satellite-based monitoring systems have been utilized to assess plant health and growth parameters in fruit nurseries, enabling precision management strategies (Luedeling *et al.,* 2009).

Advantages of Adopting Innovative Techniques in Fruit Nursery

1. Increased Efficiency: Innovative techniques often streamline processes, leading to increased efficiency in fruit nursery operations. For example, automated transplanting machines and robotic systems reduce labor requirements and speed up production.

2. Improved Quality: Techniques such as tissue culture propagation and precision propagation produce uniform, disease-free plantlets with consistent traits, leading to improved overall quality of fruit trees.

3. Enhanced Disease Resistance: Biotechnological approaches, including genetic engineering and marker-assisted selection, enable the development of fruit tree varieties resistant to pests and diseases, reducing the need for chemical pesticides.

4. Optimized Resource Use: Hydroponic and vertical nursery systems optimize resource use by maximizing space utilization, reducing water consumption, and minimizing fertilizer and substrate requirements.

5. Environmental Sustainability: Biodegradable nursery materials and sustainable production practices contribute to environmental conservation by reducing plastic waste and minimizing the carbon footprint of nursery operations.

6. Year-Round Production: Controlled environment production systems, such as greenhouses and hydroponic setups, allow for year-round propagation of fruit tree seedlings, ensuring consistent availability regardless of seasonal variations

Limitations of Using Innovative Techniques in Fruit Nursery

1. High Initial Investment: Implementing innovative techniques often requires significant upfront investment in infrastructure, technology, and training, which may pose a barrier to entry for smaller nurseries or growers with limited resources.

2. Technical Expertise Required: Some innovative techniques, such as tissue culture propagation and genetic engineering, require specialized knowledge and skills, making them challenging to adopt without adequate training and expertise.

3. Risk of Genetic Uniformity: While precision propagation techniques produce uniform plantlets, they may also lead to genetic uniformity within nursery stocks, increasing susceptibility to diseases and reducing genetic diversity.

4. Dependency on Technology: Automation and high-tech systems in nurseries rely on technology, making them vulnerable to malfunctions, power outages, or technical issues that could disrupt nursery operations.

5. Environmental Concerns: While certain techniques promote environmental sustainability, others, such as hydroponic systems, may raise concerns about water usage and nutrient runoff if not managed properly.

6. Regulatory Challenges: Biotechnological approaches, including genetic engineering, may face regulatory hurdles and public scrutiny, delaying their adoption or implementation in some regions.

7. Long-Term Sustainability: It's essential to assess the long-term sustainability of innovative techniques, considering factors such as resource availability, environmental impact, and economic viability over time.

Conclusion

Innovative techniques are revolutionizing the fruit nursery industry, offering solutions to meet the growing demand for high-quality planting materials, enhance productivity, and address sustainability challenges. From advanced propagation methods to precision management practices, these innovations are reshaping nursery operations and driving improvements across the entire value chain. These innovative techniques are driving significant advancements in the fruit nursery industry, empowering nurseries to produce healthier plants, minimize environmental impact, and meet the evolving needs of growers and consumers. Continued research, collaboration, and adoption of these techniques are essential for ensuring the sustainable growth and competitiveness of the fruit nursery industry in the years to come.

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Exploring the Potential of Silkworms as a Novel Source of Sustainable Nutrition

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Abstract
Silkworms have long been revered for their role in silk production, yet their potential as a sustainable source of food remains largely untapped. Silkworms are rich in protein, essential amino acids, and various micronutrients, making them a promising candidate for addressing global food security challenges. With a nutritional profile, silkworms offer a sustainable alternative that could revolutionize the way we think about food production and consumption. From protein-rich snacks to gourmet delicacies, chefs and food enthusiasts are finding innovative ways to showcase the versatility and flavour potential of these tiny creatures. Despite initial hesitations due to cultural taboos, adventurous eaters are increasingly embracing the idea of incorporating insects into their meals, recognizing the environmental and health benefits they offer. As awareness grows and culinary boundaries expand, silkworms are poised to emerge from their silk cocoons and take their place as a staple on the modern dinner plate. However, challenges such as regulatory frameworks, scalability of production, and public perception necessitate further research and collaborative efforts among stakeholders to realize the full potential of silkworms as a sustainable and nutritious food source.

Keywords: Silkworm, food, nutrition, Entomophagy.

Introduction
In India, sericulture boasts an ancient heritage, with all four commercially utilized silk types Mulberry, Tasar, Muga and Eri being cultivated. The Indian silk sector has experienced significant advancements over time, serving as a crucial means of reducing poverty, especially in rural regions (Sadat et al., 2022). In addition to silk production, it also acts as a good nutritional food source. As the global population is growing rapidly, leading to an increased demand for food. According to the Food and Agricultural Organization of the United Nations, food production needs to be significantly increased by 2050 to meet the needs of a projected world population of nine billion (Thangjam et al., 2020). The growing population will need protein from innovative and sustainable sources, with insects being identified as a novel alternative to meet future protein demands. Insects represent one of the most diverse animal groups, thriving in almost every environment, and can be used as nutritional supplement (Sharma et al., 2022). As per FAO (2013), over 1900 insect species are presently incorporated into the diets of at least two billion individuals worldwide. The most commonly consumed insects belong to Hemiptera (10%) followed by Lepidoptera (18%), Orthoptera (13%), Hymenoptera (14%), Coleoptera (31%) and 3% each from Odonata, Diptera and Isoptera orders. Entomophagy is primarily practiced in Asia, Africa, Australia, and Latin America (de Castro et al., 2018). it refers to practicing of eating insects as a food. Among various insects using as diet silkworm and its metabolites possess significant economic, medicinal and nutritional value (Ratcliffe et al., 2011), larvae and pupae are one of the emerging insect-based nutritious food sources with high proteins, oils, polyphenols, vitamins, and chitosan (Zhou et al., 2022) and also potential antioxidant activities, antimicrobial and therapeutic properties. In many Asian countries, SWP (Silkworm pupa) has been used as folk medicine due to its enormous nutritional and curative value (Sadat et al., 2022).

Nutritive Composition of Silkworm Eggs
The presence of omega-3 polyunsaturated fatty acids in silkworm eggs makes them a potential nutritious food for nursing mothers. These unsaturated fatty acids serve as precursors of prostaglandins, which play a significant role in infant nutrition. Moreover, consuming silkworm eggs has been associated with increased male sexual potency and reduced erectile dysfunction, attributed to elevated levels of GSH and

nitric oxide synthetase in the corpus cavernosum (Mahanta *et al*., 2023). Silkworm eggs serve various purposes, including as an embryo inducer, hepatic protector, hypolipidic agent and hypoglycemic agent. Moreover, they are widely utilized in transgenic studies.

Nutritive Composition of Silkworm Larvae

The larvae of Bombyx mori are estimated to contain 54% protein, 8% fat, 6% ash, 6% fiber and with an energy content of 390 kcal per 100 grams (Blásquez *et al*., 2012). According to Ryu *et al*., 1997 silkworm larva exhibits the highest potential for lowering blood sugar levels when powder prepared on the third day of the fifth instar, utilizing the freezing-dry method, and consumed in powdered form, compared to other methods.

Nutritive Composition of Silkworm Pupae

Silkworm pupae exhibit a protein content of approximately 21.5%, surpassing that of other conventional animal products. On a dry-weight basis, the protein content of silkworm pupae has been documented to reach levels as high as 49%–54% (Nowak *et al*., 2016). Pupae are also abundant in vitamins, boasting a diverse array of these essential nutrients. Vitamins present in pupae encompass Vitamin A, B1, B2, B3, B5, B7, B9, B12, C, and E (Paul and Day 2014). Pupal proteins also exhibit notable concentrations of essential amino acids, including phenylalanine, methionine, and valine. Moreover, silkworm pupae contains α-glucosidase inhibitor known as 1-deoxynojirimycin (DNJ), potentially mitigating postprandial hyperglycaemia and carbohydrate absorption. As such, silkworm pupae represent valuable food sources (Tomotake *et al*., 2010).

Conclusion

Silkworm is a promising and versatile option as a food source, offering a rich nutritional profile and numerous potential health benefits. With high protein content, essential amino acids, omega-3 fatty acids, vitamins, and minerals, silkworms have the potential to contribute significantly to meeting global food demand. Furthermore, their sustainable production, culinary adaptability, and cultural acceptance in various regions underscore their viability as a food source for future generations. As research continues to explore the diverse uses and benefits of silkworms, incorporating them into diets worldwide could contribute to improved nutrition, food security, and environmental sustainability. However, further investigation into optimal harvesting methods, processing techniques, and regulatory considerations is necessary to fully unlock the potential of silkworms as a valuable and accessible food resource.

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Molecular Farming: Engineering Radioisotope-Tagged Biomolecules for Advanced Crop Monitoring and Management

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Introduction

Radioisotopes have found extensive applications in agriculture, revolutionizing various aspects of crop management and soil science. These isotopes, characterized by their radioactive decay, enable researchers to trace and study the movement of nutrients within plants, analyze soil erosion rates, and determine the efficiency of fertilizers and pesticides. Additionally, radioisotopes aid in breeding programs by facilitating the development of new crop varieties with improved traits such as disease resistance and higher yields. Furthermore, they play a crucial role in understanding and controlling pests, diseases, and weeds through techniques like radiotracer studies and irradiation. Overall, the utilization of radioisotopes in agriculture enhances productivity, sustainability, and food security by providing valuable insights into plant and soil dynamics, thereby contributing to the advancement of agricultural practices.

Nuclear science and technology offer techniques that are being used to improve productivity while conserving valuable resources needed for day-to-day life (Amritpal Kaur *et al.,* 1999). Radioisotopes are used as a research tool to develop new strains of agricultural crops that are drought and disease resistant, are of higher quality, have shorter growing time and produce a higher yield. Radioactive elements emit a variety of radiation and energy particles during decay which are used in health care, agriculture, and physical sciences for basic research and in wide range of applications (Sahoo & Sahoo, 2006).

Radioactive exposure improves quality and productivity of agricultural products along with insect, pest and disease management. They are helpful in the study of optimum utilization of fertilizers, insecticides, and pesticides in cultivated crops without harmful effects to plants and other living organisms. Radioisotopes have played an important role in improving productivity in agriculture in a sustainable manner. Ionizing radiation is very useful for preservation of agricultural and food products. Many products used in our daily life have in some way benefited from radiation during their production. International Atomic Energy Agency (IAEA) promotes the wider use of radioisotopes and radiation sources in research, industry, agriculture and medicine.

Food and Agriculture Organization (FAO) and IAEA work to facilitate development and adoption of nuclear technologies at national and international levels for improving agricultural productivity. The mission of the Joint FAO/IAEA Division is to develop improved technologies for sustainable food security involving nuclear methods. Radioisotopes and controlled radiation are now used in a variety of studies like crop improvement, food preservation, determine groundwater resources, sterilize medical supplies, analyze hormones, X-ray pipelines, control industrial processes and to study environmental pollution.

FAO and IAEA jointly support and co-ordinates research projects throughout the world on the use of isotopes and radiation in the fields of irrigation and crop production, soil fertility, insect and pest control, livestock production, health and food preservation. Improvement of agriculture is one of the most significant contributions that atomic energy can make to meet the challenge of food security for present and future generations, to conserve natural resources and to protect the environment (IAEA, 1996). While some progress in this direction has already been made, the full potential is yet to be explored adequately.

Applications in Agriculture

1. Plant Nutrition Studies: Fertilizers are very expensive and their efficient use is of great importance to reduce the production cost of agricultural crops. It is essential that a maximum amount of fertilizer used during cultivation finds its way into the plant and that the minimum is lost. Radioisotopes are very useful in estimating the amount of phosphorus and nitrogen available in the soil. This estimation helps in determining the amount of phosphate and nitrogen fertilizers that should be applied to soil. Fertilizers labelled with radioactive isotopes such as phosphorus-32 and nitrogen-15 have been used to study the uptake, retention, and utilization of fertilizers. Excessive use of fertilizers affects biodiversity and damages the environment. These isotopes provide a means to determine the amount of fertilizer taken and lost to the environment by the plant Applications of Radioisotopes in Agriculture (Harderson, 1990). Nitrogen-15 also helps in assessment of nitrogen fixed by plants from the atmosphere under field conditions. IAEA develops and transfers techniques that use radioactive isotopes for measuring the nutrient uptake from various fertilizer sources with an aim to achieve higher and more stable grain yields by optimizing the uptake of nutrients from applied fertilizers (Zapata and Hera, 1995). Only a small amount of fertilizer applied to the soil is taken up by the crop. The rest either remains in the soil or is lost through several processes. FAO and IAEA have jointly conducted several research programmes for the efficient use of radioactive isotopes for fertilizer management practices in important agricultural crops like wheat, rice and maize. Studying soil characteristics is extremely valuable in devising effective methods of farming. Radioactive isotopes can be used as “tags” to monitor uptake and use of essential nutrients by plants from soil (IAEA, 1996). This technique allows scientists to measure the exact nutrient and water requirements of crops in particular conditions. A major factor in successful crop production is the presence of an adequate water supply. Nuclear moisture density gauges can monitor and determine the moisture content of soil so indicate the exact irrigation needs of a particular area. Nuclear science and technology have greatly facilitated such investigations and are now being widely used in soil plant nutrition research to make the most efficient use of limited water sources. Ionizing radiation is also used to sterilize the soil and there is a good deal of current interest in the use of radiation for the eradication of microorganisms in the soil which causes diseases and are harmful to plant life.

2. Insect Pest Management: Insect pests are responsible for significant reduction in production of agricultural crops throughout the world (Alphey, 2007). Insect pests are a serious threat to agricultural productivity. They not only reduce crop yields but also transmit disease to cultivated crops. Radiolabel pesticides were used to monitor the persistence of their residues in food items, soil, ground water and environment. These studies have helped to trace and minimize the side effects of pesticides and insecticides. There are concerns that continuous uses of pesticides have negative impacts on the environment, and it also results in development of resistance against pesticides in many insect species (ANBP, 2005). Moreover, pesticides not only kill target species but also many other beneficial pest species responsible for maintaining natural ecological balance in the crop fields.

IAEA is using nuclear science to develop environmentally friendly alternatives for pest control. FAO and IAEA division jointly sponsor projects and conducts research on control of insects using ionizing radiations. They have placed considerable emphasis on the Sterile Insect Technique (SIT) proposed by Knipling in 1955 (Knipling, 1955). This technique relies on application of ionizing radiation as a means to effectively sterilize male insects without affecting their ability to function in the field and successfully mate with wild female insects. This technique involves release of large numbers of sterile male insects of the target species in the field crop.

Sterile male insects compete with the regular male population during sexual reproduction and the eggs produced from their mating are infertile, so they produce no offspring (Morrison *et al.*, 2010). It is highly specific form of "birth control which reduces and eliminates the insect population after two or three generations. It has been effectively utilized in elimination of Mediterranean fruit fly from US, Mexico and Chile and screw worm infestation in the US and Mexico (Klassen and Curtis, 2005; Wyss, 2000; Lindquist *et al.*, 1992). It has been successfully used to eradicate several insect pests of agricultural significance throughout the world.

3. Crop Improvement: Plant breeding requires genetic variation of useful traits for crop improvement. Different types of radiation can be used to induce mutations to develop desired mutants’ line that are resistant to disease, are of higher quality, allow earlier ripening, and produce a higher yield. An initial attempt to induce mutations in plants was demonstrated by American Scientist L.J. Stadler in 1930 using X-rays. Later on, gamma and neutron radiation were employed as ionizing radiation. This technique of utilizing radiation energy for inducing mutation in plants has been widely used to obtain desired or improved characters in a number of plant varieties. It offers the possibility of inducing desired characters that either cannot be found in nature or have been lost during evolution.

A proper selection of mutant varieties can lead to improved quality and productivity. During last two decades, radiation-induced mutations have increasingly contributed to the improvement of crop plant varieties, and it has become an established part of plant breeding methods. Radiation induced mutation experiments are showing promising results for improvement of cultivated crop varieties in many countries.

Bhabha Atomic Research Centre (BARC) has developed a number of high yielding varieties of tur, green gram, black gram, groundnut, jute and rice by using radiation energy for inducing mutation (Sood *et al*., 2010). Crop varieties developed by using induced mutations have been found valuable by many national authorities, so they have been released and approved for commercial production. Most of the groundnut and black gram grown in India are from mutant varieties developed at BARC. There are many similar successful mutants in use in other countries, for example, high yielding mutant barleys which can utilize higher doses of fertilizer for increased grain production. Improved pearl millet line showing resistance to downy mildew disease was developed using irradiation treatment in India and is now grown over an area of several million hectares.

4. Food Processing and Preservation: Demand for instant food, which is wholesome, and which has a long shelf life, is growing in both the developed and the developing countries. 25-30% of the world's food produce is lost due to spoilage by microbes and pests and these losses are more in developing countries. This loss of food can be avoided by employing efficient food preservation methods. Radiation can be used to destroy microbes in food and control insect and parasite infestation in harvested food to prevent various kinds of wastage and spoilage.

Extension of shelf life of certain foods of a few days by irradiation is enough to save them from spoiling. Irradiation of food has the potential to produce safe foods with long shelf life. Certain seeds and canned food can be stored for longer periods by gently exposing them to radiation. Food irradiation is energy-conserving when compared with conventional methods of preserving food to obtain a similar shelf-life (Wilkinson and Gould, 1996). It can alleviate the world's food shortage by reducing post-harvest losses. Food irradiation can replace or drastically reduce the use of food additives and fumigants which are hazardous for consumers as well as workers in food processing industries.

Irradiation does not heat the food material, so food keeps its freshness in its physical state. The agents which cause spoilage (microbes, insects, etc.) are eliminated by irradiation from packaged food and packaging materials are impermeable to bacteria and insects so recontamination does not take place. Irradiation of food kills insects and parasites, inactivate bacterial spores and moulds, prevent reproduction of microbes and insects, inhibit the sprouting of root crops, delays ripening of fruits and improves technological properties of food. FDA has approved irradiation as a method to inhibit sprouting and to delay ripening in many fresh fruits and vegetables. Several steps were taken by the FAO and IAEA divisions in close cooperation with the World Health Organization (WHO) to promote international acceptance of irradiated food (WHO, 1988).

The Joint FAO/IAEA/WHO Expert Committees on the Wholesomeness of Irradiated Food (1980) have evaluated the safety of irradiated foods for human consumption and concluded that the irradiation of any food up to an average dose of 10 kGy causes no toxicological hazard. Irradiation of food is controversial in many parts of the world (Diehl, 1993). World-wide introduction of food irradiation is necessary to enhance confidence among trading nations that foods irradiated in one country and offered for sale in another, have been subjected to commonly acceptable standards of wholesomeness, hygienic practice, and irradiation treatment control. Efforts and support from international organizations, governments, and the food industry will be needed for the introduction of food irradiation on a truly commercial scale (Diehl, 1990).

Some organizations and industries do not recognize this cheap and efficient food preservation method. In the last 30 years of testing of irradiated foods, no harmful effects to animals or humans have been found so now the attitude of relevant organizations is changing and some irradiated foods are being released for general consumption. Many countries have accorded clearance for gamma irradiation of food items. The National Monitoring Agency (NMA) of Government of India has cleared radiation processing of onions, spices, and frozen sea foods. In India two demonstration plants one at Vashi, Navi Mumbai and another at

Lasalgaon, Nashik are providing irradiation service for processing of spices, onions, and fruits (Sood *et al*., 2010).

In agriculture, radioisotopes are used in the nutritional studies of major and minor elements, milk production, and the mechanism of photosynthesis studies. Plant protection, plant pathology, action of insecticides, uptake of fertilizers, ions mobility in soil, and plants and food preservation. In order to determine the correct nutrition for a plant we need to know the exact soil plant relationship and the factors involved therein.

Application of Radioisotopes and Radiation Sources in Agricultural Research

1. With the help of radioisotopes, we can easily locate the presence of a single atom and molecule and their movement. Hence, they give research workers the opportunity to follow up step by step all kinds of processes that are related to the nutrition of plants from germination to maturity.
2. Very small quantities of labeled nutrients can be accurately measured in the presence of large quantities of other nutrients.
3. The location of materials can be identified by radio-autography.
4. Tracer technique enables one in tracing those elements taken by the plants accurately and precisely.
5. It also helps to study accurately the effect of one element upon the absorption of another and their interaction by plants and now it has become very easy to study properly the phenomenon of interaction among mineral nutrients.

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Pollination Management in Fruit Crops to Improve Fruit Set

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Pollination Management: An Overview

Pollination management is crucial in fruit crop production as it directly impacts the yield, quality, and consistency of fruit production. Pollination means transfer of viable pollen from mature anther to receptive stigma. Flowers are fully dependent on vectors to move pollen. These vectors may be wind, water, birds, butterflies, bats and other animals that visit flowers. It is essential to understand the pollination biology of the specific fruit crop being cultivated. This includes knowing the type of pollination (e.g., self-pollination, cross-pollination), the reproductive structures of the flowers, and the pollinators involved. Different fruit crops rely on different types of pollinators such as bees, butterflies, moths, birds, and even wind. Identifying the primary pollinators for the specific crop is crucial for effective pollination management. Approximately 66% of the 1500 crop species worldwide are pollinated by honeybees, making them the principal pollinators for most angiosperms and contributing 15–30% of global food supply (Ollerton, 2012). Their ability to efficiently collect pollen and nectar from flowers makes them invaluable in fruit crop pollination. Creating and maintaining suitable habitats for pollinators around fruit crop fields is essential. This includes planting native flowering plants, providing nesting sites, and minimizing the use of pesticides harmful to pollinators.

Role of Pollinators and Pollinizing Varieties

Pollinators play a crucial role in fruit crop production by facilitating the transfer of pollen from the male reproductive organs (anthers) to the female reproductive organs (stigmas) of flowers. This process leads to fertilization and the development of fruits. Here's a breakdown of the role of pollinators and pollinizing varieties in fruit crops, along with some examples:

1. Pollinator Diversity: Pollinators such as bees, butterflies, beetles, flies, birds, bats, and moths play essential roles in fruit crop pollination. They transfer pollen between flowers, facilitating fertilization and fruit development. Example: In apple orchards, honeybees (*Apis mellifera*) are primary pollinators, while native bees such as bumblebees and solitary bees also contribute significantly to pollination (Delaplane and Mayer, 2000).

2. Pollinizing Varieties: Some fruit crops require compatible pollinizer varieties to ensure adequate cross-pollination and fruit set. These varieties must bloom concurrently and have compatible genetic traits for successful pollination. Example: In many varieties of almond trees (*Prunus dulcis*), cross-pollination between different cultivars is essential for fruit set. Varieties such as 'Nonpareil' require pollinizers such as 'Monterey' or 'Carmel' to ensure adequate pollination (Batra and Batra, 2013).

3. Enhanced Fruit Set and Yield: Adequate pollination by diverse pollinators and compatible varieties results in increased fruit set, higher yields, and improved fruit quality. Proper pollination can also lead to more uniform fruit development. Example: Studies have shown that increased pollinator diversity and abundance can significantly enhance fruit set and yield in crops such as blueberries (*Vaccinium spp.*) and strawberries (*Fragaria spp.*) (Garibaldi *et al.,* 2013).

4. Quality Improvement: Effective pollination not only increases fruit quantity but also improves fruit quality attributes such as size, shape, color, and taste. Proper pollination contributes to the development of well-formed and flavorful fruits. Example: Pollination by bees has been linked to improved fruit quality in various fruit crops, including watermelon (*Citrullus lanatus*), where bee pollination enhances fruit size, shape, and sugar content (Winfree *et al.,* 2008).

Pollination Management in Different Fruit Crops

1. Mango: Mango cultivars vary in self-fertility and self-sterility, but cross-pollination is generally beneficial for fruit sets. Bee pollination significantly increases fruit set in mango trees, highlighting the importance of pollinating insects.

2. Guava: Honeybees are effective pollinators for guava, increasing fruit set and improving fruit quality, including characteristics like length and girth.

3. Custard Apple: Beetles are the primary pollinators of custard apple, while honeybees also contribute to pollination. About 10% of custard apple yield can be attributed to honeybee pollination.

4. Fig: Fig plants rely on specific fig wasp species for pollination, especially economically valuable varieties like Smyrna fig. Fig wasps are critical for fertilization and ripening of certain edible figs.

5. Sapota: Thrips, particularly *Thrips hawaiiensis* and *Haplothrips tenuipennis*, are the main pollinators of sapota. Thrips feed on nectar, pollen grains, and stigmatic exudations, facilitating pollination.

6. Ber (Indian Jujube): Ber flowers are protandrous, and cross-pollination is essential for fruit set. Honeybees are important pollinators of ber, transferring thick and heavy pollen from flower to flower.

7. Aonla (Indian Gooseberry): Aonla is mostly cross-pollinated, with wind, honeybees, and gravity playing important roles in pollination. The use of honeybees as pollinators improves fruit set and quality in aonla orchards.

8. Apple: Most apple varieties are self-incompatible, requiring cross-pollination for good fruit set. Honeybees are important pollinators, and flowering crabapples are often used as pollinizers. Managed pollination systems involving bees have been shown to increase fruit set and reduce fruit drop in apple orchards.

9. Cherries: Sweet cherries require cross-pollination between different cultivars for fruit set. Honeybees are crucial for pollination, with insufficient or ineffective pollination leading to unsatisfactory crop yield. Sour cherries are mostly self-fertile and do not require a pollinator.

10. Almonds: Almond flowers are self-incompatible, requiring cross-pollination between cultivars for fruit set. Honeybees are essential pollinators, transferring pollen between flowers and cultivars to achieve maximum crop production.

11. Plums: European plums may set fruit with their own pollen but benefit from cross-pollination for better crops. Honeybees and wild bees are important pollinators for plums, with self-incompatible varieties requiring cross-pollination for optimal fruit production.

12. Strawberries: Strawberries exhibit complex flowering and pollination behavior, with both self-pollination and cross-pollination occurring. Insect pollinators, particularly bees, are essential for achieving optimal fruit set and yield. Intercropping with bee-friendly flowering plants and providing nesting sites can attract and support pollinators. Managing pests and diseases to avoid negative impacts on pollinator populations is important.

13. Blueberries: Blueberries are partially self-fertile but benefit from cross-pollination to increase fruit set and yield. Native bees such as bumblebees and managed honeybees are important pollinators. Increasing pollinator diversity through habitat management and providing nesting sites can enhance pollination efficiency. Planting multiple blueberry cultivars with overlapping bloom periods improves cross-pollination.

14. Citrus: Citrus trees are predominantly self-pollinated but benefit from cross-pollination to improve fruit set and yield. Bees, including honeybees and native bees, visit citrus flowers for nectar but may not be significant pollinators. Wind can also facilitate pollen transfer in citrus orchards. Maintaining healthy tree populations, managing orchard habitats, and minimizing pesticide use support natural pollination processes.

Conclusion

Effective pollination management is essential for maximizing fruit crop production, ensuring high yields, and maintaining fruit quality. By understanding the role of pollinators and pollinizing varieties, growers can implement strategies to enhance pollination and optimize fruit set. Diverse pollinator communities contribute to increased pollination efficiency and resilience in fruit crops, while compatible pollinizer varieties facilitate cross-pollination and fruit development. Conservation of pollinator habitats, promotion of pollinator-friendly practices, and preservation of genetic diversity are integral components of sustainable pollination management in fruit crops. Overall, prioritizing pollination management practices benefits both growers and the environment, ensuring the continued productivity and resilience of fruit crop systems.

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The Pharmacological Powerhouse: Guava's Medicinal Properties

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Abstract

Guava, scientifically known as Psidium guajava L., is a perennial plant belonging to the Myrtaceae family and is native to Mexico and Central America. This fruit matures and ripens at a crucial period of development and is mostly found in tropical and subtropical areas of various countries. Guava is rich in a diverse range of minerals and vitamins such as vitamin C, vitamin B, potassium, lycopene, manganese, iron, fiber, and calcium. Guava fruit, leaf, and other plant components provide rich nutritional and medicinal characteristics that offer therapeutic advantages. The extracts of guava fruits and leaves are used to treat health issues. It has several therapeutic properties, including being anticancer, antimalarial, antiobesity, antifungal, antibacterial, antidiabetic, and antihypertensive. Phytochemicals present in the leaves have the ability to reduce symptoms associated with cough and cold. It is claimed that the presence of certain nutraceuticals such as caffeic acid, gallic acid, flavonoids, apigenin, hyperin, etc., might provide health benefits.

Introduction

Guava consists of many trees and shrubs belonging to the genus Psidium (family Myrtaceae) that are indigenous to tropical America. The word "guava" seems to come from the Arawak term guayabo, meaning "guava tree", which was then adopted into Spanish as guayaba. Guava is thought to have come from Mexico or Central America and has been translated into multiple European and Asian languages with a comparable structure. It has garnered significant popularity in Asian countries and is now more readily available in the United States, particularly after the disclosure of its health benefits. India, China, Thailand, Pakistan, Mexico, Indonesia, Brazil, Bangladesh, Philippines, and Nigeria are the leading countries in guava production. India, Pakistan, and Brazil were the primary worldwide producers of commercial cultivars of Guava.

The guava fruit is abundant in essential nutrients and minerals such as vitamins A, B, and C, carbs, fiber, flavonoid, thiamin, niacin, pyridoxine, cyanocobalamin, phenolic, betacyanins, polyphenol, and carotene. According to Pandhi *et al*. (2022), guava leaves are rich in flavonoids and polyphenols, which are known for their strong antioxidant properties. It is believed that Quercetin has antiplasmodial effects by loosening the muscles in the digestive system. Guava leaf polysaccharides have the potential to be used as a treatment for diabetes and also act as a remedy for humans.

In Ayurveda, it is considered an important herbal medicine for dysentery and diarrhea. In Traditional Chinese Medicine system, it is used to treat many diseases. It has been used for ages to improve the health of humans.

Table: Ethnomedicinal use of guava parts:

S. No.	Plant Part	Compound	Use
1	Seed	Carotenoids, Glycosides	Antimicrobial activity
2	Leaf	Phenolic, flavonoids, gallic acid, rutin	Antioxidents, anti-inflammatory, antimicrobial
3	Skin	Phenolic	Improvement of food absorbtion
4	Pulp	Ascorbic acid, β-Carotene	Antioxidents,

5	Bark	Phenolic	Antidiarrheal activity

Wound Healing Properties

The guava leaves were pulverized by the ancient people of India and China and mixed with a little amount of water or oil to create a paste. This paste was then used to treat wounds by applying it directly into the affected area. The wound healing properties of a methanolic extract of guava leaves were seen when it was applied topically twice daily. The healing effects were attributed to the presence of tannins and flavonoids in the extract, as reported by Kafle *et al.* (2018). The leaves undergo a process of cleaning, crushing, and extraction using oil. In order to enhance absorption, a substance is included into the extract, generally in the form of liquefied candle wax. The completed mixture is thereafter applied to the incision twice a day for a duration of four days. Medicinal plants with properties similar to guava play a crucial role in wound healing by stimulating blood coagulation, fighting infections, and speeding up the healing process.

Relief for Cold and Cough

Guava leaves are an effective remedy for treating colds and coughs. Guava is rich in iron and ascorbic acid, which can reduce mucus production and lung congestion, while also protecting the respiratory system from harmful pathogens. The chemicals found in guava are very effective in treating influenza. The consumption of tender leaves has been shown to be beneficial in alleviating symptoms of colds and coughs, as demonstrated by Jairarj *et al.* (1999). Due to its astringent properties, it helps maintain a microorganism-free environment in the respiratory system, throat, and lungs, while also reducing microbial activity. It functions by inducing the breakdown of mucus polymers, alleviating a cough, and decreasing excessive mucus production. In India, roasted ripe guava is often used as a home remedy to alleviate symptoms of cold and cough (Kafle *et al.*, 2018). After 15 minutes of administering a hydro extract of *P.guajava* leaves, the frequency of coughing caused by capsaicin aerosol was dramatically decreased compared to the control group.

Ulcer and Antacid Protectant Activity

The high alkalinity of guava leaves effectively counteracts stomach hyperacidity. Guava leaves are often used in several rural communities as a remedy for acidity, as shown by Kafle *et al.* (2018). To prepare this combination, you need to boil 12 to 15 young guava leaves in 2 to 4 cups of water. The methanolic extract exhibited superior antacid and ulcer healing effects in vitro compared to other extract solvents. Guava fruit and leaves contain flavonoids and saponins, which have been scientifically shown to effectively reduce stomach acidity and prevent the formation of ulcers. The stomachs of Wister rats developed ulcers when they consumed ethanol. However, the ulcers were greatly decreased when the rats were given a methanolic extract of P. guajava leaves at dosages ranging from 500 to 1000 mg/kg weight gain (Uduak *et al*., 2012).

Conclusion

Guava is rich in nutrients and contains a substantial quantity of antioxidants, along with vitamins C and A, lycopene, calcium, manganese, and potassium. Moreover, the inclusion of guava in your daily diet is advantageous because of its low-calorie composition and abundant fiber, which facilitates enhanced digestion.

Guava is rich in vital nutrients that are crucial for maintaining good health and have the ability to counteract the harmful impact of free radicals in the body. Furthermore, it has a diverse range of phytochemicals that are advantageous for the management of conditions such as diabetes, obesity, and hypertension.

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Microgreen: An Emerging Functional Food

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Introduction

People have started giving more value to their health in recent years, primarily due to the rise in chronic disease incidence and the outbreak of numerous disorders. Increased public awareness of the importance of eating healthy meal has drawn attention to high-end, fresh, functional and nutraceutical foods- microgreens being one of them. Microgreens, also known as 'vegetable confetti', are young, nutrient- rich greens that are produced from a variety of commercial food crops, including vegetables, herbs and grains. They are a stage of plant growth that lies between sprouting and baby greens. A microgreen consists of a central stem, fully grown seed leaves or cotyledons, with or without the partially expanded true leaves. These functional micro- vegetables are usually 2–8 cm in height and are harvested 7–14 days (depending on variety) after germination, at which point cotyledonary leaves fully developed and the first true leaves appear.

Microgreens are considered as "superfood" or "functional food" because they are loaded with an abundance of different health-promoting phytonutrients compared to their mature counterparts, such as antioxidants, vitamins, minerals, and other bioactive compounds like carotenoids, ascorbic acid, tocopherol, tocotrienols, phylloquinones, anthocyanins, glucosinolates, etc. They have potential to prevent malnutrition, micronutrient deficiencies and incidence of chronic diseases such as cardiovascular diseases, obesity, diabetes, cancer, neurodegenerative disorders, etc. Additionally, because of distinctive sensory characteristics such as strong flavours, vivid colours, aroma and texture, microgreens are gaining the attention of more and more consumers. They have also gained popularity as a new culinary trend over the past few years and have been incorporated in many dishes.

The market of microgreen is expanding slowly. They can be found in both markets as well as on online platforms in various price ranges depending upon the type of species. But one major challenge to the growth of the microgreen industry is their rapid quality deterioration after harvest because microgreens are highly perishable and cannot be stored for an extended period of time. Some producers sell microgreens as "living microgreens" to get around this problem, allowing the consumer to harvest and wash them as needed to serve the highest quality freshness.

What Crops are Suitable to Consume as Microgreens?

Certain common vegetable crops like tomato, capsicum, eggplant, and potato are not edible at the seedling stage and are not suitable to produce microgreens because they contain alkaloids (such as solanine in potatoes, solasodine in eggplant, tomatine in tomatoes) which at high levels are toxic for humans.

Here are some commercial food crops that can be consumed as microgreens:

Crop group	Examples
Vegetables and herbs	Beet, spinach, onion, garlic, celery, coriander, carrot, fennel, parsley, lettuce, purple mustard, kale, chicory, red cabbage, cauliflower, broccoli, turnip, arugula, watercress, cucumber, radish, fenugreek, lemongrass, garden pea, basil, mint, etc.
Legumes	Chickpea, black gram, bean, cowpea, lentils, alfalfa, etc.
Cereals	Barley, maize, oat, rice, rye, wheat, maize
Pseudocereals	Amaranth, quinoa, buckwheat
Oilseeds	Sunflower, linseed, sesame, etc

Health Benefits of Microgreens

1. Reduce inflammation
2. Reduce obesity
3. Increase haemoglobin concentration
4. Improve hepatic function
5. Reduce blood glucose concentration
6. Reduce Low Density Lipoprotein and blood pressure.
7. Modulate cell proliferation and tumour suppression.

Nutrient Profile of Microgreens

Studies reveals that certain microgreens contain more micro and macro nutrients than their fully grown mature vegetables. They are dense in minerals (iron, zinc, calcium, potassium, magnesium, selenium, manganese and other), phytochemicals, antioxidants as well as good source of ascorbic acid, vitamin E, phylloquinone (Vitamin K), alpha-tocopherol, beta-carotene and other vitamins.

Vitamin C, also known as ascorbic acid, is a potent antioxidant and is essential for a variety of biological functions, such as wound healing, collagen synthesis, and immune system regulation. Yadav *et al*. (2019) measured Vitamin C contents in 9 microgreens and found that jute (*Corchoris olitorisu* L.) and cucumber (*Cucumis sativus* L.) microgreens had higher Vitamin C as compared to their mature stages.

Di Bella *et al.* (2020) noted a significantly higher vitamin C content in the microgreen stage of traditional Sicilian broccoli (7.5 mg/g) as compared to its baby green stage (6.1 mg/g). Ghoora et al. (2020), in which a 120%, 127%, and 119% higher vitamin C content was found in microgreen stages of fenugreek, spinach, and roselle as compared to their mature stage.

Yadav *et al*. (2019) found a significantly higher Zn concentration in the microgreen stage of 9 summer season leafy greens than that of their mature stage. Bottle gourd and water spinach contained higher Cu concentration at their microgreen stage as compared to the mature stage. Waterland *et al.* (2017) assessed the mineral contents of cultivars of kale (Brassica *oleracea*) at the stage of microgreen, baby leaf, and adult, showing significantly higher contents of Zn and Cu in microgreens compared to their relative adult stage.

Phytochemicals, such as carotenoids and phenolics, are also found in abundance in microgreens. Carotenoids possess antioxidant activity and play important physiological roles in human body. Niroula *et al*. (2019) studied the carotenoid profile of wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) microgreen and found that the carotenoid content in the microgreen phase was higher than that in the seed phase. Sun *et al.* (2013) identified 164 polyphenols, including 30 anthocyanins, 105 flavanol glycosides, and 29 hydroxycinnamic acids, in the 5 *Brassica* species microgreens. Microgreens have more complex polyphenol profiles and higher contents than mature *Brassica* plants, making them good sources of antioxidants.

Xiao *et al.* (2016) compared the mineral contents in 30 varieties of Brassicaceae and found that the highest contents of Zn were present in rapini microgreens while lower contents were found in red kale, red mustard, Chinses cabbage, and ruby radish microgreens.

Xiao *et al.* (2012) measured the carotenoid contents of 25 commercially grown microgreens. It was noted that red sorrel, cilantro, red cabbage, and peppercress microgreens were good sources of β-carotene, while cilantro, red sorrel, red cabbage, and garnet amaranth microgreens had a higher concentration of lutein/zeaxanthin compared to other microgreens.

How to Add Microgreens in your Diet?

Microgreens have gained popularity as a new culinary trend over the past few years due to their fresh taste and nutritional benefits. Microgreens can be considered as better substitutes for sprouts due to their rich nutritional content and more intense flavour, vibrant colours and taste. They are commonly consumed fresh and raw or can be used as a main vegetable or for garnishing.

The best way to consume includes:
1. Add them to salads, soups, sandwiches, wraps, pizza, burgers or omelette.
2. Blend them in chutney, juices, smoothies, dips or raitas.
3. Add them to pulao, sabzis, dal and curries.
4. Garnish in soup, pasta or noodles, dhokla, etc.
5. Mix them to the dough when making roti, parantha or bread.

Advantages of Growing Microgreens

1. High value crop which requires minimal horticultural inputs in comparison with mature green plants and their produce, such as vegetables and fruits
2. They have short growth cycle and can be harvested at 7-14 days after germination.
3. Do not require chemicals and pesticides for growing.
4. The requirement of water is less.
5. Best for urban farming as it can be produced in a limited space which makes it a better option when compared to traditional farming.

Conclusion

The current food system has focused on the consumption of fresh fruit and vegetables because of their nutrient profile; however, the utilisation of microgreens can alter this and direct attention towards a new product that is not only rich in nutrients but can be grown in urban setups, even homes, with minimal input and maximum yield. Because of their anti-oxidative, anti- diabetic, anti-inflammatory and anti-carcinogenic properties, they may be able to prevent micronutrient deficiencies, malnutrition and lower the chance of developing chronic diseases. As a result, incorporating microgreens into diets may enhance their nutritional value and can positively impact consumer’s health.

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Sheath Blight of Rice: Understanding Symptoms, Causes and Effective Management Strategies

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Abstract
The global prevalence of *Rhizoctonia solani* causing sheath blight disease of rice causes significant loss. It is a crucial limitation in rice growing areas. *R. solani* isolates manifests substantial aggressiveness and pathogenicity. The use of synthetic fungicides is prevalent due to unavailability of resistant cultivars. Various abiotic factors like nutrient availability, temperature, humidity, stage of the crop, agronomic practices influence the sheath blight disease development. Various studies have been done in order to understand diversification of sheath blight pathogen on the basis of cultural, morphological and molecular criteria. The most crucial hindrance is the limited knowledge about the behavior and variance of *Rhizoctonia solani* in various agrosystem. The effective management of sheath blight can be done by integrating botanical, biocontrol, cultural approaches.

Introduction
Rice constitutes the basic dietary part in many countries which is subjected to various diseases. The production of rice is adversely affected by many biotic stresses; sheath blight of rice caused by *Rhizoctonia solani* is accountable for harvest loss up to 45%. *R. solani* is a soil inhabitant facultative and saprotrophic pathogen which leads to the formation of lesions on the sheath inhibiting grain formation **(Wu *et al*., 2012)**. Besides in the soil *Rhizoctonia solani* also continues to live even during unfavorable conditions in the form of a hard resting structure known as sclerotia. Scleortia is capable of surviving in the soil for about 3 years **(Kumar *et al*., 2009)**.

Rhizoctonia solani infection advances when the healthy plant parts come in close proximity of infected plant parts. Even sclerotia which is present in the paddy filed enhances the disease development. Rice cultivation practices, 2 different plant stages exposed to contamination of the fungus, inadequate use of fertilizers, monoculture practices, varieties being used for cultivation, etc. turn out to be the major factors responsible for disease development.

Managing sheath blight of rice is strenuous as the pathogen have a wide range of host and is even capable of surviving in the form of sclerotia during unfavorable conditions. *R. solani*, the pathogen of sheath blight of rice advances rhythmically and allows the dormant structure (sclerotia) to overthrow the resistance achieved by the researchers. To restrict the proliferation of sheath blight pathogen it is essential to utilize the knowledge assembled about the infection, sign, symptoms, disease development of the pathogen for determining the management strategies.

Disease Symptoms
Typical disease symptoms start to progress at or above level of water. Lesions primarily occurs on the sheaths beneath the leaf collar measuring nearly 0.5 to 3 cm (diameter). Subsequently, these lesions formed on the sheaths enlarge up to 2 to 3 cm (length). These symptoms of sheath blight of rice appear from the milking stage upto tillering (3-4 leaf) stage of the crop followed by heading stage. Irregular greyish green spots are produced. When these spots expand the middle of the spot becomes greyish white with irregular brownish black border. Symptoms of blight appears due to merging of many lesions. Due to the increase in severity of the disease the infection reaches up to the inner sheaths causing death of the entire host plant.

Under suitable conditions, the pathogen proliferates, and the infection extends up to the aerial parts of the plant. Umber coloured velvety mycelium along with tanned sclerotia are fastened on the lesions that are displaced at maturity from the host. The sheath blight pathogen has been found to attack above parts of the paddy resulting in the formation of bronze horizontal stripes covering the infected parts known as 'banded blight phase' preventing the emergence and development of the ears which leads to poor filling or even blanking of panicles. Umber coloured blackish spots or ash grey speck are observed on the partly filled panicles **(Acharya *et al.*, 2004)**. The disease development is most prominent and swift during initial heading stage and at the time of panicle filling.

Symptoms of sheath blight of rice

Etiology of *Rhizoctonia solani*

Rhizoctonia solani is a soil dwelling facultative saprotroph. Its motion is restricted due to lack of spores and survives in the form of sclerotia which is a mass of dormant hyphae. Sclerotia is a hard resting structure which can survive in harsh environmental conditions. *Rhizoctonia solani* (anamorph or asexual stage) belongs to basidiomycetes. It gives rise to coulorless mycelium (vegetative) which eventually turns brown at maturity. The mycelium produced is septate at 90°. *R. solani* produce a hard resting structure called sclerotia which dark coloured and thick walled. These are primarily white in colour and due to formation of melanin in cell wall turn brown in colour. The cell wall of sclerotia is impermeable and has generous nutrients to withstand harsh environmental conditions. Size of sclerotia varies but is invariable in appearance. The teleomorph or sexual stage is *Thanatephorus cucumeris*. There are in total 14 anastomosis groups of *Rhizoctonia solani*. Amongst which sheath blight pathogen is placed in AG-1 IA **(Gonzalez-Vera *et al.*, 2010)**.

Disease Cycle

Infection of *Rhizoctonia solani* develops from dormant structure sclerotia of the previous cropping season **(Kumar *et al.*, 2009)**. As sclerotia is a hard structure of hyphae; a network of hyphae from sclerotia penetrate the seedlings near the water surface. Warm and humid conditions along with high dose of nitrogenous fertilizer favours the infection. The infection advances from early to late necrosis. The disease cycle is accomplished by the infested soil by resting structure (sclerotia) from infected host plants. Once the pathogen colonizes in the host tissue it produces RS toxin and pathogen effectors responsible for virulence of *Rhizoctonia solani* **(Zheng *et al.*, 2013)**. Inside the host *R. solani* advances with the hyphae penetrating the stomatal structures resulting in appressoria formation **(Singh and Subramanin, 2017)**. Enzymatic degradation activates due to the production of appressoria resulting in necrosis of the infected plant. Lesions on the aerial plant parts cover the whole sheath and stem of the plant leading to lodging of the stem. The water transport interrupted due to stem lodging which decrease photosynthesis and eventually the plant dies **(Bahuguna *et al.*, 2012)**.

Epidemiology of Sheath Blight of Rice

Sclerotia in the soil and fungal mycelia in the plant refuse facilitates the viability of *Rhizoctonia solani* between season of the crop and serve as the primary inoculum. Initially, the sclerotia sink in the water followed by subsequent floating due to lack of cellular material in the outer cells. The infection of *R. solani* commences in the host plant near the water surface due to the accumulation of sclerotia present in the water. These structures are efficient in developing the growth of the hyphae. The dormant structures are viable in the paddy growing areas for longer periods. The sclerotia and mycelium disseminate from host to different fields via flooding. The contaminated planting material also helps in the dispersal of the pathogen to other locations. Air current assist the secondary dispersal of the pathogen by transporting the basidiospores to new places and thus causing infection. The infection even disseminates from diseased plant parts to healthy host within the field.

Factors Influencing the Sheath Blight Epidemics

1. Relative humidity and temperature: Utmost temperature, leaf wetness and relative humidity are reported as the main factors for advancement of the disease in the field. The highest and the lowest temperature observed was 23.03, 9.03 respectively and rate of evaporation i. e. 61.05 % for disease incidence under field conditions. The highest disease development has been documented at 25-30◦C and 80-90% relative humidity.

2. Type of cultivar: During initial maturation, high tillering and dense cultivar; the disease severity is more in crop canopy. It has also been observed that Indica type (long grain) cultivar is less resistant than Japonica type (short and medium grain) cultivar.

3. Host nutrition: It has been perceived that sheath blight disease occurs severely resulting in yield loss due to injudicious application of nitrogenous fertilizer. Increased application of nitrogen and phosphorus reduce the period of incubation and phenolic compounds, thus enhancing the disease development whereas the use of potassium, zinc, sulphur and iron reduce the disease severity. Use of neem cake, farm yard manure (FYM), vermicompost decrease the severity of infection significantly.

4. Stage of the crop: Sheath blight pathogen attacks paddy at various phases of crop and the resistance and susceptibility in rice genotypes were better evolved on aged hosts than on seedlings. With increase in age of the host; disease incidence and seriousness of disease is enhanced. The infection of sheath blight pathogen during initial stages of the host is slow which is enhanced later in tillering stage. The highest intensity of sheath blight disease has been observed in 30 to 40 days old seedling.

Management of Sheath Blight of Rice

Resistant varieties: Resistance varieties are not available for sheath blight of rice but tolerant cultivars are available. Basmati rice lines have been developed by combining Xa 13, Xa 21, Pi 54 and a major QTL qSBR 11-1 for sheath blight of rice (Singh et al., 2012). Chitinase genes like McCHIT, Cht 42, AceAMP1, β1,3-glucanase, npr1are introduced in rice cultivars which has resulted in increased tolerance to sheath blight **(Singh *et al.*, 2015a)**.

Cultural control: Proper spacing, demolition of plant debris, weeds in and around the crop field. Acquiring green manuring, avoiding field to field irrigation, removing weeds and planting seedlings far from bunds. Silica application and soil amendments with neem cake, Sesbania aculeate and Calotropis along with neem leaf extracts, groundnut cake and Gliricidia maculate leaves are helpful in managing sheath blight of rice **(Kumar *et al.*, 2006)**.

Biological Control and Induced Resistance

Chitosan, gamma-amino-butyric acid and salicylic acid are used as seed treatments or foliar sprays to induce resistance against sheath blight **(Liu *et al.*, 2012)**. Pseudomonas fluorescens, Pseudomonas putida and Bacillus subtilis show antagonistic approach towards sheath blight of rice. *Trichoderma asperellum* T12 and Wenquning (microbial pesticide) is promising against *R. solani*. Extracts of Siam weed leaves used as foliar spray and seed soaked had shown effectiveness up to 68 per cent **(Khoa *et al.*, 2011)**.

Chemical Control

Bavistin for seed treatment is effective to reduce disease incidence of sheath blight of rice. Other fungicides effective against *R. solani* are carbendazim, difenoconazole, hexaconazole, propiconazole, tebuconazole, azoxystrobin are very efficient in controlling sheath blight. Chemicals in combination like propiconazole + difenconazole **(Kandhari, 2007)**; carbendazim + mancozeb **(Prasad *et al.*, 2006)** have been found promising against sheath blight in different parts of the country.

Conclusion

Significant attempts have been done to understand the epidemics of *Rhizoctonia solani* with paddy crop. Present day agricultural practices like monocropping, injudicious use of nitrogen fertilizers have a considerable influence on the epidemics of *Rhizoctonia solani* in paddy field. It is also favoured by humid climatic condition and large number of hosts available. Various studies have been done in order to understand diversification of sheath blight pathogen on the basis of cultural, morphological and molecular criteria. The most crucial hindrance is the limited knowledge about the behavior and variance of *Rhizoctonia solani* in various agrosystem. Trying amalgamation of organic fungicides with bio-control agents will enhance healthier approach to manage sheath blight pathogen.

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Role of Semio-Chemicals in Pest Management

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Introduction

The term Semio-chemicals is derived from a Greek word 'someone' meaning a mark or a signal. Semio-chemicals are chemical substances that mediate communication between living organisms and which cause changes in their behaviour. Semiochemicals that repel pests or attract their natural enemies could be used to maintain insect pest population. Pheromones are intraspecific chemicals that act within the same species and allelochemicals are interspecific chemicals which act between the species, are two different types of semiochemicals. Pheromones derived for contact purposes that provide sex, warning, monitoring, and territory marking signals. Allelochemicals are classified as signals that beneficial either the recipient (kairomones), the releaser (allomones), or both (allomones) (synomones). Semiochemicals are providential tools for the management of insect pests, particularly in organic cropping systems, due to their advantages over traditional insect pest control agents. There is an environmental validation for reducing the use of poisonous insecticides for pest management, as well as a public consideration.

Pheromones

The term "pheromone" was introduced by Karlson and Luscher in 1959, based on the Greek word pherein (to transport) and hormone (to stimulate). They are also sometimes classified as ecto-hormones. The characterization of the silk moth sex pheromone (E, Z)-10,12-hexadecadien-1-ol which is released by the female silkworm moth, Bombyx mori (Lepidoptera: Bombycidae) to attract mates. Pheromones are of two types: Releaser effect pheromones: These produce an immediate and reversible behavioural change in the recipient insects. Primer effect pheromones: These trigger a chain of physiological changes in the body of the insect and act through gustatory sensillae. These regulate caste determination and reproduction in social insects.

Types of Releaser Effect Pheromones

1. Sex pheromone: Several species released sex pheromones that trigger behaviour patterns in the other sex and facilitate in mating. Eg. Gossyplure (pink bollworm), the commercial utilization of this pheromone for the control of PBW has received terrific efforts. Helilure (*Helicoverpa armigera*) and Litlure (*Spodoptera litura*) etc.

2. Aggregation pheromones: These pheromones produce aggregation or congregation of insects for protection, reproduction and feeding. It is produced by some species of coleopteran pests and attractive to both sexes. Eg. Bark beetles, Ips spp. and Dendroctonus spp. and banana weevil, Cosmopolites sordidus (Dryophthoridae).

3. Alarm pheromones: These are chemical substances released by insects to warn the members of the same species about the presence or attack by enemy. Ex: Terpenes (Aphids), aldehydes (Hemipterans), formic acid (Ants).

4. Trail pheromone: These are help in find mates, or to utilize food resources more efficiently. Ex: Caproic acid (Zootermopsis sp.), hexanoic acid and heptanoic acids (Ants).

Allelochemicals

These are interspecific chemical that mediate the communication between two different species. Different types of allelochemicals are:

Types of allelochemicals:

a. Allomone: A compound released by one organism that is beneficial to releaser but not favourable to receiver. Eg. Sting glands in bees.

b. Kairomone: A chemical substances released by one organism that is beneficial to receiver but not favourable to releaser. Eg. Male sex pheromone of bug, *Nezara viridula* acts as an attractant to its parasite, the tachnid fly, *Trichopoda pennepes*

c. Synomone: A substance released by organism which benefits both the sender and the receiver. Eg. Termites and protozoans

d. Apneumone: A chemical released by nonliving substance that is beneficial to the receiver but detrimental to other organism in the substance. Eg. *Venturia canescens* is attracted by smell of the oatmeal.

Semiochemicals are Used for the Management of Insect Pests through the Following Strategy

1. Detection of invasive species and in delimiting surveys
2. Monitoring the populations of endemic species to synchronize the timing of insecticide treatments.
3. Improvement of old method of insect counts used for decision-making.
4. Increasing the effectiveness of biological control by increasing the predation/parasitism rates of predators and parasitoids.
5. Reduction of pest population through mating disruption, attract and kill, mass trapping and repellency techniques.
6. Strategy for use of the semiochemicals in the Pest Suppression.

In Pest Management Pheromones are Used for Numerous Purposes such as

1. Monitoring: Pheromone baited traps are used to detect both the presence and population of the pest species. pheromone lures are used in traps to monitor many different crop pest species. Monitoring systems help farmers to time application of insecticide, which reduces economic and environmental costs of insecticide application.

2. Mass trapping: Mass trapping is allowing the use of species-specific semio-chemical baited monitoring traps, with the object of reducing or suppressing populations of target pests by catching as many individuals as possible. Traps have to catch a large proportion of the population in an area, before mating or oviposition, and retain or kill catched individuals.

3. Mating disruption: Mating disruption aims to break down chemical communication by organisms and disrupt normal mating behaviour by dispensing synthetic sex pheromone.

Conclusion

Semio-chemicals have an eminent potential to dispense alternative solutions, because they are relatively non-toxic to animals and beneficial insects, are generally used in small amounts, and are often host specific. Semiochemicals also provide a sustainable and eco- friendly substitute to the broad-spectrum insecticides, either as monitoring or management tools of critical integrated pest management programmes.

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Vertical Farming: Today's Farming

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Abstract

Vertical farming is the technique of using no soil and relatively little water to grow crops in vertically stacked layers. Global population is increasing, and traditional farming practices face increasing challenges. Vertical farming can produce food around the clock and save up to 90% of water. In the near future, vertical farms and industrialized farming within buildings will supplement alternative agricultural production systems by providing a product with precise specifications that is produced under controlled conditions. However, they will not completely replace traditional agriculture. This product is adaptable and will change to meet the evolving needs of urban residents. Modelling many design options for cities that are continuously changing is made possible by combining urban vertical farms into a multi-dimensional (multi-scale, multifunctional) system. Newly constructed vertical urban farms will not only increase harvests and lower production costs in the future, but they will also significantly raise the standard of agricultural goods supplied to city dwellers, minimizing the negative environmental effects of urbanization.

Introduction

An innovative method in the area of agriculture that we are going to explore is called vertical farming. As global population increases and environmental concerns rise, traditional farming practices face numerous obstacles. The globe will need to produce 50% more food by 2050 to feed its estimated 8.9 billion human beings, which will require additional arable land, which is simply not accessible (FAO, 2020). To feed the globe in a sustainable manner, we need innovative approaches. Let's explore how this novel approach might contribute to overcoming the problems associated with global food security and sustainability. Vertical farming is the technique of using no soil and relatively little water to grow crops in vertically stacked layers or integrated into other structures (like an old warehouse or building). Vertical farming is seen as a crop producing activity that is marginal up to a system that is necessary to ensure food security in the future. Compared to conventional farming and alternative farming practices, this kind of farming allows for a notable increase in the quantity of crops cultivated in a significantly smaller area, leading to a decrease in the amount of agricultural land utilized. The most basic definition of "vertical farming" as a practice is the multilayering of plant production with the goal of increasing yield per unit space (Meena *et. al.*, 2022).

Why Vertical Farming?

1. Produce food around the clock, every day of the year
2. Keep crops safe from erratic and dangerous weather
3. Reuse water collected from indoor spaces
4. Create jobs for locals and communities
5. Use as little pesticides, fertilizers, and herbicides
6. Reduce drastically and rely less on fossil fuels
7. Avoid crop loss due to storage, shipping, and long transportation
8. Stop agricultural runoff, saving up to 90% of water
9. School children receiving instruction and training in food production
10. The ecstatic pride that comes with producing food (Reja *et. al.*, 2019).

Types of Vertical Farming

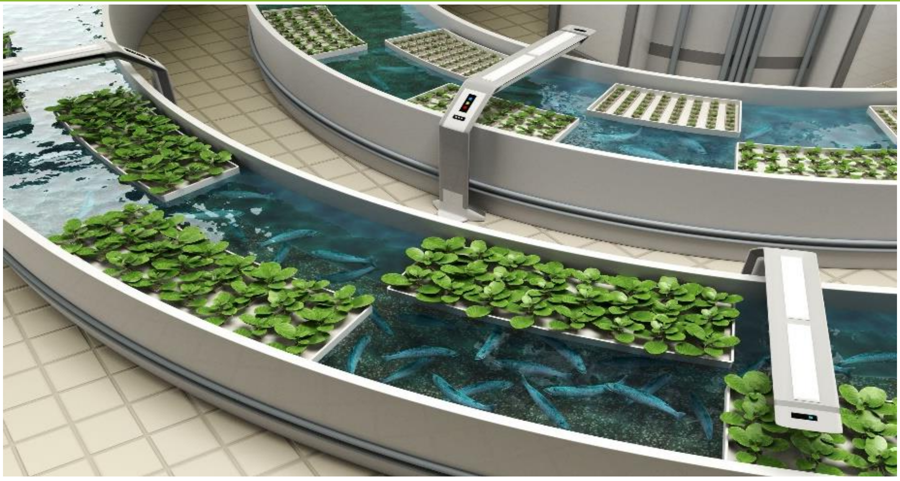
Hydroponics: The term comes from the Greek word's "hydros" and "ponos". In which "hydros", meaning water and "ponos", meaning working water. This approach involves immersing the plant root in a nutrient-rich solution that is regularly checked and recirculated to preserve the proper chemical composition. Hydroponics provides the benefits of higher yield per area and lower water consumption. Hydroponics is defined as "the cultivation of plants in nutrient-enriched water with or without the mechanical support of an inert medium such as sand or gravel" (Harris, 1992).

Aeroponics: Aeroponics grows plants without the need for a liquid or solid medium, in contrast to conventional hydroponics and aquaponics. In air chambers where the plants are suspended, a liquid solution containing nutrients is misted instead. As it consumes up to 90% less water than the most efficient conventional hydroponic systems and doesn't require growing medium replenishment, aeroponics is by far the most sustainable soilless growing method available. Additionally, the lack of a growing medium enables aeroponic systems to have a vertical design, which further reduces energy consumption because gravity automatically removes excess liquid, whereas conventional horizontal hydroponic systems frequently need water pumps to control excess solution (Meena *et. al.*, 2022).

Aquaponics: Aquaponics is a hydroponics modification that combines hydroponics with recirculated aquaculture or fish farming. The mini ponds are used to raise fish and plant in indoor condition, the excreta of fish in indoor ponds, creating nutrient-rich water solutions that supply the nutrients to plants in vertical farming. Wastewater is recycled into ponds after being filtered and purified by the plants.

It has numerous advantages such as:

a. Water conservation as a result of biological filtration and recirculation
b. Removes the need for artificial fertilizers.
c. The utilization of waste products from one biological system as nutrients for another makes it both efficient and cost-effective.
d. Additionally, it offers organic liquid fertilizers that promote the healthy growth of plants.
e. Purifying water to support fish habitat (Meena *et. al.*, 2022).



Vertical Greenery's Effect on Urban Life

Vertical garden positive aspects vary depending on the project's size, geographical conditions, type of vegetation and design elements. This effect could be beneficial in the urban environment at both the urban and architectural scales, this impact may help to:

1. Lessen the impact of the urban heat island effect by enhancing natural cooling systems, lowering external shading and ambient temperature
2. Assist in reestablishing the natural water balance in urban regions
3. Enhance the quality of outdoor air by capturing pollutants in the air through filtration and dust accumulation on leaf surfaces
4. Enhance the visual appeal by presenting panoramic and city views, hiding unsightly surfaces, raising property values, and offering unique free-standing buildings
5. Enhance the energy efficiency of buildings by reducing heat loss and air conditioning costs by establishing a wind buffer zone and limiting heat loss
6. Strengthen the structure of buildings against UV radiation and temperature swings by making partition openings more tightly
7. Enhance the quality of agricultural products supplied to urban residents
8. Lower food production costs by better supplying food to local/district markets
9. Increase accessibility to recreational areas
10. Multiply harvests in urban areas and enhance the quality of agricultural products supplied to urban residents
11. Reduce noise by absorbing and reflecting sound waves (Zareba *et. al*., 2021).

Challenges

Although vertical farming has enormous potential, it also confronts a number of difficulties, including a high initial cost, pollination difficulties (for cross-pollinated crops) and a lack of skilled labour to maintain and operate vertical farms. Starting a vertical farm can cost as little as Rs. 60 lacks for a semi-automated system and as much as Rs. 1.5 crore for a fully automated facility. The amount of energy used can account for up to 40% of overall operating expenses. Vertical farming takes place in a controlled environment. Insects are not used in the manual pollination of fruits.

This increases the indirect cost of fertilizing fruits and vegetables. Furthermore, vertical farming requires professional management (Mishra, 2023).

Conclusions

Modern cities are affected by sustainable development and environmental preservation. A green economy is a novel idea that is gaining popularity. The concept of local production is evolving in response to urban demands. Reducing imports of items that can be produced locally, boosting the local economy and adding jobs in urban farming are all essential needs in today's cities. In the near future, vertical farms and industrialized farming within buildings will supplement alternative agricultural production systems by providing a product with precise specifications that is produced under controlled conditions. However, they will not completely replace traditional agriculture. This product is adaptable and will change to meet the evolving needs of urban residents. Modelling many design options for cities that are continuously changing is made possible by combining urban vertical farms into a multi-dimensional (multi-scale, multifunctional) system. Newly constructed vertical urban farms will not only increase harvests and lower production costs in the future, but they will also significantly raise the standard of agricultural goods supplied to city dwellers, minimizing the negative environmental effects of urbanization.

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Exploring the Potential of Hydroponics: Sustainable Farming for the Future

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Introduction

Hydroponics, a method of growing plants without soil, has emerged as a sustainable farming technique with the potential to revolutionize agriculture. By providing precise control over nutrient delivery and environmental conditions, hydroponic systems offer numerous advantages over traditional soil-based farming.

The Greek terms "hydro," which means "water," and "ponos," which means "labour," are the source of the phrase 'hydroponics'. Hydroponics is a method of growing plants in nutrient solutions that supply all the nutrients required for optimal plant growth. It can be used with or without an inert medium, such as gravel, vermiculite, rockwool, peat moss, sawdust, coir dust, coconut fibre, etc., to provide mechanical support. The term was coined by Professor William Gericke in the early 1930s. Researchers at Purdue University achieved a major milestone in 1940 when they developed the Nutri culture system. Commercial hydroponic farms began to appear in the 1960s and 1970s in a number of nations. Automated hydroponic systems were developed mainly outside the nation and were intended to control the amount of water, nutrients, and photoperiod in accordance with the unique needs of various plants (Resh, 2013).

Hydroponic systems are incredibly adaptable and can be found anywhere from simple backyard installations to quite complex commercial operations. With hydroponics, a wide range of commercial and specialised crops, including green vegetables, tomatoes, cucumbers, peppers, strawberries, and many more, can be cultivated. This article explores the principles, benefits, and applications of hydroponics in modern agriculture.

Why Hydroponics?

Humans are now up against a myriad of new demanding issues that are leading dramatic change to our global lifestyles: climate change, hazardous infectious diseases, increasing urbanization, and the depletion of natural resource deposits. Hydroponic farming has strong potential to mitigate the threats these issues pose to our agricultural system. Growing crops in near optimal conditions using controlled environment agriculture (CEA) technology is one of the biggest benefits of hydroponic farming. Crops grown indoors and hydroponically can be grown anywhere on earth at any time of the year, regardless of weather conditions, availability of cultivable land, or soil quality. Hydroponic farming has the potential to provide fresh, local food for areas with extreme droughts and low soil quality, such as in sub-Saharan Africa where access to leafy green vegetables is often limited.

Keeping crop production in a controlled environment enables trained scientists and advanced climate control technology to optimize the inputs of water, nutrients, and light fed to the plants. For example, sensors can measure the amount and nutrient content of the water that each plant transvaporates. This gives farmers insight into the amount of unused water and nutrients by the plants at each stage of the growth process. From this, farmers are able to ensure the maximum amount and highest quality of yields by optimizing the timing, quality, and number of inputs to the plants. This technology, along with design features such as precise irrigation methods, helps CEA farmers reduce water waste exponentially: compared to traditional farms, hydroponic farms use up to 90% less water. Light inputs are also optimized to ensure maximal absorption by the plants and maximal yield outputs. Photosynthetic active radiation, or PAR, is a measurement of the amount of usable light (photons) delivered to different plants. The range between 400 and 600 nanometres represents the usable wavelengths of light energy for plants, though scientists have found that the peak of absorption is often at 440nm (blue light) and 660nm (red light). If the delivery of these optimal wavelengths of light are targeted, the amount of energy being delivered to the plants can be optimized by omitting the wavelengths of light that will not be absorbed by the plants. This is the reason for the purple-ish light often seen shining on plants in hydroponic farms. This is also the logic behind the colour of greenhouses: the green glass ensures that green light does not pass through to the plants, so they only receive the colours that they most readily absorb. Since LED lights are heavy energy users, optimizing the light delivered to plants to the maximum amount of light absorption helps limit wasted energy.

The modular design of vertical farms allows farmers to alter the layout of the plants to maximize space use and optimize ground space. Since vertical farms spread upwards instead of outwards on a horizontal plane, farmers are able to grow 3 to 10 times more crops in the same amount of space as conventional farms, depending on the specific layout. Ground space can be multiplied by stacking horizontal racks on top of each other. This same modular design also offers a highly efficient way to isolate diseased or dying crops with a quick and easy way to neutralize compromised plants. In a traditional farm that might cover many square miles of land, diseased crops are much more difficult to identify and take out of contact with the other crops in the field. As a business model, modular farming also enables a much more efficient growth process, where transferring and packaging plants can be completed without causing any disturbance to other crops. Finally, with the help of soil-less growing, this modular design allows growth space to be in constant use. In other words, no wait period is needed after harvesting a crop cycle before the next crops can be planted again. With the help of a constant stream of nutrient and light inputs that significantly reduces the crop cycle, this farming model can result in 7 to 14 times more growth cycles than traditional practices.

Another benefit of the secure indoor growing environment is the protection it provides the plants against harmful pests and microbial diseases. Traditional agriculture makes use of intense applications of herbicides and pesticides to shield crops from natural threats, though these chemicals have become under increasing scrutiny for the adverse effects they pose to humans and surrounding ecosystems. Pesticides often contaminate surface water, are toxic to many non-targeted insects, animals and plants, can eliminate positive and healthy soil microbes, and have been linked to breast cancer in humans. In the United States, more than 1 billion pounds of pesticides are used annually, 90% of which is used by the agriculture industry. The faster we can cut down on the number of pesticides contaminating our food and environment, the better off our health and world will be.

Furthermore, pesticides have failed to make our agriculture industry completely resilient against invasive species. This past summer, a devastating swarm of locust pests descended upon East Africa, guzzling up the food supplies of up to 25 million people. Despite emergency applications of pesticides across the continent, nothing could stop these locusts from demolishing the year's work of farmers and the precious food supply of millions of East-Africans. Farming indoors eliminates crop vulnerability to extreme circumstances such as these and more common, lower grade pest invasions alike.

Principles of Hydroponics

1. Hydroponic systems utilize water-based solutions enriched with essential nutrients to nourish plant roots directly.

2. Instead of soil, plants are grown in inert mediums such as perlite, rockwool, or coconut coir, which provide support while allowing roots to access water and nutrients.

3. Nutrient solutions are carefully balanced to meet the specific requirements of different plant species, ensuring optimal growth and productivity.

Advantages of Hydroponic Farming

Efficient Water Use: Hydroponic systems use significantly less water compared to traditional farming methods since water is recirculated within the system.

Space Optimization: Hydroponic systems can be implemented vertically or in confined spaces, making them suitable for urban agriculture and indoor farming initiatives.

Reduced Environmental Impact: By minimizing soil erosion, chemical runoff, and pesticide use, hydroponic farming promotes environmental sustainability and soil conservation.

Year-Round Production: Controlled indoor environments allow for year-round cultivation, irrespective of seasonal variations or adverse weather conditions.

Higher Yields and Faster Growth: With optimized nutrient delivery and environmental control, hydroponic crops often exhibit accelerated growth rates and higher yields compared to conventional farming practices.

Applications of Hydroponics

Urban Agriculture: Hydroponic systems enable urban dwellers to cultivate fresh produce locally, reducing transportation costs and carbon emissions associated with long-distance food distribution.

Vertical Farming: In densely populated urban areas, vertical farming utilizing hydroponics maximizes land utilization while minimizing the ecological footprint of agricultural production.

Specialty Crop Production: Hydroponics facilitates the cultivation of high-value specialty crops, including herbs, leafy greens, and microgreens, meeting the demand for premium-quality produce in niche markets.

Research and Innovation: Hydroponic farming serves as a platform for agricultural research and innovation, driving advancements in crop genetics, nutrient management, and sustainable farming practices.

Challenges and Considerations

Initial Investment: Setting up hydroponic systems requires initial capital investment in infrastructure, equipment, and technology.

Technical Expertise: Successful hydroponic farming demands specialized knowledge in hydroponic system design, nutrient management, and environmental control.

Energy Consumption: Indoor hydroponic operations may consume significant amounts of energy for lighting, heating, and climate control, necessitating measures to enhance energy efficiency and reduce environmental impact.

Conclusions

Hydroponics represents a promising paradigm shift in agriculture, offering sustainable solutions to address the challenges of food security, resource scarcity, and environmental degradation. By harnessing the power of hydroponic technology, farmers and innovators can cultivate resilient food systems that prioritize efficiency, productivity, and environmental stewardship. As we embrace the potential of hydroponics, we pave the way for a greener, more sustainable future where agriculture thrives in harmony with nature.

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Food Miles – The Journey from Field to Plate

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Summary

"Food miles" is a term used to describe the distance food travels from its point of production to the consumer's plate, emphasizing the environmental impact of transportation in the food supply chain. The concept underscores the importance of reducing carbon emissions associated with long-distance transportation by promoting local sourcing and consumption. However, critics argue that focusing solely on food miles overlooks other significant factors such as production methods, packaging, and transportation modes, necessitating a more holistic approach to sustainability in the food system.

Introduction

In light of the prevailing focus on climate change, the term 'carbon footprint' has risen to prominence as a key metric for assessing environmental impact. As the environmental impact of global agro-food system has been exposed, carbon foot print accounting of food articles also gained importance.

Every step-in getting food from the farm to our plate involves emission of greenhouse gases (GHGs). The carbon footprint of food refers to the amount of GHGs it produces — from production to its consumption. Often, it is expressed in terms of the amount of carbon dioxide or its equivalent of other GHGs emitted.

Over the last fifty years, there have been dramatic changes in the food production and supply chain, the most striking changes have been:

a. The food industry has become more globalized, seeing a rise in food trade (imports and exports) and broader sourcing of food.

b. To meet the demand for consistent, bulk supplies of produce throughout the year, the food supply base has consolidated into fewer, larger suppliers.

c. Delivery patterns have undergone significant changes, with most goods now passing through regional distribution centers operated by supermarkets. Additionally, there's a shift towards using larger Heavy Goods Vehicles (HGVs) for transportation.

d. Supermarkets have become central to food sales, leading to a transition from frequent visits to small local shops to weekly trips by car to large out-of-town supermarkets.

These trends have led to a large increase in the distance food travels from the farm to consumer, known as "food miles". The rise in food miles has led to increases in the environmental, social and economic burdens associated with transport. These include carbon dioxide emissions, air pollution, congestion, accidents and noise. There is a clear cause and effect relationship for food miles for these burdens – and in general higher levels of vehicle activity led to larger impacts. Growing concern over these impacts has led to a debate on whether to try to measure and reduce food miles.

The idea of food miles is quite recent, focusing on how far food travels from where it's made to where it's eaten. Evaluating the sustainability of the global food system in terms of energy use now includes considering food miles. In the past decade, there's been more interest in food miles due to growing awareness of climate change. This includes looking at how much energy is used to transport food and how it impacts producers and consumers, suggesting ways to make the food system more sustainable. Food miles are a measure of how far a food item has been transported from its site of production to its site of consumption (From field to plate).

"**Food miles**" is a term commonly used to measure the transport distance travelled by food products between production and consumption.

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The Development and Application of this Term has been Motivated by Two Primary Concerns

1. An environmental concern – namely an argument that a food product(s) travels from where they are produced to where they are consumed, the greater the consumption of energy, and hence the greater the emissions of Greenhouse Gases (GHGs).

2. A regional development concern – an argument that sourcing food close to where it is produced can generate important benefits to the local economy and stimulate 'regional development'.

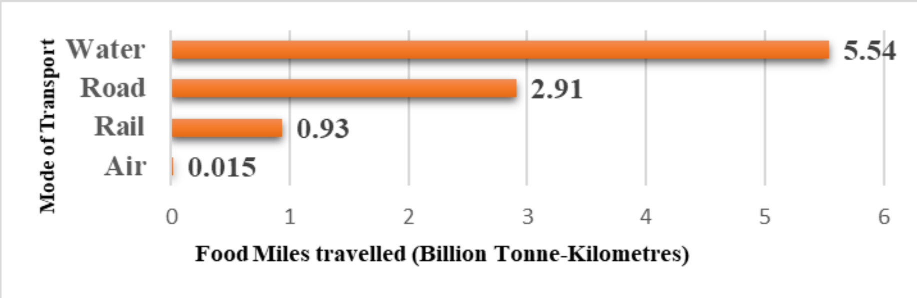

Fig. 1: Share of Different Modes of Transport in Food Miles per Year
Source: Poore and Nemecek (2018)

How to Measure the Food Miles?

Food miles' calculator:

Step 1: Check the label-where did your product come from?

Step 2: Look it upon the chart-how many kilometres did your food travel from its origin to your house (use the distance chart)

Step 3: Which method of transportation did your food use to get here?

Step 4: Now you are ready to do the calculations: (Km travelled multiplied by GHG emissions) The most prominently used methods for calculating food miles are The Weighted Average Source Distance (WASD) and The Weighted Total Source Distance (WTSD).

Why Consumers should Care about Food Miles

For consumers, convenience and cost are often driving factors when purchasing food. The choices consumers make, however, can have a great deal of influence on the direction our food system is headed. Reducing the energy intensiveness of our food has several economic, social and environmental benefits. Consumers who are reducing their food mile footprint: Enjoy fresher, healthier food Support local farmers Keep their money in the community Know where their food comes from Reduce their carbon footprint.

Limitations of 'Food Miles'

1. Simplifying the complex relationship between distance and emissions: While 'food miles' is often used as a measure of transport emissions, it overlooks nuances such as co-transportation scenarios and varying attribution of miles to specific food items, potentially leading to misleading emissions rankings.

2. Neglecting transport method variance: 'Food miles' fails to differentiate between transport modes, disregarding the significant disparity in emissions between, for instance, sea and air transport, resulting in inaccurate assessments of the environmental impact of food.

3. Limited Scope in GHG Assessment: Focusing solely on 'food miles' excludes emissions from other crucial stages like production, packaging, and disposal, undermining the effectiveness of such measures in mitigating overall greenhouse gas emissions.

4. Oversimplification of energy usage: Despite equal travel distances, the use of different fuels in transport, such as petrol versus diesel, can lead to divergent energy consumption and emissions levels, challenging the validity of 'food miles' as a comprehensive measure.

5. Economic development considerations: While promoting low 'food miles' products may theoretically stimulate regional development, the actual impact is uncertain, as it could lead to ambiguous effects on consumer spending patterns and potentially hinder export competitiveness, particularly in distant markets where 'food miles' concerns hold sway.

Conclusion

Food Miles are a growing cause of concern due to the greenhouse gas emissions released through transportation of food. Encourage businesses and Government bodies to adopt procurement policies favouring locally grown, organic, and sustainably harvested foods that are minimally processed. Purchase local, organic, seasonal produce directly from the farmers' market; buy food with little packaging because packaging consumes more energy; and, as a consumer, adopt the “Grow on Your Own” mentality to reduce fuel consumption, greenhouse gas emissions and global warming associated with the transportation of food. The aforesaid options help to lift local agricultural communities, strengthen the local economy, and protect the environment in the long run by eating fresh and locally available food items.

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Integrated Fish Farming Systems in India

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Integrated fish farming in India is an important agriculture practice in India that combines fish culture with other agriculture activities to maximize resource utilization, increase farm productivity, and enhance rural livelihoods. This approach integrates the farming of fish with other components such as livestock, poultry, agriculture and aquaculture to create a sustainable and diversified farming system.

Advantages for Integrated Fish Farming (IFF)

1. Integrated fish farming typically involves combining fish culture with components like agriculture (rice, wheat, vegetables), livestock (cattle, goats, poultry), and aquaculture (shrimp, fish and prawn farming) on the same piece of land.

2. It optimizes resource use by recycling organic matter and nutrients. Fishponds can be used to store water for irrigation and provide nutrients for crop fields through pond sediments.

3. By diversifying farm activities, farmers can generate additional income streams. For example, they can sell both fish and agricultural produce, or use fish waste as organic fertilizer.

4. Integrated fish farming enhances food and nutritional security by providing a source of protein and additional agricultural products.

5. IFF systems allow better water management. Fishponds can be stocked with a variety of fish species, and wastewater from the fishponds can be used for irrigation, reducing the need for chemical fertilizers.

6. The integration of fish farming with other components often promotes sustainable practices. Fish help control pests and weeds in crop fields, reducing the reliance on chemical pesticides.

7. Integrated fish farming generates employment opportunities in rural areas. It not only provides jobs related to fish farming but also supports agriculture and other activities.

8. The Indian government has initiated various programs and subsidies to promote integrated fish farming, recognizing its potential for rural development and enhancing fish production.

9. Challenges in integrated fish farming include proper farm management, disease control, and ensuring the compatibility of different farm components. Proper training and knowledge-sharing are crucial.

Types of Integrated Fish Farming

Basically, the integrated fish farming is of two types:
1. Agri-based fish farming
2. Live-stock fish farming.

Agri-Based Fish Farming

Paddy cum-fish culture: Paddy-cum-fish culture, also known as integrated rice-fish farming, is an agricultural system that combines the cultivation of rice (paddy) and fish in the same field or water body. This integrated farming method has been practiced for centuries in various parts of the world, including Asia, where rice and fish are staple foods. The basic concept of paddy-cum-fish culture involves growing rice and raising fish simultaneously in a way that benefits both crops. In India, this farming is practised in the states of Bihar, West Bengal, Orissa and Assam where enough water is present in the paddy fields. The paddy fields retain water for 3-8 months in a year. Paddy-cum-fish culture offers several advantages, including increased agricultural productivity, improved food security, and reduced chemical pesticide use due to the natural pest control provided by fish. It also contributes to greater farm diversity and resilience.

This practice can be done in following types of paddy plots-

- **a. Perimeter type-** paddy grows in the middle.
- **b. Central Pond type** — paddy growing area is on the perimeter.
- **c. Lateral trench system**- trenches are provided on either one or both sides of the moderately sloping field.

The variety of rice used in this culture is Panidhan, Jalmagna, CR26077, Tulsi etc. while the fish spp. are, *Channa spp, Oreochromis mossambicus, Clarias batrachus, Anabas testudineus,* silver carp, grass carp, common carp. The total production in such practice is approximately 90 quintals from 2 paddy crops while the fish production is about 1000 kg from 1 ha.

Horticulture-cum-fish farming: Horticulture-cum-fish farming is an integrated agricultural system that combines the cultivation of fruits, vegetables, or other horticultural crops with the rearing of fish in a mutually beneficial manner. This integrated approach allows for efficient use of resources and land, while also providing economic and environmental benefits. In this system, horticultural crops such as fruits, vegetables, herbs, or ornamental plants are grown alongside fish farming activities. The fish are typically raised in ponds, tanks, or other water bodies, while the horticultural crops are cultivated on the same piece of land.

In This system optimizes the use of land, water, and nutrients. Nutrient-rich water from the fishponds can be used to fertilize the horticultural crops, reducing the need for synthetic fertilizers. In turn, the plants help filter and purify the water, creating a healthier environment for the fish.The fish waste and uneaten feed provide organic matter and nutrients to the horticultural crops, acting as a natural source of fertilization. This nutrient cycling minimizes the environmental impact and improves the overall sustainability of the farming system.

Combining horticulture and fish farming diversifies farm income and reduces the risk associated with relying solely on one type of agricultural activity. If there are problems with one component (e.g., poor fish growth), the other component (e.g., fruit and vegetable production) can still provide income and food. The choice of horticultural crops depends on local climate, market demand, and farmer preferences. Common choices include tomatoes, cucumbers, watermelon, papaya, and various herbs and spices.

The type of fish used in horticulture-cum-fish farming can vary, but common choices include tilapia, catfish, and carp. The choice of fish species may depend on local conditions and market demand. The agri-based fish farming includes the mushroom fish system, sericulture-fish system, fodder crop integration etc. Pond bundhs may also use for growing pulses and oil seed crops. Aquatic cash crop like Makhana (*Euryale ferox)* and Singhara (*Trapa sp)* integration can also be done along with air-breathing or carnivorous fishes.

Live-Stock Fish Farming

1. Poultry-cum-fish farming: In this system fish farming is integrated with poultry farming where poultry droppings or deep litter materials are utilized by fish as feed materials. In India, this system of freshwater fish culture has assumed greater significance in view of its potential role in recycling of organic wastes and in integrated rural development.

Advantages of fish cum poultry farming:

- a. Save fertilizer cost.
- b. Save supplementary feed cost (account 60%).
- c. Chicken get its required quantity of water from the fishpond.
- d. From the same places at the same time chicken meat, eggs and the fish can be produced.

This system utilises poultry droppings of fully built- up poultry litter for fish culture. The fish production obtained is about 5000 kg/ha/yr. with 1250 kg chicken meat and 70000 no. of eggs. Approximately 500-600 no. of birds is reared in a 1 ha pond. The Rhode Island or Leghorn variety birds are more preferred over others. They require 0.3-0.4 square meterspace/bird. Hoppers are used to feed them and to minimise feed wastage.

Poultry-cum-fish farming is a sustainable and diversified approach to agricultural production. It allows for efficient resource utilization, minimizes waste, and enhances farm income. This integrated farming system is particularly suitable for regions where poultry and fish are essential components of the diet and economy.

It not only provides a variety of protein sources but also promotes resource efficiency and resilience in agriculture.

Fig- integrated fish and poultry farming

In summary, integrated fish farming is a sustainable and economically viable approach in India that promotes resource utilization, diversifies income streams, and contributes to food security. It offers a promising model for rural development and improving the livelihoods of farmers while enhancing fish production.

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Eat Before Sunset

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Introduction

Food is first and foremost need of all living beings. Consumption of nutritious and healthy food is of utmost importance to remain healthy and disease-free, butit is equally important to eat food at the right time. When we eat is as important as what we eat. Eating food during the daytime and avoiding it at night can prevent us from many metabolic diseases, as the body digests the food best when we are active, and light is present.

Mechanism

The human body has evolved to function in sync with the solar day. The endogenous system responsible for maintaining the daily bodily rhythms is known as the circadian system. It is the biological timing system and is found in every cell of the body. Its function is to synchronize our behaviour with internal physiology (Manoogian *et. al*., 2019).

The whole system consists of two types of clocks- central and peripheral. The central circadian clock (CCC) is governed by the Suprachiasmatic Nuclei (SCN) present in the hypothalamus part of the brain (Scheer *et. al*., 2009). SCN is highly photosensitive and sends signals to CCC via 20,000 neurons. On the other hand, the Peripheral Circadian Clock (PCC) is influenced by our behaviours like sleep/wake and feeding/fasting cycles (Chellappa *et. al*., 2021).

The human is designed to function during the day hours and rest during the night. When we eat, the PCC is stimulated. At night, dim light melatonin onset (DLMO) reduces pancreatic beta cell function and hence, the insulin releases (Qian *et. al*., 2018). This results in uncoupling or misalignment between the two circadian clocks (Chellappa *et. al*., 2021). The Thermic Effect of Food (TEF) value also decreases after DLMO. Due to these factors, nocturnal eating can have adverse effects on health in the long run (Xiao *et. al*., 2019).

Effects

The misalignment between CCC and PCC, DLMO and decreased TEF value result in increased glucose levels in the blood or glucose intolerance (Mc Hill *et. al*., 2014). Prolonged periods of glucose intolerance expose us to obesity and type 2 diabetes (Chellappa *et. al*., 2021). Glucose intolerance, in the long run, also contributes to cardiovascular diseases and cardiometabolic disorders like atherosclerosis (Manoogian*et. al*., 2019).

It has also been found that food timing affects our mental health. According to the studies, eating at the wrong time increases the risk of depression and anxiety by 26 and 16%, respectively. The greater the circadian misalignment, the greater would be the influence on mental health (Qian *et. al.,* 2022). Night eaters also face an 11-13% increased risk of colon cancer and breast cancer (Li *et. al*., 2017).

The eating time also affects our food choices. Those who eat early in the day have been found to prefer healthier and nutritious food items, over those who eat at night. Nocturnal eating has also been associated with increased food intake, which can lead to obesity (Bian *and Markman*, 2020).

Hyperphosphatemia (increased phosphate levels in the serum) and disturbed gut microbiota composition are some other problems that result from night eating. Late-night eating promotes the development of proinflammatory taxa, which hinders the production of tryptophan (necessary for mental health) (Chellappa *et. al*., 2022).

Conclusion

Nocturnal eating causes misalignment between the Central Circadian Clock and the Peripheral Circadian Clock. As Dim Light Melatonin Onset reduces insulin at night, the body is unable to process glucose properly when we eat at night or very early in the morning (resulting in complications.

Eating only during the daytime can prevent circadian misalignment. Not skipping and having a heavy and healthy breakfast can help in reducing night eating. Also, avoiding eating at night would induce a gap between the last meal and the first meal of the next day (intermittent fasting), which has been proven to reduce obesity and improve digestive health. It also helps in getting a sound sleep.

Circadian rhythms, nutrition and metabolism are linked with each other. When we eat is as important as what we eat. Eating during the day prevents circadian misalignment and helps us ameliorate metabolic diseases along with obesity.

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Women Friendly Farm Tools and Implements

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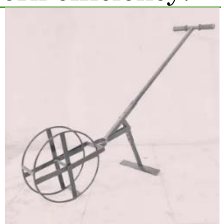
Introduction

Agriculture is a crucial sector for human life and women's contribution is inevitable to it. Women plays both major, minor, allied agricultural activities, their household activities and beyond. Women contributes 33 per cent agriculture labor force. Increase migration of male to urban area which put more pressure on women labors of agriculture. Women contribute to agriculture by performing various roles like cultivators, entrepreneurs, labors and also engaged agriculture allied activities like livestock rearing, horticulture, post-harvesting operations, agro/social forestry, fishing, etc. labour-intensive activities like cattle management, fodder collection, milking, threshing, winnowing, etc., are performed by women. Therefore, women are exposed to harsh condition of work which leads drudgery. Mechanization developed to reduce drudgery, increase utilization efficiency, increased productivity of Woman-Machine System, so they can also get leisure time, conserving energy, improving quality of work and produce, and enhance the quality of working life of farm women. Various drudgery reduction technologies and farm tools were developed by various institutions. So this paper explore the women friendly farm tools and implements which used in activities like weeding, harvesting and transport of agriculture produce.

Weeder (Flat, Notch)

Weeders come in two in one - flat and notch. Weeding is a continuous process, and using these weeders can improve the worker's posture and enhance work efficiency.

		
Weeder (Flat, Notch)	**Twin Wheel Hoe Weeder**	**Cycle Weeder**

Twin Wheel Hoe Weeder

The twin wheel hoe weeder is designed to reduce the human power required for weeding, increase efficiency, and reduce drudgery and labour wages.

Cycle Weeder

The cycle weeder is another tool that reduces the risk of musculoskeletal disorders, physical hazards, health problems, and drudgery. It saves time, cost, and energy and increases efficiency.

Wheel Hand Hoe

The wheel hand hoe was developed by Chaudhary Charan Singh Haryana Agricultural University to reduce drudgery and fatigue. It operates in a push and pull method and has a rate of 15 strokes per minute. It is best to use in sugar cane fields and this tool saves labour time, energy, and is cost-effective.

Improved Sickle: The indigenous sickle weighs around 234 gm and has a length of 20.5 cm. Its non-serrated iron blade causes drudgery, leading to more fatigue and reduced productivity. To overcome these issues, an improved sickle was developed that is light in weight (180gm) and has a self-sharpening blade, making it easier to use for women. Compared to the conventional sickle, the productivity increased up to 23.4%, and it covers a wide area. It causes minimum grip fatigue and reduces the stress in energy expenditure to below 13%.

		
Wheel hand hoe	**Improved Sickle**	**Saral Khurpi**

Saral Khurpi
This tool was developed to remove deep-rooted weeds and can be used while adopting a squatting position. Women farmers evaluated that it was moderate to heavy, but it reduced the drudgery by 5-10%. The stress in hand, wrist and palm was diminished. The tool increases efficiency by being light in weight and costing less energy, leading to low heart rates.

Sitting Type Groundnut Decorticator
It is easy to operate, increases work efficiency and output, and also saves energy and time. Its cost-effectiveness and user-friendliness are some of its benefits. The muscular and physiological efforts of farm women are reduced, leading to reduced fatigue in hand and wrist.

Standing Type Groundnut Decorticator
This tool helps in reducing the incidence of physiological and muscular efforts in the hands, wrists and fingers of farm women. It can decorticate almost 51 kg of groundnuts within an hour which increases the work efficiency of farm women.

Comb Stripper for Groundnut
The efficiency of the developed stripper has increased by 6-8 kg per hour compared to the traditional technique. This tool saves time and energy and reduces the occupational health hazards in fingers and nails. It also helps in reducing musculoskeletal pain in the wrist, elbow and waist.

		
Sitting Type Groundnut Decorticator	**Standing Type Groundnut Decorticator**	**Comb Stripper**

Eared Cutter for Jowar Harvesting
This implement increases production efficiency and reduces the risk of drudgery, thereby saving time.

		
Eared Cutter Machine	**Cotton Stalk Puller**	**Cotton Picking Machine**

Cotton Stalk Puller

This tool helps in reducing the risk of musculoskeletal pain in the upper and lower back, legs, shoulders, and fingers. It increases efficiency, saves time, and reduces the risk of physical hazards.

Cotton Picking Machine

Traditionally, cotton picking was carried out by women who could manually collect up to 1-2 kg per hour. With the help of the cotton-picking machine, the yield can be increased up to 6-7 kg per hour. This tool increases efficiency, is cost-effective, reduces physiological hazards and drudgery, and consumes minimum energy to use. The clean cotton obtained also increases the cost of the product.

Grain Picker

This tool reduces exhaustion and pain in the palm and reduces the incidence of damage in the wrist and forearm. It helps in reducing the forced grip.

		
Grain Picker	**Head load manager**	**Potato Pickers**

Head Load Manager

The head load manager is a user-friendly tool that is mainly used to carry materials from one place to another. It is light in weight and helps in reducing heart rate, physiological cost of work, work-related musculoskeletal disorders, and grip fatigue.

Potato Pickers

Potato pickers are tools used to collect potatoes during harvesting. They reduce the physical strain and risk of musculoskeletal disorders in the back, shoulder, hand, and wrist, while also saving time and increasing productivity.

Ring Cutters

Ring cutters were developed to help harvest vegetables and flowers. Manual harvesting by women farmers can yield around 20-22 kgs per day, while a ring cutter can increase that to 30 kg per day. This tool reduces physical injuries, cuts, and strain on fingers, while also improving efficiency and saving time, energy and labour costs.

	
Ring Cutters	**Harvesting Bag**

Harvesting Bags

Harvesting bags are designed to collect vegetables, flowers, and other agricultural produce. Three different types of bags were developed and evaluated: front load, back load, and basket shape bags. These bags increase efficiency and productivity by up to 80 per cent and can increase the harvesting quantity to 1.75 kg per hour per person. They also reduce the risk of physical hazards and injuries.

Mittens for Vegetable Harvesting

Mittens for vegetable harvesting are used during the harvesting of vegetables like okra and brinjal. They increase efficiency and safety, while reducing physical hazards.

Conclusion

In the agricultural sector, women were responsible for carrying out several secondary activities such as weeding, harvesting and other allied tasks. These activities were either done for income or to reduce the labour charges in their own fields, in addition to their household responsibilities. However, such work often led to health problems such as musculoskeletal disorders and other related issues. Therefore, state agricultural universities, centre for women agriculture and other notable institutions developed farm tools and implements to reduce such risks. Creation of awareness about these tools are much needed and commercialized and made available to end-users. The tools will play a vital role to eradicate the enormous physical strain to the people who involved in agriculture sector.

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Ecological Fruit and Seed Types

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In addition to the taxonomic similarity of fruit and seed types and convergence according to dispersal adaptations, the environment in which the species grow and their regeneration strategy within that environment have an impact on seed handling. Species growing in the same type of environment, and occupying similar niches, tend to have similarities in their fruiting and seeding habit.

Although some genetically related species as reflected in taxonomic groups tend to grow under similar climatic environments, e.g. dipterocarps in tropical rain forests and conifers in cool climate in the temperate zones and tropical and subtropical highlands, other groups have adapted to quite different environments. For example, Leguminosae are typically dry zone species, but some grow in the humid tropics and have adopted a regenerational strategy appropriate for that climate. A particular niche also tends to develop a particular regeneration strategy, which is reflected in the fruiting and seeding habit and morphological and physiological adaptations.

Some typical features of fruits and seeds in distinct tropical and subtropical environments are enumerated below.

Mangroves

Mangroves grow in an aqueous environment which is daily inundated with sea water. The seeds are extremely recalcitrant, have no dormancy and usually germinate while still attached to the mother tree. They are extremely sensitive to desiccation and have very short viability. These viviparous seeds, which are actually seedlings, are typically dispersed by tidal water.

Typical mangrove genera are *Rhizophora, Sonneratia, Avicennia* and *Bruguiera*.

Tropical Rain Forests

Rain forests are characterized by high annual rainfall, little seasonal climatic variation and dull, moist forest floors with very little diurnal micro-climatic variation. Openings in the canopy drastically change the microclimate and hence the regeneration pattern. Regeneration and hence seed types can be grouped by:

1. Climax Forest species.
2. Pioneer species.

Climax forest species have seeds adapted to germination in the humid and dull rain forest floor. They are usually extremely recalcitrant (i.e. sensitive to desiccation and with short viability) and germinate rapidly under poor light conditions. Apart from the large SE Asian dipterocarp group, most of which are wind dispersed, many rain forest species are dispersed by animals with adaptations as specialized dispersal agents,

e.g. fruit bats (*Psidium* (guava), *Garcinia* (mangosteen), *Chlorophora*, and *Artocarpus*), or birds (*Syzygium, Antiaris, Trilepisum*). The seeds are often large. Most climax forest species have erratic and often unpredictable seed crops with occasional mastings. They usually fruit only at an advanced age (Janzen 1978).

Typical rain forest climax type genera are dipterocarps (e.g. Dipterocarpus, *Hopea, Shorea, Parashorea, Vatica*), *Artocarpus, Tectona*, (Asia-Pacific), Khaya (Africa), *Swietenia, Cedrela* and *Vochysia*, (S-C. America) and *Agathis* (Australia).

	
Fruit bats dispersing guava seeds	**Birds dispersing *Syzgium* seeds**

***Artocarpus* (bread fruit)**

Cedrela

Khaya (mahogany)

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Pioneers: Pioneers are adapted to regeneration of large gaps occurring after e.g. tree fall. The seeds are usually orthodox and have dormancy. Light stimulus or regularly fluctuating temperatures often break dormancy. The seedlings are light demanding. Pioneers are relatively short lived and bear regular and abundant fruit crops from a young age. Many pioneers have diffused flowering and fruiting which may occur any time of the year, presumably often triggered by an external environmental stimulus, e.g. a brief drought. The seeds are often small wind or animal dispersed diaspores, the latter with usually little specialization to a particular agent. Many pioneer species are prone to heavy pre-dispersal predation.

Typical rain forest pioneer genera are *Paraserianthes* (Pacific), *Albizia, Afzelia* (Africa), *Calliandra, Sesbania, Leucaena* (America), *Derris, Gmelina* (S. Asia), *Grevillea, Acacia, Eucalyptus* (Australia).

Grevillea

Savannas and Other Seasonal Forests

In the majority of the subtropics there is a pronounced seasonality in rainfall and temperature. Rainfall is the most important factor and apart from the regular dry season many areas are prone to recurrent long droughts. Most dry zone species have orthodox seeds and physical dormancy. Fruiting generally takes place just before the rainy season. Environmental conditions such as long droughts often trigger flowering. Many seasonal forests are prone to regular fires. Some species mainly regenerate after fires, e.g. Banksia and some eucalypts. Seeds which fail to germinate during the first rainy season may remain dormant in the soil seed bank for many years. Physical dormancy is broken by e.g. mechanical scarification. Once the dormancy has been broken, the seeds usually germinate quickly. Seedlings are usually light demanding.

Typical seasonal forest genera are *Acacia, Albizia, Brachystegia, Julbernardia, Pinus, Colophospermum, Callitris, Casuarina, Eucalyptus, Melaleuca*.

Banksia

High Altitude Species

Many high-altitude species have similarities with temperate species, but in contrast to the temperate region, there is little variation in diurnal photoperiod and temperature regime over the year. Consequently, thermo-dormancy (chapter 9) is not prevalent among these species. Regular seasonal flowering is not prevalent in high altitude species (Whitmore 1982).

Typical high-altitude genera are Alnus, Brachystegia, Podocarpus, Populus, Juniperus, Betula, Castanopsis, Quercus, Eucalyptus, Pinus.

Brachystegia

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Hybrid Seed Production Technology of Rice

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Paddy Phenology

Botanical name	*Oryza sativa*
Chromosome number [2n]	24
Family	Poaceae
Inflorescence	Panicle
Pollination	Self-Pollination
Flower Opening Pattern	Tip of primary & secondary branches and proceeds downward (basipetal)
Time of Anthesis	7.00 –10.00 A.M
Temperature favorable for flowering	24 -280C
Favourable RH for flowering	70-80%
Difference between day and Night temperature	8-100C
Stigma receptivity	3 days
Pollen viability	10 minutes

Breeding Technique for Hybrid Rice

Hybrid seed production	Cytoplasmic genetic male sterility system (CGMS) 3-line breeding system.
Stages of seed production	Breeder seed – Foundation seed – Certified.

Seed Multiplication Work at Different Stages

Stages of Seed Production	Seed Multiplication
Breeder Seed stage	A (AxB), B, R lines are raised separately under isolation
Foundation Seed stage	A (AxB) and R lines raised separately under isolation
Certified seed stage	A and R line are crossed under isolation to get hybrid

High Altitude Species

Many high-altitude species have similarities with temperate species, but in contrast to the temperate region, there is little variation in diurnal photoperiod and temperature regime over the year. Consequently, thermo-dormancy (chapter 9) is not prevalent among these species. Regular seasonal flowering is not prevalent in high altitude species (Whitmore 1982).

Desirable Characteristics of the 3 Lines in the CMS System

A-line	B-line	R-line
• Stable Sterility • Well-developed floral traits for outcrossing • Easily, wide-spectum, & strongly to be restored	• Well-developed floral traits with large pollen load • Good combining ability	• Strong restore ability. • Good combining ability • Taller than A-line • Large pollen load, normal flowering traits and timing

Land requirement: Land should be fertile**,** Be free from volunteer plants, Have good sunlight & aeration, Have assured irrigation, Be isolated from other varieties of the same crop, Favourable season, Avoid highly alkaline and acidic soil, Field should not grow with the same crop in the previous season. If grown, it should be the production of the same class of seed for the same variety.

Season: Kharif – second fortnight of May; Rabi – second fortnight of December.

Climatic condition: Favourable climatic conditions during flowering for higher seed set, Daily mean temp. 24-30°C, RH ranging from 70- 80%, Difference between day & night temp. 8-10°C, Sufficient sunshine & moderate wind velocity (2-3 m/sec), Free from continuous rain for above 10 days during peak flowering.

Pre-Sowing Seed Treatments

Upgrading of seeds (EGG FLOTATION TECHNIQUE) - Salt solution: 1.13 specific Gravity (1.5 kg of salt / 10 lit)

Seed hardening - 1% Kcl for 10 hrs in 1:1 ratio

Fungicidal seed treatment - Captan / Thiram @ 4g/kg

Azospirillum seed treatment- 3 pkts / ac seeds.

Pre-germinated seeds - Overnight soaking and incubation for 24 hrs

Dormancy breaking - 0.18N HNO_3 (240 ml in 45 lit) at 1:1 for 12-16 hrs.

Nursery Raising and Seed Rate

For this, 30 g seeds/m² would be required. Fifteen kg seed for A line and 5 kg seed for B or R line would be required for planting crop in one hectare of land. 250 kg FYM, 1 kg N and 1/2kg each of phosphorus and potash per 100m² should be applied. Pre-soaked seeds should be treated with carbendazim (50%WP) @ 4 g/kg of seeds.

The seeds should be incubated in gunny bags for 1-2 days for better sprouting. The sprouted seeds should be sown sparsely and uniformly on well-prepared seed beds. Total nursery area required for sowing 20 kg of seeds is 1000-1200 m². A thin film of water should be maintained, and the beds should not be allowed to get dry at any time.

The nursery beds should be top dressed after 15 days of sowing with 600-800g of Nitrogen per 100 m². Appropriate plant protection measures should be taken during the period when the seedlings are in the nursery bed.

Pest Management (Nursery)

Insect	Control measures
Thrips	Phosphamidon85 WSC 25 ml(or)Monocrotophos 36 WSC 40ml (or) Endopsulfan 35 EC 80 Ml
Green leaf hopper	As above or maintain 2.5 cm of water in the nursery and broadcastanyone of the following Carbofuran3g3.5kg or Phorate 10G1.0kg or Quinalphos 5g 2.0kg
Case worm	Mix kerosene in standing water and remove the cases and destroy and spray Monocrotophos 36 WSC 40ml (or) Quinalphos 25 EC 80 ml
White tip nematode	Sun drying of seeds for two days at 6h interval
Rice root nematode	Carbofuran3g at 3.5kg / 20cents

Disease Management (Nursery)

Disease	Control measures
Blast	Spray with insecticide Copper oxy chloride100g or Mancozeb 80 g
Tungro disease	Apply carbofuran 3g at the rate of 3.5 kg ten days after sowing or spray two rounds of Monocrotophos 36 WSC 40ml or Phosphamidon 85 WSC 25 ml
Brown spot	Carbendazim 40 g

Main Field Preparation

Total 150N 60P 60K
Seed rate: A-line – 20 kg/ha; R-line – 10 kg /ha
Planting ratio: A line: R line – 8:2.

Isolation

1. Barrier isolation: This can be achieved through physical barriers:

a. Natural means like mountains, forests and rivers and

b. Growing taller crops like sorghum (jowar), maize, pearl millet (bajra), sugarcane, Sesbania (dhaincha), etc.

These barrier crops are planted covering a distance of 30 m between hybrid seed producing plot/parental seed producing plot and other rice varieties.

2. Time isolation: It can be provided by planting the parental lines of the hybrid in such a way that they come in full flowering stage 21 days either prior or after the rice varieties grown nearby start flowering.

3. Space isolation: Foundation seed: 200m; Certified seed: 100 m.

Irrigation

'R' line will respond more to water regulation. Irrigation at critical stages is important.

Prediction of Heading Date

The development of the panicle classified into 8 developmental stages. Usually, parent will take 27 and 32 days from panicle initiation to heading in 8 stages.

Synchronization and Supplementary Pollination Techniques

1. Staggered sowing in nursery.
2. Urea application.
3. Withholding of irrigation.
4. Rope pulling / Rod driving.
5. Shaking of plants.
6. GA_3 Application.
7. Flag leaf clipping.

Roguing

Roguing is a process of removal of unwanted rice plants from the seed production plots to ensure high genetic and physical purity of hybrid seed.

Harvest & Post-Harvest

Pollen and seed parents should be harvested separately, Harvest and thresh the pollen parent first and later the seed parent can be harvested and threshed, Preferable moisture for threshing 15-18%, Properly dried and bagged, Safe moisture content for storage 10-12%.

Problems in Hybrid Rice Seed Production

SPLIT HUSK: Problem of split husk occur in hybrid rice seed production where the lemma and palia are not closed properly at tip portion. Occurrence is claimed to nutrient deficiency synchronization defects and genetic factors, as it occurs more in female line than male line. Split husk reduces the germination due to heavier load of fungal colonies.

Seed Multiplication Ratio: 1:100

Storage: Fort short term storage use gunny bag or cloth bag; For long term storage use polythene bag of > 700 gauge and dry the seeds to 8% moisture content.

Seed Yield: Hybrid yield (F_1): **800-1200 kg per hectare.**

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Managing Food Waste and By-Products in the Food Industry

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Food industries are growing rapidly to huge numbers due to globalization and population increase and are providing a wider range of food products to satisfy the needs of the consumers. The major food industries of the world include dairy, fruits and vegetables, meat and poultry, seafood and cereal. However, these industries generate huge amounts of by- products and wastes, which consist of high amounts of organic matter leading to problems regarding disposal, environmental pollution and sustainability (Russ and Pittroff, 2004).

According to a report by the Food and Agriculture Organization of the United Nations in 2019, approximately one-third of the world's food production is lost or wasted annually, resulting in a staggering global economic loss of around USD 7.5 trillion each year (Bartocci *et al*., 2020).

The current emphasis in food industries lies on addressing waste management and recycling issues through valorization. This involves utilizing by-products and discarded materials to create new value-added products for commercial purposes. Valorization presents a compelling alternative to conventional waste disposal or land-filling methods. It opens up avenues for reusing nutrients in primary product production, underscoring potential benefits. Traditional waste utilization methods encompass their use as animal feed, fertilizer, or disposal (Jayathilakan *et al*., 2012).

Food waste and by-products (FWBP) have been a concern for decades, but the urgency to address this problem intensified only recently. The by-products generated by the agri-food industry, such as peels, seeds, shells, pomace, and leaves, are valuable resources owing to their rich content of bioactive compounds like phenols, peptides, carotenoids, anthocyanins, and fatty acids, as well as fibers and enzymes. These components are highly sought after for the production of functional foods and pharmaceuticals targeting both acute and chronic diseases. Additionally, they contain antioxidants with potential applications in the cosmetic industry (castrica *et al*., 2019).

In food industries the large volume of wastes is produced in both the solid and liquid form during the receiving stage, processing and packing. Food-processing wastes and by- products are generated during processing of the various food products by the industries, which have not already been used for other purposes and have not been recycled. Crude raw materials such as cereals, fruits, vegetables and animals are processed to final products with the production of large amounts of materials in the form of wastes (Ezejiofor *et al*., 2014).

Table 1. Different food processing industries and their wastes (Ezejiofor *et al*., 2014; Narasimmalu and Ramasamy, 2020):

Food processing industry	Waste materials generated
Cereal processing	Husks, hull, rice bran
Fruits and vegetable processing	Skin, peels, pulp, seeds, stem, fiber, spoiled fruits and vegetables
Poultry processing	Skin, bones, blood, feathers, liver, intestines and fat
Marine products processing	Viscera, heads, backbones, blood and shells
Dairy products processing	Whey, lactose
Oil industry	wastewater, organic solid waste (i.e. seeds and husks) and inorganic residues

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Remediation and Rehabilitation of Polluted Soils

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Summary
Remediation and rehabilitation of polluted soils involve the application of various techniques to restore soil quality and mitigate the negative impacts of pollution. These techniques can include physical methods such as excavation and soil washing, chemical methods like soil stabilization and oxidation, and biological methods such as phytoremediation and microbial remediation. The choice of method depends on factors such as the type and extent of contamination, site conditions, and cost-effectiveness. Successful remediation efforts aim to minimize environmental risks, restore soil fertility and support sustainable agriculture practices.

Introduction
Soil pollution is a pressing environmental concern with far-reaching consequences for ecosystems, human health and socioeconomic development. Soil pollution is a major threat to agricultural production because it degrades soil health, which is necessary for food security, health safety and sustainable agriculture. Soil pollution is caused by both naturally occurring and synthetic human-made contaminants (Yadav *et al.*, 2017). Nevertheless, with advancement in industrial activities, urbanization, agriculture and improper waste disposal are among the primary sources of soil contamination, leading to the accumulation of hazardous substances such as heavy metals, organic pollutants and industrial chemicals. The remediation and rehabilitation of polluted soils have emerged as critical strategies to restore soil quality, mitigate environmental risks and to sustain safe food production.

According to Ravi *et al.* (2015), physical separation, soil washing, thermal treatment, soil replacement, encapsulation aim to remove, destroy, or immobilize contaminants through chemical oxidation, electrochemical method, chemical stabilization, bioremediation and phytoremediation are among the innovative technologies utilized to degrade, immobilize or remove contaminants from soil matrices. Additionally, revegetation, soil amendment and land reclamation practices have potential in restoring soil fertility, promoting ecosystem resilience and preventing further degradation for sustainable production.

Physical Remediation
The physical remediation mainly includes soil replacement method and thermal desorption (Liao *et al.*, 2016). The soil replacement means using clean soil to replace or partly replace the contaminated soil with aim of dilute the pollutant concentration and thus remediate the soil. The soil replacement is also divided into three types, including soil replacement, soil spading and soil importing. (1) Soil replacement is removing the contaminated soil with new soil. This method is suitable for small area. (2) Soil spading is deeply digging the contaminated soil, making the pollutant spread into the deep sites and achieving the aim of diluting and naturally degrading. (3) New soil importing is adding lots of clean soil into the contaminated soil, covering it at the surface or mixing to make the pollutant concentration decreasing.

The thermal desorption is based on the basis of pollutant's volatility by heating the contaminated soil using steam, infrared radiation to make the pollutant (e.g., Hg, As) volatile. The volatile heavy metals are then collected using the vacuum negative pressure and achieve the aim of removing the heavy metals. Traditional thermal desorption can be classified into high temperature desorption (320~560°C) and low temperature desorption (90~320°C).

Chemical Remediation

Chemical leaching: It is washing the contaminated soil using reagents and others fluids that can leach the pollutant from the soil (Zhang *et al.*, 2020). Through the ions exchange, precipitation, adsorption and chelation, the heavy metals in soil were transferred from soil to liquid phase and then recovered from the leachate. The leachate using mainly include inorganic eluent, chelation agents such as hydrogen fluoride, phosphoric acid, sulfuric acid, hydrogen chloride, nitric acid and EDTA.

Chemical fixation: Chemical fixation is adding reagents into the contaminated soil and using them with heavy metals to form insoluble or hardly movable, low toxic matters, thus decreasing the migration of heavy metals to other environmental media and achieving the remediation of soil. The soil conditioning materials used include clays, metallic oxides, biomaterials etc.

Electrokinetic remediation: Electrokinetic remediation is a new remediation technology, which includes applying voltage at the two sides of soil by anode and cathode electrodes and forming electric field gradient, which facilitates the movement of negative charged ions toward anode and positively charged ion to cathode. The pollutant was carried to two poles treatment room via electromigration, electroosmotic flow or electrophoresis and then treated further. It is suitable for low permeable soil and has advantages of easily install and operate, low cost and not destroy the original nature environment.

Vitrification: Vitrification is heating the soil at temperature of 1400~2000°C, in which the organic matters volatilize or decompose. The steam produced and pyrolysis product was collected by off-gas treatment system. The melt after cooling forms rock shape vitreous, sieges the heavy metals and make it lose migration. It was reported that the strength of the vitreous is high 10 times than concrete.

Biological Remediation

Biological processes permit the removal of heavy metals and metalloids by exploiting microorganisms and plants. Biological agents respond to contamination through their defense mechanisms, such as enzyme secretion and cellular morphological changes.

Bioremediation: The removal of heavy metals and metalloids can be actuated by fostering the growth and development of specific microorganisms in contaminated soil, namely through bioaugmentation and/or bio stimulation processes. Heavy metals/metalloids can be oxidized, reduced, immobilized, and metabolized by microorganisms. The main microbial processes are biosorption and bioleaching.

Biosorption: In the biosorption process, the heavy metals are immobilized onto the cellular structure of microorganisms. This is possible through the extracellular binding created between the cell surface (anions) and metal ions (cations). Extracellular materials have active functional groups that promote the binding mechanisms.

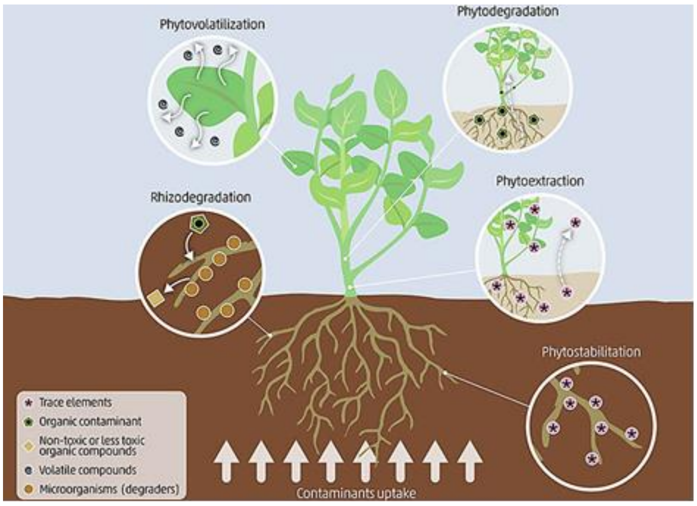

Figure 1. Phytoremediation techniques

Bioleaching: The bioleaching process reduces mobility and stabilizes pollutants using the capacity of microorganisms to produces secretions, such as low molecular weight organic acids, that can dissolve heavy metals and soil particles containing heavy metal ores. In this way, heavy metals are directly solubilized by the metabolism of microorganisms or indirectly by their metabolites. The agents that promote the leaching are biosurfactants, namely polysaccharides, lipids, and lipopeptides, produced by microorganisms.

Phytoremediation: Phytoremediation is a bioremediation technique that exploits the capacity of plants to intercept, take up, accumulate, adsorb, or stabilize contaminants. The phytoremediation process aims to sequester contaminants via the roots of plants to lesser toxic elements or absorb them to the roots or shoots (Pardo., 2003). Some plants, called hyperaccumulators, can tolerate and accumulate more than 1000 $mg \cdot kg^{-1}$ of dry matter of copper, cadmium, chromium, lead, nickel, cobalt, or up to 10,000 $mg \cdot kg^{-1}$ of dry matter.

Several trees, as well as agricultural and herbaceous crops, are used, such as willow (*Salix* spp.), poplar (*Populus* spp.), wheat (*Triticum aestivum* L.), sweet and grain sorghum (*Sorghum bicolor*) and smilo grass (*Piptatherum miliaceum*). The phytoremediation process can be assisted by natural chelators, which promote the bioavailability and adsorption of heavy metals. The phytoremediation techniques can be divided into Phyto stabilization, Phyto evaporation and phytoextraction (Fig.1).

Conclusion

In conclusion, remediation and rehabilitation of polluted soils are critical processes for restoring soil health, mitigating environmental impacts, and safeguarding human health. By employing a combination of physical, chemical, and biological techniques tailored to specific contaminants and site conditions, polluted soils can be effectively treated and rehabilitated. These efforts not only restore ecosystem functions and biodiversity but also contribute to sustainable land use practices and safeguarding food security. However, successful remediation requires careful planning, monitoring and long-term management to ensure the effectiveness and sustainability of soil restoration efforts.

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Metagenomics for Assessing Soil Microbial Diversity

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Summary
Metagenomics is a new approach to study soil micro-organisms present in particular area. In this technique microbial DNA is extracted directly from the soil samples. This DNA represents the genetic material of all organisms present in the soil, including bacteria, archaea, actinomycetes, fungi, algae and viruses. Sequencing technologies are employed to sequence the extracted DNA, which include millions of short DNA sequences or "reads.". Bioinformatic tools and algorithms are used to analyse the sequenced data. These tools help in assembling the short DNA reads into longer sequences (contigs), identifying microbial taxa present in the sample and assessing their relative abundance. By comparing the sequences against reference databases, researchers can determine the taxonomic identity of the microbial species present in the soil sample. This allows for the estimation of microbial diversity at various taxonomic levels, from phyla to species. Metagenomic data can also provide insights into the functional potential of soil microbial communities, by identifying genes associated with specific metabolic pathways.

Introduction
Soil is responsible for providing Earth's distinct ecosystem services including being one of the largest deposits of nutrients and water for plants, regulating gas emissions and cycling of elements. Microbial diversity within the soil is crucial due to their high abundance and relationship with the degradation of organic matter and bio-geochemical cycles. Microbial communities have a rapid response to environmental changes and thus is a perceptive factor that can be used as bioindicator of soil health. On an average, 1 g of soil contains 4000 - 5000 and 1000-1500 different bacterial and fungal "genomic units". But the major limitation in studying this rich diversity of microorganisms is that vast majority of microbial species are unculturable. Riesenfeld *et. al.,* (2004) reported that only 1% of soil microbes are culturable, leaving a gap for finding the taxonomical and functional knowledge of the rest 99% population. To overcome this limitation, many researchers have focused on further characterizing these unculturable microorganisms using advanced molecular methods and phylogenetic analysis based on the DNA sequence information in order to understand their distribution and relationship with the environment and this technique is known as metagenomics. The development of "metagenomics" has overcome this problem through the direct extraction of DNA from soil, allowing the characterization of such non-culturable microorganisms. This technique is useful in studying soil microbial diversity.

Fundamentals of Metagenomics
The methodology of this technique consists of extracting DNA or RNA directly from a soil sample (Ranjard *et al*., 2001), creating a library which contains the genomes of every microbe that is found in that particular area. This extracted DNA/RNA can be sequenced for bioinformatic analyses, such as taxonomic assignments, analyses of abundance, and the identification of potential functioning for select genes. Based on sequence differences of conserved genes of DNA i.e., 16 rRNA genes (16S rDNA) for bacteria, 18s rRNA gene (18s rDNA) for eukaryotes and internal transcribed spacer ("ITS") for fungi. Zhang *et al*., (2021) classified the metagenomics into functional and sequencing metagenomics. The field of studies on the discovery of new functional genes and related bioactive substances is called as functional metagenomics. Meanwhile, sequencing metagenomics is used to explore the diversity of microbial community. Metagenomics can be divided into two groups based on the types of data used: amplicon or targeted gene data and shotgun or untargeted gene data (Fig. 1).

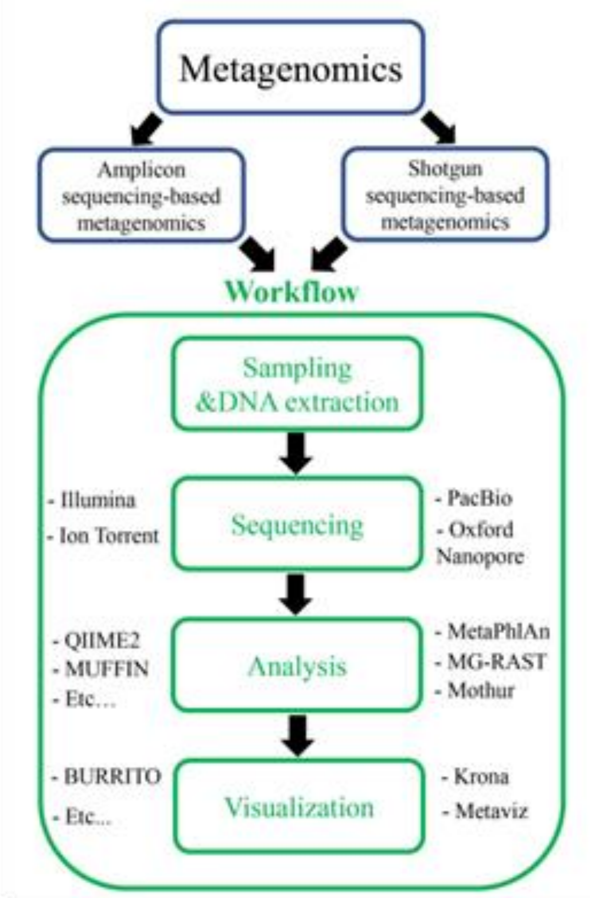

Figure 1. Types and workflow of metagenomics using different sequencing platforms and bioinformatic tools

Extraction and Enrichment of Metagenomic DNA

Extracting high concentration and large fragments of soil microbial total DNA is the first and most critical step in building a metagenomic library. It can be divided into direct extraction and indirect extraction. Direct extraction uses physical (such as freeze-thaw) and chemical (such as the addition of protease or SDS) to lyse cells directly to release microbial DNA (Gabor et al., 2003). The total DNA in all samples can be obtained by the direct extraction method, which is suitable for extracting 1-50 kb DNA. The direct extraction method is simple and efficient, but the purity is low. The indirect extraction method requires isolating the microbial cells at first and then extracting DNA using a gentle method. The DNA obtained by indirect extraction is of high purity and suitable for the extraction of 20-500 kb DNA.

Construct Metagenome Libraries

In the construction of a metagenome library, microbial DNA should first be cut mechanically or digested into a certain size of DNA and then randomly recombined with an appropriate clone vector and finally transformed into suitable host cells. The strategy of building microorganism DNA library changes with the research objective: low abundance genes or high abundance genes and small segments of a single gene or large segments of gene clusters in a metabolic pathway. The vector is selected only if it is conducive to the amplification of the target DNA fragment and is convenient for screening after the transformation and expression. The common vectors include plasmid, cosmid and bacterial artificial chromosome (BAC). Escherichia coli is easy to culture and is the most common host, but it is a prokaryotic host with limitations. Some new host cells are gradually applied, such as host Streptomyces, pseudomonas and mycobacterium.

Screening of Metagenome Library

Currently, there are three approaches to environmental metagenomic library screening: function-driven screening, sequence-driven screening and substrate-induced gene expression screening (SIGEX). Other techniques include DNA stable-isotope probing (DNA-SIP) and fluorescence in situ hybridization (FISH).

Metagenomic Sequencing and Analysis Techniques

Rapid progress has been made in sequencing technologies, from shotgun sequencing to high-throughput, next-generation sequencing (NGS) and third-generation sequencing (TGS) (Branton *et al.,* 2008). Metagenomic DNA can be sequenced from DNA libraries obtained from target gene cloning or directly from samples. The purity and content of the DNA must be ensured before it is sequenced. When selecting different sequencing methods, there are many factors to consider, including the length of the target gene, the requirement of sequencing accuracy, the purpose of sequencing (whole genome sequencing) and the gene abundance of the sample. At present, NGS is the mainstream sequencing method, but TGS is still in the initial stage of development due to its high cost and high error rate in a single base.

Processing of DNA Sequenced Information Data

Large number of reads are obtained by preliminary metagenomic DNA sequencing, these reads should be assembled into a complete genome sequence by software and taxonomic profiling should be obtained at the same time. Then gene prediction and function annotation are carried out. Genome sequencing mainly includes quality control (QC), sequence assembly, sequence binning, taxonomic profiling, gene prediction, and function annotation.

Advantages of Metagenomics in Soil Science

Functional metagenomics: (1) Functional metagenomics can obtain target genes or active products through screening without culture conditions. (2) Functional metagenomes help us to discover new members of existing enzyme families or enzymes that function only under specific physicochemical conditions. (3) Functional metagenomics combined with metabolomics helped in studying the C, N, and S cycle metabolism of microorganisms in the environment.

Sequencing metagenomics: (1) Microorganisms in extreme environments are difficult to culture. Metagenomics can find such unculturable microorganisms. (2) Species, genetic and evolutionary information of microorganisms can be obtained by studying the diversity of the microbial community. (3) In terms of emerging infectious diseases, the target of pathogenic microorganisms can be quickly identified.

Conclusion

Thus, it can be concluded from the above that metagenomic techniques have huge potential in soil microbiology and have revolutionized our understanding of soil microbial diversity in distinct environments which can help researchers to unravel the complexities of soil ecosystems, identifying novel taxa, elucidating functional potentials and ecological significance of microorganisms that hold importance for sustainable agriculture, that were previously inaccessible through traditional culture-based methods.

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Physiological Role of Auxin and Cytokinin on Growth and Development of Crops

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Abstract
With a very diverse structure and small molecules, phytohormones are regulators of plant growth and development. Despite the fact that they are synthesized by plants in small quantities, they are highly active physiologically. According to their action, phytohormones can be divided into two categories, as either activators of plant growth and development or as inhibitors, with auxins and cytokinins belonging to the former group. Auxins are synthesized by plants in the apical meristems of shoots, but also in young leaves, seeds, and fruits. They stimulate the elongation growth of shoots and initiate the production of adventitious and lateral roots. Cytokinins, in turn, are formed in root tips and in unripe fruits and seeds. These hormones are responsible for stimulating the growth of lateral shoots, they also stimulate cytokinesis and, consequently, cell division. The aim of this review paper is to present the progress of the research on the effect of selected auxins and cytokinins on crops, considering the prospect of using them in plant growing methods.

Keywords: hormones; indole-3-butyric acid; naphthyl-1-acetic acid; 6-benzylaminopurine.

Plant Growth and Development Regulators
In recent years, great attention has been paid to growth substances that can contribute to increasing the yield potential of crops and their biological value, in particular in unfavourable climatic conditions [1]. Regulators of plant growth and development are most often organic substances that even in small amounts modify plant physiology. This modification is based on supporting or inhibiting chemical reactions regulating such processes as germination, root formation, fruit setting, or plant senescence. Today, natural plant hormones are rarely applied to crops since their synthetic counterparts are mostly used i.e., 2, 4-dichloro-phenoxyacetic acid (2, 4-D), benzyladenine (BA), kinetin, tetrahydropyranyl-benzyladenine (PBA) [2-5]. Synthetic and natural hormones differ in the method of obtaining the substance. In the case of natural hormones, they come from the part of the plant where they are produced. On the other hand, synthetic hormones are usually salts obtained as a result of chemical reactions. Generally, Flasinski and Hac-Wydro [6] showed that the natural plant hormone (IAA) interacts with the investigated lipid monolayers stronger than its synthetic derivative (NAA). The reason of these differences connects with the steric properties of both auxins. The naphthalene ring of a NAA molecule occupies a larger space than the indole system of an IAA, making it less well absorbed.

In Poland, there are about two hundred products/preparations that perform regulatory and stimulating functions in relation to plants or soil. In the countries of the European Community, there are over a thousand such products. In Poland, there are officially four categories, distinguished in the relevant legal acts: plant growth regulators, plant growth stimulants, agents improving soil properties, and organic and organic-mineral fertilizers. The above preparations are commercialized on the basis of Article 5 of the Act of 10 July 2007 on Fertilizers and Fertilization. This article states that “Fertilizers and plant conditioners authorized for marketing in another Member State of the European Union or the Republic of Turkey, which have been produced in another Member State of the European Union or the Republic of Turkey, or in a country that is a member of the European Free Trade Association (EFTA), may also be placed on the market—a party to the agreement on the European Economic Area, if the national regulations under which they are manufactured and placed on the market ensure the protection of human and animal health and the protection of the environment and suitability for use”. “Stimulator”, as an official term, is not mentioned in the Regulation (EC) No. 1107/2009. This document defines the term “growth regulators”—these are mainly substances known as plant hormones (IAA, NAA, and gibberellins), ethylene precursors (ethephon, ethyl trinexapac), the wellknown and popular CCC, i.e., chlormequat chloride retardant, inhibiting germination (chlorpropham and maleic hydrazide) and several other less popular ones. This group also includes a product that is a mixture of nitrophenols, stimulating the processes of plant resistance to (abiotic) stresses and inhibiting the aging and cell breakdown processes. The company that commercializes this product in Poland, and globally002C uses the term "biostimulator" when referring to it. Plant growth regulators are products that are registered in a similar way to pesticides. The procedure is regulated very precisely by Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market.

Growth regulators can also be used in the nursery of ornamental plants (Abas, L.et al.,), where the aim is to produce well developed seedlings in the shortest possible time. Plants growing for a long time in small pots are prone to distortion of the root system. By the deformation of the roots of trees and shrubs grown in containers, the growth of their aboveground part may be inhibited because of insufficient amounts of water and minerals. Tangled roots in large quantities limit longer retention of water and mineral salts in the rhizosphere, which in turn may lead to a reduction in plant growth, as well as to a decrease in plant resistance to drought, heat, diseases, and pests (Heisler, M.G.*et al*.,). According to Balušek et al. [3] and Abas et al. (Abas, L.*et al*.,), auxins positively affect the regeneration of the root system of transplanted plants. In nurseries, the most commonly used auxins are indole-3-butyric acid (IBA) and naphthyl-1-acetic acid (NAA).

The Importance of Auxins in Plant Growth and Development Processes

Auxins, the second group of phytohormones, are organic compounds that can lengthen stem cells in a manner similar to cytokinins. The initial research on auxins dates back to the nineteenth century. It turned that the coleoptile of Elymus canadensis was sensitive to light, bending towards its source. Researchers [3] concluded that there must be some substance that penetrated into an agar block and that it was produced by the tip of the plant and then transported to the coleoptile, causing this organ to bend towards light. The above conclusions were confirmed by other studies in which oat coleoptile tips were placed on agar blocks for several days. After this time, it turned out that both coleoptile tips and the agar exhibited growth-stimulating properties. Based on the above findings, the first quantitative bioassay for the detection of auxins was developed. The name auxin comes from Greek auxein 'to grow', which reflects the role of this group of hormones. The substance behind this name is indole-3-acetic acid (IAA) [9]. Many years of research on phytohormones have made it possible to identify a number of substances constituting the group of auxins. It is known now that in addition to IAA, natural auxins include indole-3-butyric acid (IBA) and 4-chloroindole-3-acetic acid (4-CL-IAA). These substances contain an indole ring in their molecule.

Auxins also support a large number of development processes in the plant. Such processes include, among others, the formation of lateral roots, leaves and flowers, tropisms, differentiation of vascular tissues, as well as the formation of the apical-basal axis during the process of embryogenesis [29, 30]. Despite research and great progress in understanding the mechanisms of their effect on plants, auxins still constitute a large field of studies for researchers.

Effect of Auxins and Cytokinins on Selected Physiological Parameters of Plants

Growth and development of plants and, consequently, their yields are primarily dependent on the activity of basic physiological processes, such as photosynthesis and transpiration (Table 1). According to studies on soybean cultivars, their physiological activity, expressed as photosynthetic and transpiration intensity, was the highest during the flowering stage. However, during the stage of seed development the intensity of both processes decreased significantly, almost 3–4 times. A radical decrease with age in gas exchange parameters of two soybean cultivars was reported by Fu et al., who also found that their photosynthetic efficiency was the highest between the 10th and 17th day of flowering, after which leaf senescence followed. During the stage of seed development, 30–40 days after flowering began, leaves reduced their photosynthetic activity up to five times. Contrary to that, Subrahmanyam noted the highest photosynthetic and transpiration efficiency of soybean plants during the stage of seed formation. He also pointed out that the intensity of these processes could vary greatly, and, consequently, demand for photosynthetic products also varied, depending on plant variety, genetic properties, and development stage, as well as on the external environment and habitat conditions. Similar changes in photosynthetic activity were observed by Luquez, Starck, and Wróbel.

The Use of Phytohormones as Growth Regulators in Plant Production

According to Nowak and Wróbel, fertilizers and plant protection products can no longer increase plant yields significantly, so more attention is paid to the use of various growth substances. According to the above authors, the purpose of such products is to increase plant yield potential in adverse weather or in any other unfavorable conditions not suitable for a given plant. In particular, according to von Richthofen and Ulmasov et al., growth-promoting substances are of great importance in the cultivation of leguminous plants, with their unstable yield and high sensitivity to weather conditions. Such substances include exogenously applied phytohormonal growth regulators used on crops and vegetables (Harms, H and Sosnowski, J.).

In their studies on the effect of synthetic auxin and cytokinin and of their mixture on soybean, Nowak and Wróbel reported a significant yield increase. According to the authors, auxin was the most effective, followed by cytokinin and their mixture, with an increase, compared to control plants, of 34, 32, and 29%, respectively.

Reinecke et al. reported an increase in pea yield in response to a hormonal regulator containing, indole-3-butyric acid. Furthermore, beneficial effects of synthetic auxins and cytokinins on the yield of some plants were presented by Czapla et al., Barcley and David and Nowak et al. At the same time, in response to auxin application Nowak et al. reported a significant increase in field bean seed weight, on average by 10%. Kertikov and Vasileva reported higher grain yield and better chemical composition in vetch. Treating soybean with auxin (IBA) and cytokinin (NAA) and their mixtures, Czapla et al. found that auxin was the most effective in increasing the number of pods and seed yield. However, some other researchers did not observe significant effects of synthetic growth hormones on crops. According to some authors [78], the rate of plant growth and development and the yield are primarily determined by the intensity of basic physiological processes, such as photosynthesis and transpiration.

According to some authors, the rate of plant growth and development and the yield are primarily determined by the intensity of basic physiological processes, such as photosynthesis and transpiration. According to Reinecke et al., auxins, as exogenously applied growth hormones, can increase the physiological activity of plants and thus affect their productivity.

Kuang and Peterson suggest that plants respond positively to synthetic hormones because they affect physiological processes, especially an earlier increase in tissue vascularization, which manifests itself in the thickening of such morphological organs as stems, leaves, and inflorescences. According to Rylott and Smith, synthetic auxin and cytokinin increase plant yield and make generative organs competitive over vegetative ones.

This was confirmed by Pandey et al. who using synthetic auxin on cotton plants found a significant increase in the number and weight of flowers. A similar trend was observed by Qifu and Kuang et al. Using cytokinin, they reported better vascularization of plant tissues and an increase in the transport of photosynthesis products from vegetative to generative parts, which increased their concentration in generative organs, and consequently resulted in higher yield and better seed filling. Moreover, according to the literature, exogenously used phytohormones stimulate phloem transport of photosynthesis products, improving the level of nutrition of plant tissues, which improves plant condition and resistance to stress, increasing the yield and its quality.

Conclusions

Research on plant hormones as growth regulators proves that hormones can have practical applications in the cultivation of many plant species. Auxins and cytokinins can be used to stimulate the rhizosphere regeneration process. Exogenous use of auxins and cytokinins in appropriate concentrations increases the dry matter yield of plants and also improves its stability. It also reduces the occurrence of diseases. Adverse effects of auxin and cytokinin include a decrease in the content of vitamin C and an increase in the content of phenolic compounds. These hormones contribute to better tillering, growth of foliage, and improvement of induction, mass, and intensity of flowering. Auxins and cytokinins in foliar applications affect the chemical composition of the dry matter of plants in different ways. Most often, they increase the content of potassium and calcium, but do not change the concentration of phosphorus in plants.

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Machine Learning for Prediction of Soil Properties and Digital Soil Mapping

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Summary

Soil is one of the major natural resources and the vehicle that sustains human activity as well as the growth of plants and animals. The accurate understanding and rational interpretation of soil properties and its spatial distribution patterns are the basis for the sustainable development of soil resources. Precise mapping of soil properties is an urgent demand in the fields of precision agriculture, land use planning, and environment protection. In developing countries, like India the resources are scarce, understanding the spatial variability of soil properties is crucial for effective agricultural ecosystem management. Traditional soil mapping has been found to be difficult and time-consuming due to the intrinsic spatial variability of soil which may lead sometime to the loss of specific information due to the high spatial variability of soil. Digital soil mapping (DSM) is an emerging, efficient mapping method widely used to predict soil classes and properties. Digital soil mapping has emerged as a new method to describe the spatial distribution of soils economically and efficiently. Recently, demands for applying machine learning (ML) methods to improve the knowledge and understanding of soil behavior have increased. It is critical to use machine learning techniques and computational research to the agriculture industry in order for India to become a better quantity and quality food producer. ML approaches are particularly beneficial for building relationships and abstracting patterns between disparate data sets, as well as forecasting a realistic outcome as an output.

Introduction

A map is a symbolic representation of selected characteristics of a place by showing sizes and shapes, locations of features, and distances between places and also it can show exact locations of houses and streets in a particular location. Mapping is a critical tool for understanding the ground beneath our feet. Soil mapping involves locating and identifying different soils and collecting information about their location, nature, properties and spatial distribution in the desired location of our interest. Soil mapping provides essential information for better understanding of physical, chemical and biological properties of soil which enables us for making informed decisions for effective land use planning, soil conservation and agricultural management. Soil mapping has gained significant attention than ever before for whomever, whether you are a student, a researcher, an entrepreneur, or simply someone who wants to make better-informed decisions, mapping can help you achieve your goals. Conventional soil mapping (CSM) is usually based on the soil surveyor's personal model, which divides homogeneous areas into soil polygons or classes. However, because these classes neglect class variances, they are difficult to comprehend. Based on observed values at sampled sites and other environmental covariates, the DSM approach gives rapid measurements to predict soil qualities at areas that have not been sampled. Unlike conventional soil maps, digital soil maps give us estimations of the accuracy and uncertainty of the created soil maps. It is also referred to as predictive soil mapping is computer assisted production of digital mapping of soil properties and soil types. It is also called 'predictive soil mapping' or 'pedometric mapping'. Use of machine learning algorithms in predicting the spatial distribution and their digital mapping helps in providing detailed information regarding the different soil properties such as soil pH, soil moisture content, soil organic carbon (Emadi et al., 2020), electrical conductivity (EC), cation exchange capacity (CEC), the nutrient concentrations in soil like nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulphur (S) and other micronutrients, gypsum concentration, percentage of base saturation, concentration of heavy metals, nature of parent material, etc. through digital elevation models, geostatistical modeling and spatial interpolations of the collected soil samples from a given area. Machine learning algorithms along with digital soil mapping can also be used to predict the spatial variability of soil microorganisms with higher accuracies (Jha and Ahmad, 2018). Instruments like Portable X-Ray Fluorescence Spectrometer (PXRF) along with polynomial algorithms and different 'R' software packages play an important role in Digital Soil Mapping. Geostatistical modeling tools like kriging, splines, simulation options, covariance functions, semi-variance functions and variograms are used in spatial interpolation of the collected data to generate digital soil maps. Digital soil mapping works on different spatial data models. Polygon and raster data models are the most commonly used for mapping applications today. The polygon data model (points, lines, and polygon shapes) is generally the one used on paper maps, largely because those shapes can be efficiently drawn by hand. Precise prediction and mapping of the soil physical (Mallah et al., 2022) and biological properties (Jha and Ahmad, 2018) with the help of ML and digital spatial mapping are very useful for future decision-makers.

Machine Learning

It is the branch of artificial intelligence that focuses on developing models and algorithms that let computers learn from data and improve from previous experience without being explicitly programmed for every task (Kumar et al., 2022). In simple words, ML teaches the systems to think and understand like humans by learning from the data.ML is generally a training system to learn from past experiences and improve performance over time which helps to predict massive amounts of data.

Types of Machine Learning (ML)

There are several types of machine learning, each with special characteristics and applications. Some of the main types of machine learning algorithms are as follows:

1. Supervised Machine Learning (SML): SML is defined as when a model gets trained on a "Labelled Dataset" which has both input and output parameters (Random Forest, Support vector machine, Multiple linear regression etc.).

2. Unsupervised Machine Learning: is a type of machine learning technique in which an algorithm discovers patterns and relationships using unlabeled data (K-means clustering, Principal component analysis etc.).

3. Reinforcement Learning: It is a learning method that interacts with the environment by producing actions and discovering errors. Trial, error, and delay are the most relevant characteristics of reinforcement learning.

Importance of Digital Soil Mapping Use

1. Better Decision-Making: Mapping can help decision-makers understand the bigger picture and make more informed choices.

2. Improved Communication: Mapping is a powerful communication tool. It allows complex information to be conveyed in a simple and understandable way.

3. Enhanced Analysis: Mapping can help individuals and organizations analyze data more effectively. By visualizing data, it becomes easier to identify outliers, patterns, and relationships that might not be apparent from raw data.

4. Efficient Planning: Mapping can help organizations and individuals plan more efficiently.

5. Improved Safety: Mapping can help improve safety in various industries. For example, in the transportation industry, mapping can help identify accident-prone areas, roadblocks, and other safety concerns.

6. Understanding Complex Data: Mapping allows us to understand complex data in a visual format. Whether we are analyzing demographic data, tracking disease outbreaks, or studying weather patterns, mapping can help us identify patterns and trends that might not be immediately obvious in a spreadsheet or a table.

Covariates Selection

Covariate/feature selection aims at reducing the number of covariates used to calibrate the ML models. There are several reasons for selecting a subset of covariates to calibrate the model. Some of them are: (i) to calibrate the ML model faster, (ii) to reduce complexity, (ii) to increase the prediction accuracy, (iv) to avoid multicollinearity, or (v) to prevent over-fitting of the ML model, i.e. to prevent poor prediction accuracy on unseen data. They consist of the 7 predictive "*SCORPAN+E*" factors, which in turn are generalization of Jenny's conventional 5 soil forming factors: Cl (climate), O (organism), R (relief), P (parent material), T (time).

S= f(SCORPAN)+E factor

SCORPAN model is the base of Digital Soil Mapping So, the soil (S) at an unvisited site is a function(f) of Soil (S), Climate (C), Organisms (O), Relief (R), Parent Material (P), Age (A) and Location (N). The E basically represents the error. The integration of the ML algorithm in the various software permits us to produce maps of the spatial distribution of different soil parameters model results (Bouslihim et al., 2021).

Conclusion

Precise prediction and mapping of the soil physicochemical and biological properties with the help of ML and digital spatial mapping are very useful for future decision-makers. These predicted digital soil maps are the source of valuable information to determine appropriate soil management strategies and sustainable use of available natural resources. The digital soil maps generated at the higher spatial resolution can help the farmers to execute effective farm planning through the choice of efficient crops, scientific scheduling of irrigation and need-based nutrient application, effective management practices case of soil constraints, and the facilitation of the transformation to digital agriculture. Spatial and temporal changes in soil attributes can effectively be reassessed and monitored through the modern tools with high accuracy.

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The Rise of Urban Farming: How Cities are Embracing Agriculture?

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Abstract
Urban farming offers numerous benefits such as local food production, utilization of underutilized spaces, food security, environmental sustainability, community engagement, educational opportunities and economic development. However, it also faces challenges such as land availability, water scarcity, pollution, lack of infrastructure, regulatory hurdles and limited awareness and support. Various organizations like Urban Leaves India, Edible Routes, Green Souls, Urban Kisaan, ISAP and UANI are actively promoting and supporting urban farming across different cities in India. These initiatives provide resources, training and networking opportunities, empowering individuals and communities to embrace sustainable agriculture practices. The rise of urban farming signifies a fundamental shift towards a more sustainable, resilient and community-driven approach to food production and consumption in urban environments.

Introduction
In the concrete jungles of our modern cities, a green revolution is quietly taking root. Urban farming, once seen as a niche movement, is now gaining momentum as more and more city dwellers embrace the idea of growing their own food right in the heart of urban landscapes. From rooftop gardens to community plots, urban farming is reshaping the way we think about agriculture and sustainability. One of the driving forces behind the rise of urban farming is the growing awareness of the environmental impact of traditional agriculture. The carbon footprint of transporting food from rural farms to urban centres is significant, contributing to greenhouse gas emissions and air pollution. By growing food locally, urban farmers are able to reduce the distance their produce travels, cutting down on transportation emissions and creating a more sustainable food system. But urban farming isn't just about reducing carbon footprints - it's also about reconnecting city dwellers with the source of their food. In an era where many of us are disconnected from the origins of our meals, urban farming offers a way to bridge that gap. By growing their own fruits and vegetables, city residents gain a deeper appreciation for the work that goes into producing food and develop a greater sense of connection to the land.

Advantages of Urban Farming
There are several advantages of urban farming, including:

1. Local food production: Urban farming allows for fresh produce to be grown and harvested in close proximity to where it will be consumed, reducing the need for long-distance transportation and associated carbon emissions.

2. Utilization of underutilized spaces: Urban farming can make use of vacant lots, rooftops, and other unused spaces in cities, turning them into productive green areas that contribute to a healthier urban environment.

3. Food security: Urban farming can help increase access to fresh, healthy food in urban areas, particularly in food deserts where residents may have limited access to affordable and nutritious options.

4. Environmental benefits: Urban farming can help reduce the carbon footprint of food production by minimizing transportation distances, promoting biodiversity, and reducing the need for chemical inputs.

5. Community engagement: Urban farming projects can bring communities together, fostering a sense of connection and collaboration among residents who work together to grow food and care for shared green spaces.

6. Educational opportunities: Urban farming provides valuable opportunities for hands-on learning about agriculture, sustainability, and the environment, particularly for children and young people who may not have access to traditional farming experiences.

7. Economic development: Urban farming can create jobs and entrepreneurial opportunities in local food production, distribution, and related industries, contributing to economic development and resilience in urban areas.

Challenges of Urban Farming

1. Land availability: Urban areas in India are already densely populated, making it challenging to find suitable land for farming. High land prices and competition for space with other urban development projects further complicate the situation.

2. Water scarcity: Urban areas in India often face water shortages due to rapid urbanization and inefficient water management practices. This makes it difficult for urban farmers to access adequate water for irrigation and other farming needs.

3. Pollution: Urban areas in India are often plagued by air and soil pollution, which can have negative impacts on the quality of crops grown in urban farms. Contaminated soil and water can also pose health risks to consumers.

4. Lack of infrastructure: Urban farming requires proper infrastructure such as storage facilities, transportation networks, and market access. Many urban farmers in India struggle to access these resources, limiting their ability to scale up their operations and reach wider markets.

5. Regulatory challenges: Urban farming in India is often subject to complex and restrictive regulations, which can hinder the growth of the sector. Obtaining permits, complying with zoning laws, and navigating bureaucratic red tape can be time-consuming and costly for urban farmers.

6. Lack of awareness and support: Despite the potential benefits of urban farming, there is still limited awareness and support for the practice in India. Many people are unaware of the importance of urban agriculture in addressing food security and sustainability issues, leading to a lack of investment and policy support for the sector.

There are several organizations and initiatives in India that are dedicated to promoting and supporting urban farming. Some of them include:

a. Urban Leaves India: Urban Leaves India is a social enterprise based in Mumbai that promotes rooftop gardening and urban farming through workshops, consultations, and community engagement.

b. Edible Routes: Edible Routes is an organization based in Delhi that offers workshops, training programs, and consultancy services for urban farming, including rooftop gardening and terrace farming.

c. Green Souls: Green Souls is a community-based organization in Bangalore that focuses on sustainable urban farming practices and conducts workshops, events, and outreach programs to promote urban agriculture.

d. Urban Kisaan: Urban Kisaan is a vertical farming startup based in Hyderabad that provides solutions for urban agriculture, including hydroponic and aquaponic systems for growing food in urban spaces.

e. Indian Society of Agribusiness Professionals (ISAP): ISAP is a national organization based in New Delhi that works on promoting sustainable agriculture practices, including urban farming initiatives.

f. Urban Agriculture Network India (UANI): UANI is a network of organizations and individuals working to promote urban agriculture and sustainable food systems in India through advocacy, research, and capacity-building activities.

These organizations and initiatives can provide resources, training, networking opportunities, and support for individuals and communities interested in urban farming in India.

As urban farming continues to gain popularity, it's clear that this movement is more than just a passing trend - it's a fundamental shift in the way we approach food production and consumption. By bringing agriculture back into the city, urban farming is not only providing fresh, locally grown food to city residents but also fostering a deeper connection to the land and promoting sustainability in our urban environments. So, the next time you bite into a juicy tomato grown on a rooftop garden or savor a salad made from greens harvested from a community plot, remember that you're not just enjoying a delicious meal - you're also part of a growing movement that is reshaping our cities and our relationship to food. Urban farming is here to stay, and it's time for all of us to embrace this green revolution.

Conclusion

Urban farming's growth in India signifies a transformative approach to food production, emphasizing sustainability, community empowerment, and environmental stewardship. Embracing and supporting this green revolution is crucial for building resilient and healthy urban environments in the future.

Harnessing the Power of Brown Manuring in Rice Farming: A Sustainable Approach for Enhanced Yield and Soil Health

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Abstract

Brown manuring, a sustainable agricultural practice rooted in ancient wisdom, involves incorporating organic matter derived from crop residues into the soil to enhance soil fertility and promote sustainable rice production. This article explores the benefits, implementation strategies, and challenges associated with brown manuring in rice farming. By replenishing soil nutrients, suppressing weeds, conserving soil resources, and mitigating climate change impacts, brown manuring offers promising solutions to address the challenges facing modern agriculture. However, widespread adoption requires concerted efforts to overcome barriers and promote knowledge dissemination and capacity-building initiatives. Through collaborative action and innovation, brown manuring can contribute to a more resilient and sustainable agricultural future, ensuring food security for generations to come.

Keywords: Brown manuring, Rice farming, Soil fertility, Sustainable Agriculture, Weed suppression.

Introduction

Rice, as a staple crop feeding billions globally, plays a pivotal role in ensuring food security. However, the escalating demand for rice production to sustain a growing population presents numerous challenges, including environmental degradation and declining soil fertility. In response, sustainable agricultural practices such as brown manuring have emerged as viable solutions to address these challenges while promoting productivity and environmental stewardship.

Brown manuring represents a unique approach to green manuring, characterized by a 'no-till' methodology that diverges from traditional cultivation practices. In this method, a selective herbicide is applied to green manure crops before they reach flowering stage, rather than resorting to cultivation techniques (Das et al., 2021). Typically, green manure crops, preferably legumes, are grown alongside the main crop for an initial period of 25-30 days after sowing. Subsequently, these crops are desiccated using a selective herbicide, without being incorporated into the soil. Unlike conventional green manuring methods that involve plowing or tilling, the desiccated green manure crops are left standing in the field alongside the main crop, where they naturally decompose over time. The application of the herbicide causes the leaves of the green manure crops to turn brown, hence giving rise to the term "brown manuring".

Brown manuring, deeply rooted in traditional agricultural wisdom, involves the incorporation of organic matter derived from crop residues into the soil before or during rice cultivation. Unlike green manuring, which utilizes fresh plant material, brown manuring primarily relies on straw or stubble left in the field after harvest (Zalak and Parthsinh, 2021). This organic matter acts as a natural fertilizer, enriching the soil with essential nutrients and fostering beneficial microbial activity, thereby enhancing soil fertility and promoting sustainable rice production.

The benefits of brown manuring extend beyond nutrient enrichment. By suppressing weeds, conserving soil moisture, and improving soil structure, brown manuring contributes to soil conservation and ecosystem resilience (Das and Rao, 2023). Furthermore, the practice facilitates carbon sequestration, mitigating greenhouse gas emissions and combating climate change. However, the successful implementation of brown manuring requires careful planning, proper timing, and nutrient management to optimize its effectiveness.

This article delves into the multifaceted benefits, implementation strategies, and challenges associated with brown manuring in rice farming. By examining the latest research findings and practical insights, we aim to provide farmers, policymakers, and agricultural stakeholders with valuable information to promote the adoption of brown manuring as a sustainable agricultural practice. Through collaborative efforts and innovative approaches, brown manuring has the potential to revolutionize rice farming, ensuring food security and environmental sustainability for present and future generations.

Benefits of Brown Manuring

Soil Enrichment: Brown manuring is renowned for its capacity to replenish soil nutrients, essential for sustaining healthy rice crops. The gradual decomposition of crop residues releases nitrogen, phosphorus, potassium, and other micronutrients into the soil, providing a natural and balanced fertilizer source (Nawaz et al., 2022). Unlike synthetic fertilizers, which may leach or cause nutrient imbalances, organic matter from brown manuring fosters long-term soil health by improving nutrient retention and availability. This enrichment not only supports vigorous rice growth and development but also enhances the nutritional quality of harvested grains, contributing to human health and well-being.

Weed Suppression: Incorporating crop residues through brown manuring creates a natural mulch layer on the soil surface, effectively suppressing weed growth. By forming a physical barrier, this organic mulch inhibits weed seed germination and establishment, reducing competition for water, nutrients, and sunlight. As a result, rice plants can allocate resources more efficiently, leading to higher yields and improved crop quality. Furthermore, reduced weed pressure translates into lower reliance on herbicides and manual weeding, minimizing production costs and environmental impacts associated with weed management practices.

Soil Conservation: Sustainable land management practices are essential for preserving soil health and preventing erosion, particularly in rice-growing regions susceptible to water and wind erosion. Brown manuring plays a significant role in soil conservation by enhancing soil structure, stability, and resilience. The incorporation of crop residues improves soil aggregation, creating a crumb-like structure that enhances water infiltration, reduces surface runoff, and mitigates soil erosion. Additionally, the increased organic matter content boosts soil moisture retention and aeration, promoting a conducive environment for beneficial soil organisms and root growth. By maintaining soil integrity and fertility, brown manuring safeguards valuable agricultural land, ensuring its productivity and sustainability for future generations.

Carbon Sequestration: As a form of organic farming, brown manuring contributes to carbon sequestration and climate change mitigation. The incorporation of crop residues into the soil stores carbon in the form of stable organic matter, reducing atmospheric carbon dioxide levels. This process not only helps mitigate the adverse impacts of climate change but also enhances soil health and fertility. By promoting carbon sequestration, brown manuring aligns with global efforts to reduce greenhouse gas emissions and build resilience to climate-related challenges in agricultural systems. Furthermore, the carbon stored in agricultural soils through brown manuring represents a valuable asset in the transition towards a low-carbon economy, contributing to sustainable development goals and environmental sustainability.

Enhanced Biodiversity: Brown manuring promotes biodiversity by creating a conducive habitat for diverse soil organisms, including bacteria, fungi, earthworms, and beneficial insects. The presence of organic matter provides food and shelter for these organisms, stimulating microbial activity and nutrient cycling in the soil. This enhanced biodiversity not only improves soil health and fertility but also enhances ecosystem resilience to pests, diseases, and environmental stressors. Moreover, a diverse soil biota contributes to ecosystem services such as nutrient recycling, pest regulation, and soil structure formation, supporting the long-term sustainability of rice production systems.

Implementation of Brown Manuring in Rice Farming

Crop Rotation: Integrating brown manuring into crop rotation systems can enhance its effectiveness in rice farming. Alternating rice cultivation with leguminous crops or other suitable cash crops allows farmers to diversify their production systems while replenishing soil nutrients through brown manuring. Legumes, such as soybeans or mung beans, have nitrogen-fixing capabilities, further enriching the soil and reducing the reliance on synthetic fertilizers. Crop rotation also helps break pest and disease cycles, reduce weed pressure, and improve overall soil health, contributing to sustainable rice production.

Timing and Application: Proper timing and application methods are crucial for maximizing the benefits of brown manuring in rice farming. Crop residues should be incorporated into the soil shortly after harvest to facilitate decomposition and nutrient release. Ideally, this should occur before the onset of the rainy season or irrigation, allowing sufficient time for the organic matter to break down and integrate into the soil. Mechanical methods such as plowing, disking, or chiseling can aid in the incorporation process, ensuring uniform distribution of crop residues throughout the field. Additionally, applying microbial inoculants or composted organic materials can accelerate decomposition and enhance nutrient availability for rice plants.

Nutrient Management: While brown manuring provides valuable nutrients to rice crops, proper nutrient management is essential to optimize yield and minimize environmental impacts. Soil testing and analysis can help determine nutrient deficiencies and guide fertilization practices accordingly. By integrating organic and inorganic fertilizers based on soil nutrient levels and crop requirements, farmers can ensure a balanced nutrient supply while reducing reliance on chemical inputs. Moreover, incorporating green manures or cover crops alongside brown manuring can further enhance soil fertility and nutrient cycling, promoting sustainable nutrient management practices in rice farming.

Farmer Training and Support: Promoting the adoption of brown manuring requires adequate farmer training and support systems. Agricultural extension services, research institutions, and non-governmental organizations play a vital role in disseminating knowledge and providing technical assistance to farmers. Training programs covering various aspects of brown manuring, including its benefits, implementation techniques, and associated challenges, empower farmers to adopt sustainable agricultural practices and improve their livelihoods. Furthermore, providing access to appropriate machinery, inputs, and financial resources can facilitate the adoption of brown manuring, particularly among smallholder farmers in resource-constrained settings.

Policy and Incentives: Government policies and incentives can also play a crucial role in promoting the adoption of brown manuring in rice farming. Subsidies, grants, and tax incentives for adopting sustainable agricultural practices can incentivize farmers to integrate brown manuring into their production systems. Moreover, policies supporting research and development, infrastructure development, and market access for organic and sustainably produced rice can create an enabling environment for brown manuring adoption. By aligning agricultural policies with sustainability goals, policymakers can foster innovation, investment, and collaboration towards building resilient and environmentally friendly rice production systems.

Monitoring and Evaluation: Continuous monitoring and evaluation are essential to assess the effectiveness of brown manuring practices and identify areas for improvement. Farmers can track soil health indicators, crop performance, and pest and disease incidence to evaluate the impact of brown manuring on their farms. Participatory approaches, such as farmer field schools and demonstration plots, facilitate knowledge sharing and experiential learning among farmers, leading to continuous adaptation and refinement of brown manuring techniques. Moreover, collaboration between researchers, extension agents, and farmers can facilitate data collection, analysis, and dissemination, informing evidence-based decision-making and enhancing the scalability and sustainability of brown manuring interventions.

Challenges and Future Directions

While brown manuring offers numerous benefits for rice farming, several challenges must be addressed to promote its widespread adoption. Limited access to appropriate machinery, labor shortages, and conflicting land use practices can hinder the implementation of brown manuring in some regions. Additionally, the availability of high-quality crop residues and the potential risk of nutrient imbalances pose challenges for farmers seeking to integrate brown manuring into their production systems.

Investments in agricultural research and innovation are crucial for overcoming these challenges and advancing sustainable rice production systems. Developing improved crop varieties with higher nutrient-use efficiency and resilience to environmental stressors can enhance the effectiveness of brown manuring in diverse agroecological settings. Furthermore, investment in infrastructure development, including mechanization and post-harvest processing facilities, can facilitate the adoption of brown manuring practices and improve farm productivity and profitability.

Conclusion

Brown manuring represents a promising approach to sustainable rice farming, offering multiple benefits for soil health, crop productivity, and environmental sustainability. By harnessing the power of organic matter derived from crop residues, farmers can improve soil fertility, suppress weeds, conserve soil resources, and mitigate climate change impacts. However, achieving widespread adoption of brown manuring requires concerted efforts from policymakers, researchers, extension services, and farmers to overcome challenges and promote knowledge dissemination and capacity-building initiatives. Through collaborative action and innovation, brown manuring can contribute to a more resilient and sustainable agricultural future, ensuring food security for generations to come.

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Carbon Trading for Soil Health Management

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Climate Change

Long term changes in global and regional climate characteristics, including temperature, humidity, rainfall, wind and severe weather events.

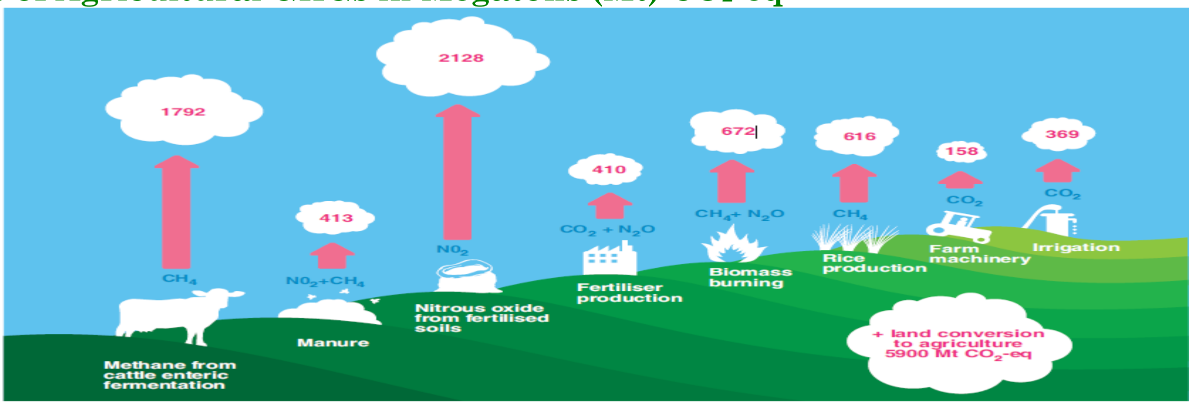
Green House Effect

Incoming solar short-wave radiation is reflected by the atmosphere and earth surface. The outgoing long wave radiation is absorbed by GHGs (CO_2, CH_4, N_2O, CFC, HFC, etc.) and reradiated back to earth surface which warm up the earth resulting in increase in temperature of earth called Greenhouse effect.

Change in Atmospheric Concentration of GHGs

GHGs	Present Concentration	Per cent increase since 1750	Per cent rate of increase per year
CO_2	379 ppm	31	0.4
CH_4	1745 ppb	151	0.4
N_2O	314 ppb	17	0.25
CFCs	268 ppt	A	

Sources of Agricultural GHGs in Megatons (Mt) CO_2-eq



Source: Greenpeace International, 2008.

Loss of Soil Carbon

Cultivation Practices.

Increased aeration., Increased soil temperature., Crop Residue Removal., Residue removal., Over grazing., Drought.

Shifting Land Use: Grass or trees to crops or development.

Soil Erosion:

a. Carbon Transport.
b. Lower Productivity

Kyoto Protocol: Birth of Carbon Credits

The issue of climate change and global warming became the topic of International concern in 1997, during "Climate Change Convention" in Kyoto, the primary topic of discussion was the reduction of greenhouse gases (GHGs) "Kyoto Protocol" is internationally binding and enforceable agreements that will encourage

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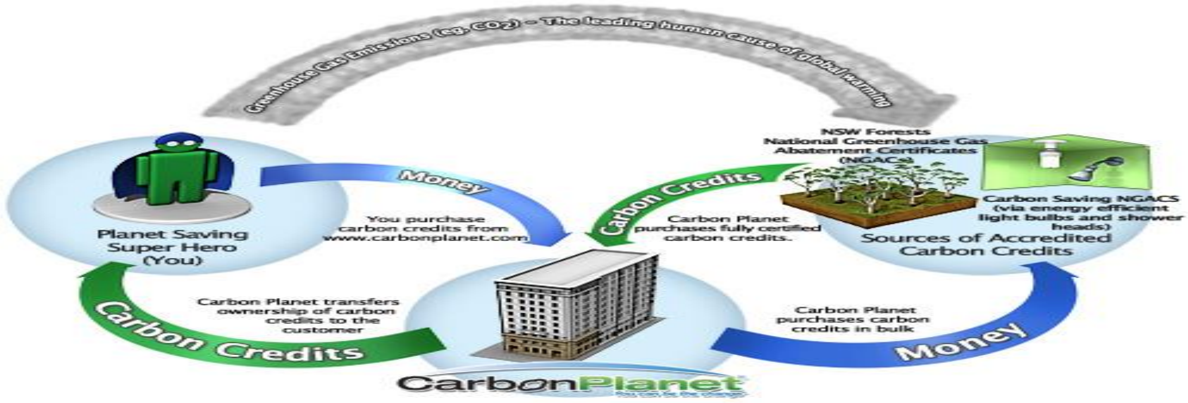
countries to reduce greenhouse gas emissions. Target: Reduce GHGs emission by 5.2% below 1990 levels by 2012Introduced groundbreaking concepts on Carbon crédits and emissions trading.

Concept of "Carbon Credits" and "Carbon Trading"

Carbon credit is currency for trading carbon. Carbon credits are certificates issued to countries/organisation that reduce their emission of GHGs below baseline. Carbon credits or Certified Emissions Reductions (CER) are the "certificate" just like a stock. A CER is given by the CDM Executive Board to projects in developing countries to certify they have reduced greenhouse gas emissions by one ton of carbon dioxide per year.

Mechanisms of Emission Reductons to Earn Carbon credits:
1. Clean Development Mechanism (CDM)
2. Joint Implementation (JI)
3. Emissions Trade (ET)

Carbon Credits and Carbon Trading



Measuring Soil Organic Carbon and CER

- There are two kinds of test for SOC determination *viz.* acid digestion and the other based on combustion principle.
- The latter measures all the carbon presents in a sample of soil whereas, the former measures only part of the organic carbon.
- It is more practical to express SOC on per ha basis, namely as tonnes C ha^{-1}.

Tonnes carbon ha^{-1} = SOC (%) x Soil bulk density (Mg m^{-3}) x Sampling depth (cm)
= 1.0 x 1.3 x 30
= 39 tonnes C ha^{-1}
Tonnes CO_2 per ha^{-1} = 39 x 3.67
= 143.13 tonnes CO_2 per ha $^{-1}$
≃ 143 CER

Region	Potential Tg C yr^{-1}
1. World:	600 – 1200
2. USA:	144 – 432
3. India:	40 – 50
4. Iceland	1.2 – 1.6
5. Brazil	40 – 60
6. W. Europe:	70 – 190
China:	126 – 364

Soil Carbon Sequestration Related Agricultural Practices

Cropland:

a. Reduced tillage
b. Crop Rotations
c. Cover crops
d. Residue Management

e. Fertility management
f. Erosion control
g. Irrigation management
g. Fallow Management

Rice:

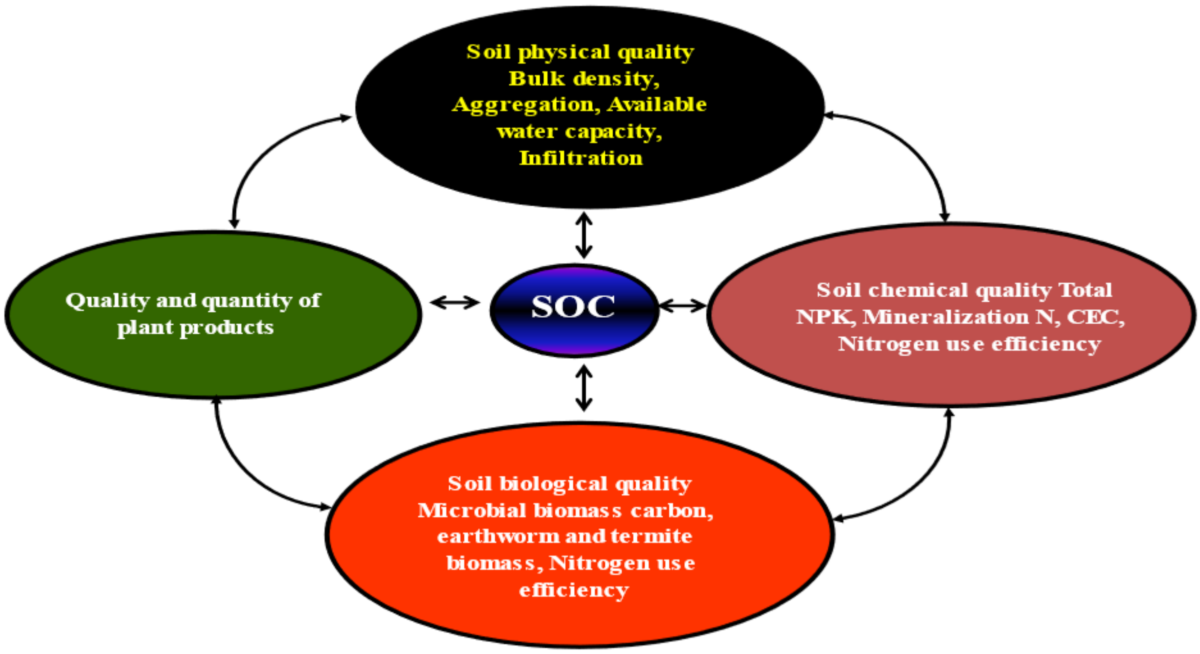
a. Irrigation
b. Chemical and organic fertilizer
c. Plant residue management.

Agroforestry:

a. Improved management of trees and cropland
b. Restoration of degraded land
c. Conversion of agricultural land into permanent grass land.

Improved system (IM)	Traditional system (TM)
1. Ploughing once in two years in summer. 2. An integrated watershed management system with a broad-bed and furrow (BBF) landform 3. Improved high yielding varieties (Pigeonpea ICPL-6, sorghum CSH 9) chickpea (Annigeri) 4. Dry sowing for the period 8-15 June each year. 5. Sorghum intercropped with pigeon pea (2:1 proportion) followed by chickpea	1. Kharif fallow– rabi sorghum/ chickpea cropping system 2. No fertilizers, but 10 t ha-1 of farmyard manure (FYM) was broadcast each alternate year

INTERACTIVE EFFECT OF SOC AND OTHER SOIL QUALITY INDICATORS



Options for Sustainable Management of Soils

1. Retention of crop residue.
2. No-till farming.
3. Inclusion of leguminous crops in the rotation.
4. INM
5. Precision farming/SSNM. Water conservation and water harvesting.
6. Restoration of marginal / degraded / desertified soils.
7. Grow improved/GM plants along with agroforestry measures.
8. Integrate principles of watershed management.

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1. Carbon trading has created a market for reducing GHG emissions by giving a monetary value to the cost of polluting the air.
2. India has emerged as a leader in carbon trading.
3. Carbon trading through soil management has a bright future in addition to improvement soil quality parameters, which in turn supports better crop productivity, sustainability and C-sequestration.

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The Success Story: Vermicomposting Unit

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Name of farmer	Pareshbhai Manubhai Donga
Age	49
Mobile	7984120405/ 9974537518
Address	Nesadi, savarkundla
Land holdings (Rainfed & Irrigated)	4 Acre (irrigated) 2 Acre (unirrigated)
Livestock	3 Buffalo

Success story-1	
Technology demonstrated:	Vermicompost Unit
Problem identified:	chemical fertilizer deteriorates the soil and also increase the cost of cultivation in lemon and Cotton
Description of technology:	Farmer benefited Vermibed and vermiworm from the NICRA project and utilize their Vemicompost fertilizer in lemon and cotton
Impact of intervention:	Farmer Utilize the vermicompost in their lemon and cotton field and farmer dosn't require to add chemical fertilizer in the field and also reduce the cost of cultivation and yield is also increase.
How the interventions minimized the impact of climate variability	Vermicomposting Provides plants with essential nutrients and aids in the suppression of plant diseases along with increases the soil water holding capacity to minimize the water stress in dry spell condition.
Yield and Economics:	Farmers have land holding of 6 Acre (2.4 ha) out of that 3.6 Acre (1.44 ha lemon Orchard and in the 2.4 Acre (0.96ha) cotton crops. lemon yield and economics/ha

	yield Q/ha	% increase	cost of cultivation	Cost of fertilizer	Gross return	Net profit	B:C ratio
Before Intervension	115		41560.0	18375/-	108900.0	67340.0	2.62
After intervention	122	6.08	31250.0	6000/-	121520.0	90270.0	3.89

Cotton yield and economics/ha

	yield Q/ha	% increase	cost of cultivation	Cost of fertilizer	Gross return	Net profit
Before Intervension	24.2		72916.0	30000/-	339940	2670
After intervention	24.8	2.47	48920.0	6000/-	379908	3309

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Green Manuring

Article ID: 48851

N Dr. D. M. Patel[1]
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Introduction

Practice of incorporating undecomposed green plant tissues into the soil for the purpose of improving physical structure as well as fertility of the soil.

In agriculture, a green manure is a type of cover crop grown primarily to add nutrients and organic matter to the soil. Typically, a green manure crop is grown for a specific period, and then plowed under and incorporated into the soil. Green manures usually perform multiple functions that include soil improvement and soil protection:

1. Leguminous green manures such as clover and vetch contain nitrogen-fixing symbiotic bacteria in root nodules that fix atmospheric nitrogen in a form that plants can use.

2. Green manures increase the percentage of organic matter (biomass) in the soil, thereby improving water retention, aeration, and other soil characteristics.

3. The root systems of some varieties of green manure grow deep in the soil and bring up nutrient resources unavailable to shallower-rooted crops.

4. Common cover crop functions of weed suppression and prevention of soil erosion and compaction are often also taken into account when selecting and using green manures

5. Some green manure crops, when allowed to flower, provide forage for pollinating insects.

Historically, the practice of green manuring can be traced back to the fallow cycle of crop, which was used to allow soils to recover.

Types of Green Manuring

Broadly two types of green manuring can be differentiated.
1. Green manuring in situ
2. Green leaf manuring

Green manuring in situ: In this system green manure crops are grown and buried in the same field, either as a pure crop or as intercrop with the main crop. The most common green manure crops grown under this system are Sannhemp, dhaincha and guar.

Green leaf manuring: Green leaf manuring refers to turning into the soil green leaves and tender green twigs collected from shrubs and trees grown on bunds, waste lands and nearby forest areas. The common shrubs and trees used are Glyricidia, Sesbania (wild dhaincha), Karanj, etc.

The former system is followed in northern India, while the latter is common in eastern and central India.

Advantages of Green Manuring:

a. It adds organic matter to the soil. This stimulates the activity of soil micro-organisms.
b. The green manure crops return to the upper topsoil, plant nutrients taken up by the crop from deeper layers.
c. It improves the structure of the soil.
d. It facilitates the penetration of rainwater thus decreasing run off and erosion.
e. The green manure crops hold plant nutrients that would otherwise be lost by leaching.
f. When leguminous plants, like sunhemp and dhaincha are used as green manure crops, they add nitrogen to the soil for the succeeding crop.
g. It increases the availability of certain plant nutrients like phosphorus, calcium, potassium, magnesium and iron.

Disadvantages of Green Manuring

When the proper technique of green manuring is not followed or when weather conditions become unfavourable; the following disadvantages are likely to become evident.

1. Under rainfed conditions, it is feared that proper decomposition of the green manure crop and satisfactory germination of the succeeding crop may not take place, if sufficient rainfall is not received after burying the green manure crop. This particularly applies to the wheat regions of India.

2. Since green manuring for wheat means loss of kharif crop, the practice of green manuring may not be always economical. This applies to regions where irrigation facilities are available for raising kharif crop along with easy availability of fertilizers.

3. In case the main advantage of green manuring is to be derived from addition of nitrogen, the cost of growing green manure crops may be more than the cost of commercial nitrogenous fertilizers.

4. An increase of diseases, insects and nematodes is possible.

5. A risk is involved in obtaining a satisfactory stand and growth of the green manure crops, if sufficient rainfall is not available.

Green leaf manure crops:		
Sr. No.	Leguminous	Non-leguminous
1.	Sannhemp	Bhang
2.	Dhaincha	Jowar
3.	Mung	Maize
4.	Cowpea	Sunflower
5.	Guar	
6.	Berseem	

Selection of Green Manure Crops in Situ

Certain green manure crops are suitable for certain parts of the country. Suitability and regional distribution of important green manure crops are given below:

Sannhemp: This is the most outstanding green manure crop. It is well suited to almost all parts of the country, provided that the area receives sufficient rainfall or has an assured irrigation. It is extensively used with sugarcane, potatoes, garden crops, second crop of paddy in South India and irrigated wheat in Northern India.

Dhaincha: It occupies the second place next to sannhemp for green manuring. It has the advantage of growing under adverse conditions of drought, waterlogging, salinity and acidity. It is in wide use in Assam, West Bengal, Bihar and Chennai with sugarcane, Potatoes and paddy.

Guar: It is well suited in areas of low rainfall and poor fertility. It is the most common green manure crop in Rajasthan, North Gujarat and Punjab.

Technique of Green Manuring in Situ

The maximum benefit from green manuring cannot be obtained without knowing:
1. When the green manure crops should be grown,
2. When they should be buried in the soil
3. How much times should be given between the burying of a green manure crop and the sowing of the next crop.

Time of sowing: The normal practice usually adopted is to begin sowing immediately after the first monsoon rains. Green manure crops usually can be sown/broadcast preferably giving somewhat higher seed rate.

Stage of burying green manure crop: From the results of various experiments conducted on different green manure crops, it can be generalized that a green manure crop may be turned in soil at the stage of flowering. The majority of the green manure crops take about six to eight weeks from the time of sowing to attain the flowering stage. The basic principle which governs the proper stage of turning in the green manure crops, should aim at maximum succulent green matter at burying.

Time interval between burying of green manure crop and sowing of next crop. Following two factors which affect the time interval between burring of green manure crop and sowing of next crop.

a. Weather conditions.
b. Nature of the buried green material.

In paddy tracts the weather is humid due to the high rainfall and high temperature. These favour rapid decomposition. If the green material to be buried is succulent there is no harm in transplanting paddy immediately after turning in the green manure crop. When the green manure crop is woody, sufficient time should be allowed for its proper decomposition before planting the paddy.

Regions not Suitable for Green Manuring

The use of green manures in dry farming areas in arid and semiarid regions receiving less than 25 inches of annual rainfall is, as a rule, impracticable. In such areas, only one crop is raised, as soil moisture is limited. Such dry farming areas are located in Punjab, Maharashtra, Rajasthan, M.P. and Gujarat (Kutch and Saurashtra). On very fertile soils in good physical condition, it is not advisable to use green manures as a part of the regular rotation. In areas where rabi crops are raised on conserved soil moisture, due to lack of irrigation facilities, it is not practicable to adopt green manuring. If green manuring is followed in these areas, there is danger of incomplete decomposition of the green matter and as such less moisture for the succeeding crop.

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From Shuttle to Speed: Transforming Crop Breeding for a Faster Future

Article ID: 48852

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Abstract

Crop breeding stands at the forefront of addressing global challenges in agriculture, from feeding a growing population to adapting to climate change. Traditionally, shuttle breeding has been employed to select desirable traits across diverse environments, but its time-consuming nature has prompted a shift towards speed breeding. This innovative approach leverages controlled environments to accelerate the breeding cycle dramatically, compressing generations of crops into a fraction of the time required by traditional methods. In this article, titled "From Shuttle to Speed: Transforming Crop Breeding for a Faster Future," we explore the evolution of crop breeding methodologies and their impact on global food security and sustainability. Through a combination of tradition and technology, speed breeding offers a promising pathway towards developing resilient crop varieties capable of meeting the challenges of the 21st century agricultural landscape.

Keywords: Shuttle Breeding, Speed Breeding, Transformation, Agriculture, Traditional, Technology.

Introduction

We are constantly challenged by the ever-growing demands on global agriculture, from feeding a burgeoning population to mitigating the impacts of climate change. Central to our efforts is the art and science of crop breeding, where we strive to develop resilient, high-yielding varieties capable of meeting these pressing needs. In our quest to enhance crop genetics, we have long relied on traditional methods such as shuttle breeding, where the movement of breeding materials between diverse environments drives the selection for desirable traits. While effective, this approach is time-consuming and resource-intensive, often unable to keep pace with the rapid changes facing modern agriculture.

Enter speed breeding – a revolutionary advancement poised to transform the landscape of crop improvement. Speed breeding represents a paradigm shift, leveraging innovative techniques and controlled environments to accelerate the breeding cycle dramatically. By harnessing artificial lighting, temperature control, and other environmental manipulations, we can compress multiple generations of crops into a fraction of the time required in traditional field-based breeding programs.

In this article, titled "From Shuttle to Speed: Transforming Crop Breeding for a Faster Future," we embark on a journey through the evolution of crop breeding methodologies. We explore how the transition from shuttle breeding to speed breeding reflects our commitment to efficiency, innovation, and adaptability in the face of complex agricultural challenges.

Traditional Breeding Methods

Overview of Traditional Methods: Traditional crop breeding methods, such as selective breeding and hybridization, have been the foundation of agricultural progress for centuries. Selective breeding involves choosing plants with desired traits, such as high yield or disease resistance, and crossing them to produce offspring with those traits. Hybridization, on the other hand, involves crossing two different but related plant varieties to combine their best traits in the offspring.

Time and Resources: Traditional breeding programs are known for their lengthy timelines and resource-intensive nature. Developing a new crop variety through selective breeding can take many years, often spanning multiple generations of plants. This is because each generation must be grown, evaluated, and selected for the desired traits before moving on to the next generation. Additionally, hybridization programs require meticulous crossbreeding and selection processes, further extending the time and resources needed.

Challenges:

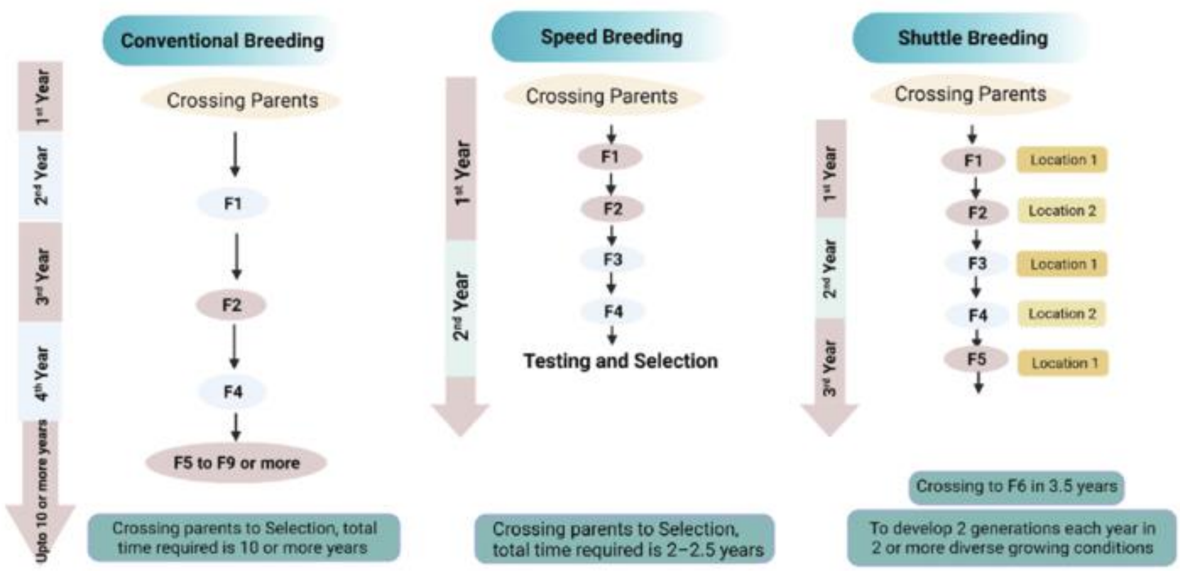
a. Limited Genetic Diversity: Traditional breeding methods can lead to a narrowing of genetic diversity within crop populations. This reduction in genetic variation can make crops more susceptible to pests, diseases, and environmental stresses. Susceptibility to Environmental Stresses: As climate change accelerates and unpredictable weather patterns become more common, crops bred using traditional methods may struggle to adapt. These crops are often not equipped to withstand new pests, diseases, or extreme weather conditions.

b. Long Breeding Cycles: Due to the time required for each breeding cycle, traditional methods may not be able to keep pace with the rapidly changing needs of agriculture. This lag in development could hinder efforts to address emerging challenges such as food security and climate resilience.

c. Resource Intensive: Traditional breeding programs require significant resources including land, labor, and financial investment. This can pose challenges for smaller-scale breeders or those with limited access to resources.

Join us as we delve into the science behind shuttle and speed breeding, examining their strengths, limitations, and potential impacts on global food security and sustainability. Together, let envision a future where the fusion of tradition and technology propels us towards a faster, more resilient agricultural ecosystem.

Leveraging Technology for Accelerated Breeding with Speed Breeding



Speed breeding represents a transformative leap in crop breeding, enabled by advancements in technology. This innovative approach condenses the traditional breeding cycle from years to mere months, revolutionizing the pace of crop improvement. Utilizing controlled environments with optimized lighting, temperature, and nutrient conditions, speed breeding allows for rapid growth and reproduction of plants. This not only expedites the selection of desired traits but also ensures year-round production, breaking free from the constraints of seasonal changes. Success stories abound, from wheat varieties with enhanced disease resistance to fast-maturing vegetable crops. Speed breeding's precision and efficiency hold promise for developing climate-resilient crops, crucial for adapting to the challenges of a changing environment.

As we glimpse into the future of agriculture, speed breeding stands as a beacon of hope. Its ability to swiftly develop tailored crop varieties addresses the pressing needs of feeding a growing population and mitigating climate change impacts. With its rapid cycle times and controlled environments, speed breeding is poised to play a pivotal role in ensuring food security and sustainability. This technology-driven approach is not just a glimpse into the future but a tangible path forward towards a resilient and thriving agricultural ecosystem.

Data-Driven Breeding Strategies in the Era of Speed Breeding

In the context of speed breeding, data-driven breeding strategies are becoming increasingly essential for optimizing crop improvement efforts. This approach harnesses the power of advanced technologies such as genomics, bioinformatics, and high-throughput phenotyping to guide breeding decisions. Genomic data provides valuable insights into the genetic makeup of crops, aiding in the identification of desirable traits. Bioinformatics tools efficiently manage and analyze vast datasets, allowing breeders to pinpoint genetic markers associated with target traits. High-throughput phenotyping, enabled by sensors and robotics, accelerates the process of trait evaluation on a large scale. Speed breeding thrives on this data-driven approach, as breeders can quickly screen and select plants based on their genetic profiles and performance in controlled environments. The integration of data analytics and breeding techniques allows for more precise and efficient selection of traits, ultimately expediting the development of new crop varieties. As we embrace the era of speed breeding, data-driven strategies will continue to play a crucial role in optimizing breeding programs, ensuring the rapid and targeted improvement of crops to meet the evolving challenges of agriculture.

Overcoming Challenges and Ethical Considerations in Speed Breeding

While speed breeding offers immense potential for accelerating crop improvement, it also presents challenges and ethical considerations that must be addressed. One challenge is ensuring the reliability and accuracy of data-driven breeding strategies. The vast amount of genetic and phenotypic data generated requires robust bioinformatics tools and skilled personnel for effective analysis and interpretation. Additionally, the cost associated with implementing and maintaining speed breeding facilities may limit access for smaller-scale breeders and resource-constrained regions. Ethical considerations also come into play, particularly concerning the safety and environmental impact of genetically modified (GM) crops developed through speed breeding. Transparency in communicating the methods and outcomes of GM crop development is crucial to fostering public trust. Additionally, there are concerns about unintended consequences, such as gene flow to wild populations or unforeseen ecological disruptions. Ethical frameworks and regulations must be in place to ensure responsible and sustainable use of speed breeding technologies.

Conclusion

Speed breeding emerges as a transformative solution to the challenges facing modern agriculture. With its ability to condense breeding cycles and leverage advanced technologies, it offers hope for developing resilient crop varieties in a rapidly changing world. This shift from traditional methods to speed breeding signifies a paradigm change in crop improvement, emphasizing efficiency and innovation. While speed breeding presents challenges and ethical considerations, such as data accuracy and the responsible use of genetically modified crops, collaborative efforts are key to addressing these concerns. By embracing speed breeding and its data-driven approaches, we pave the way for a faster, more resilient agricultural ecosystem.

"In a world where the demands on agriculture continue to grow, speed breeding stands as a beacon of hope. Its potential to rapidly develop tailored crop varieties, optimized for diverse environments, is crucial for ensuring food security and sustainability. This fusion of tradition and technology propels us towards a future where agriculture can meet the ever-growing demands of our world while preserving the planet for generations to come."

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Easiest Way to Appraise Micronutrients Such as Boron and Zinc Using Mulder's Chart

Article ID: 48853

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Introduction

Proper crop nutrition management is extremely important for maximum yield of the crops. It is necessary to understand what the plant needs under different conditions. After all, without proper management of essential nutrients, there wouldn't be any yields. Plant nutrients are broadly classified as macronutrients and micronutrients based on the requirement of the plant. [Table1].

In this regards micronutrient are often neglected and in many cases the crop yield can be hampered without timely intervention. Even though demands for micronutrients are small in quantity, these nutrients directly affect crop growth and development even when all other nutrients are present in adequate amounts. One micronutrient that has profound role in plant is boron which has integral role in cell wall synthesis and in maintaining structure integrity.

Plants take up boron in the form of small uncharged boric acid (H_3BO_3) or B $(OH)_3$. About 50% of the world's potentially arable soil is acidic. In such soils, deficiencies of anionic plant nutrients Boron (B) through fixation and leaching are foremost factors limiting crop production. Boron deficiency also leads to considerable yield reduction in many annual, cereal, legume/pulse, oilseeds and perennial crops. Zinc is another essential micronutrient that is necessary for plant growth and development. It occurs in plants as a free ion, as a complex with a variety of low molecular weight compounds, or as a component of proteins and other macromolecules.

In many enzymes, zinc acts as a functional, structural, or regulatory cofactor. Zinc may be involved in the control of gene expression; it appears important in stabilizing RNA and DNA structure, in maintaining the activity of DNA-synthesizing enzymes and in controlling the activity of RNA-degrading enzymes. In general, Zn-deficient plants are more susceptible to diseases. Globally Zinc and Boron are classified as one of the most major nutrient deficiencies in the soil. It is necessary to supplement them externally. Furthermore, the presence of one element can impede the availability of other elements or have synergistic effect.

It is therefore essential to know the antagonism-synergism effect of various elements while formulating fertilizers or micronutrients. Figure 1 shows Mulder's chart which can provide useful information regarding this. Based on Mulder's chart, it is unlikely that B and Zinc would have antagonism-synergism interaction when they are applied together. Therefore, B and Zinc can be applied as soil application or as a foliar spray. Similarly, based on Mulder's chart two micronutrients can be formulated as per our choice.

Table 1: Lists of essential macro and micronutrients:

Essential plant nutrients		
Primary Macronutrients	Secondary Macronutrient	Micronutrients
Nitrogen (N)	Calcium (Ca)	Boron (B)
Phosphorus (P)	Magnesium (Mg)	Zinc (Zn)
Potassium (K)	Sulphur (S)	Iron (Fe)
		Manganese (Mn)
		Copper (Cu)
		Molybdenum (Mo)
		Chlorine (Cl)

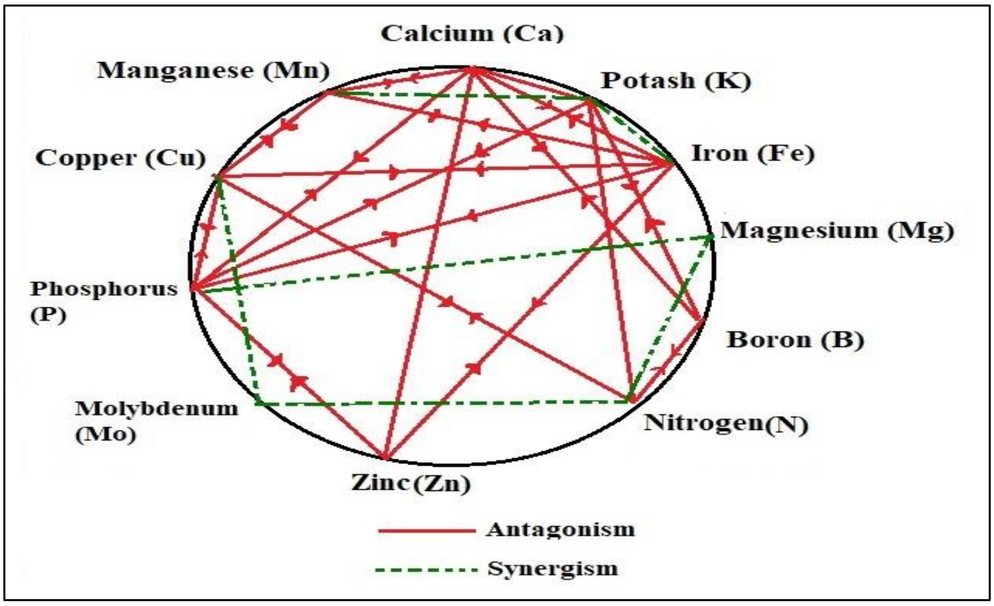

Figure 1: Mulder's chart of antagonistic (solid lines (and synergistic (dashed lines) elements

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Farmer Producer Organizations (FPOs): A Boon to Indian Agriculture

Article ID: 48854

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Introduction

India has made impressive strides during the last six decades in the agriculture sector. Indian agrarian economy provides livelihood and a continuous source of income for 58 percent of rural households. Agriculture, along with animal husbandry and fishery sector occupy 18.3 percent share of India's Gross Domestic Product (GDP), showcasing the significant role of agriculture in the growth and development of the Indian economy. India has attained self-sufficiency in food grain production with a continuous rise in food production from 1950-51 (50.82 mT) to 2022-23 (330.5 mT). Though the agriculture sector has been attributed to achieving a miraculous growth rate, the condition of farmers' income has not seen any striking change. Small and marginal farmers are predominant in India implying smaller marketable surplus, limited access to agricultural inputs by farmers, limited production level, lack of credit facilities as well as extension activities, low adoption rate of improved technologies. These along with frequent crop failure, poor access to public resources, and impoverished supply chains increase the dependency of farmers on exploitative intermediaries and local money lenders. Since independence, the Government has been working to raise agricultural productivity and improve food security, which has shown positive results.

Despite all these measures it was found that in many cases the income received by the farmers didn't follow a similar trend and the gap between incomes of agriculture and non-agricultural laborers widened. So, to reduce this gap and increase farmers' welfare, the central government has set a goal of doubling farmers' income by 2022. Hence the above condition necessitates the emergence of several structural transformations for reforming the agriculture sector by stepping up investments for productivity enhancements as well as the revitalization of the marketing segment which can be done by collectivizing the agricultural produce through value addition by achieving the economy of scale and creating product-specific agri value chains with participations of primary producers on equitable terms.

Collectivization of producers, especially small and marginal farmers, into producer organizations can be a welcome step for addressing the above-mentioned shortcomings and, most importantly improved access to investments, technology, inputs and markets. Farmer producers' organization is a legal entity that harnesses the benefits of economies of scale where profits are shared among members –farmers.

Farmer Producer Organization (FPO)

This is an organization of the producers, by the producers and for the producers. These organizations are a collective entity of farmers built with the main aim of ensuring better income. FPOs considerably reduce the role of intermediaries and create opportunities for the farmers to participate more effectively in the markets which directly affect their income, thereby reducing poverty. The Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare identified FPOs registered under special provisions of the Companies Act, 1956 as the appropriate institutional form to mobilize farmers and their capacity building to collectively leverage their production and marketing strength. Understanding the importance of FPOs, the Government of India has even declared 2014 as the year of FPOs.

Features of an FPO

1. Registered body and a legal entity
2. Members will be primary producers for either farm or non-farm activities
3. Producers are shareholders in the organization
4. Works for the benefit of the members
5. Deals with business activities related to primary produce/product
6. A part of the profit is shared among the members

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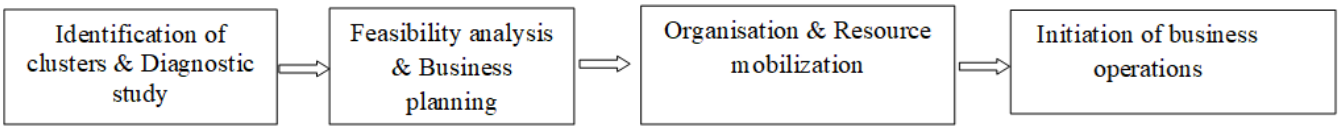
7. The rest of the surplus is added to PO's funds for business expansion.

The Developmental Processes of FPOs

1. Identification of clusters & diagnostic study: A cluster area of 8,000-10,000 farmers, residing within one or two blocks should be selected by the resource institutions as per the guidance of State Government departments. After identifying the cluster areas, diagnostic study is conducted in order to assess the preliminary situation of farmers and agriculture as well as the potential interventions which are required in those areas.



2. Feasibility analysis & Business planning: Feasibility analysis regarding socio-economic, political, financial and technical aspects will promote the FPOs in the prevailing environment. Following the feasibility study of the proposed FPO, a business plan is prepared for shaping the operational orientation of the FPO. The thumb rule is to develop a business plan by considering at least 10% of the FPO farmer-members. After preparation of a proper business plan, the farmers get mobilised into Farmers' Interest Groups (FIGs) and then as members in FPOs.

3. Organisation and resource mobilization: 50-70 FIGs form an aggregate cluster together to form FPOs. FPOs can be registered under the Producer Company provision under the Companies Act. Around 18-24 months after formation, the FIGs gradually understand the conditions of aggregation and then they attempt to register as a FPO. After formation of the FPO, the first and foremost step is the mobilization of required resources *viz.* technical, financial and human resources to the newly formed FPO.

4. Initiation of business operations: Resource mobilization to the FPOs leads to the commencement of several business operations such as production, procurement, processing, marketing as well as financial activities of the FPO. Training facilities are provided to the FPO personnel for smooth management of the entire value chain associated with various agricultural commodities. Following the ongoing business operations, performance evaluation and accounting audits are facilitated to ensure transparency in the institutional network of FPO.

Benefits of Farmers' Producer Organization

An FPO is a collective of farmers who are the primary producers of a product that can work as a platform to facilitate better access to government services, like PDS, MNREGA, Scholarships and Pensions etc. It can liaise with Government Departments for convergence of programs, like drinking water, sanitation, health and hygiene. Some of the important benefits of organizing farmers into Collectives, as demonstrated through various pilots, are as under:

1. Farmers can reduce their cost of production through FPO by procuring all necessary inputs in bulk at wholesale rates.
2. FPOs can aggregate the produce and transport that bulk produce to the market which will reduce marketing costs. Thus, enhancing the net income of the farmers.
3. Pooling of the produce gives economies of scale which attracts traders to collect produce at the farm gate.
4. The FPO helps in accessing modern technologies, facilitation of capacity building, extension and training on production technologies and ensuring traceability of agriculture produce.
5. Every year 30 to 40 percent of losses occur due to transport and storage, which can be minimized through value addition and efficient management of the value chain.
6. Regular supply of produce and quality control is possible through proper planning and management, which also improves the bargaining power of the producer.
7. The most important risk that affects farmers is the price risk. Through this collective entity price fluctuation can be managed.
8. Easy communication for dissemination of information about price, volume and other farming-related advisories.
9. Access to financial resources against the stock, without collaterals.
10. Easy access to funds and other support services by the government/donors/service providers.

Challenges and Issues in Building Robust FPOs

The positive role of FPOs in terms of increased net income of farmers through informed decision-making, improved access to inputs and agro-services, institutional credit, marketing facilities and enhanced efficiency in farming operations. However, there are challenges and policy gaps in the ecosystem. The important challenges and confronting issues in building sustainable FPOs, are as under:

Inadequate Professional Management: Farmers' Organizations are required to be efficiently managed by experienced, trained and professionally qualified CEO and other personnel under the supervision and control of democratically elected Boards of Directors. However, such trained manpower is presently not available in the rural space to manage FPO business professionally.

Poor technology adoption: FPO members are mostly involved in adoption of low-cost technologies. From the study done in Bihar by TCI (2020) found that 52 percent of the farmers have adopted crop production technologies while 15 percent, 4 percent and 1.6 percent of farmers have adopted pest management, water management and post-harvest technologies respectively. However, a very low rate of adoption was felt in the case of polyhouse technologies.

Weak Financials: FPOs are mostly represented by Small Farmers and Medium Farmers with a poor resource base and hence, initially they are not financially strong enough to deliver vibrant products and services to their members and build confidence.

Inadequate Access to credit: Lack of access to affordable credit for want of collaterals and credit history is one of the major constraints the FPOs are facing today. Further, the credit guarantee cover being offered by SFAC for collateral free lending is available only to Producer Companies (other forms of FPOs are not covered) having minimum 500 shareholder membership. Due to this, a large number of FPOs, particularly those which are registered under other legal statutes as also small size FPOs are not able to access the benefits of credit guarantee scheme.

Lack of Risk Mitigation Mechanism: Presently, while the risks related to production at farmers' level are partly covered under the existing crop / livestock / other insurance schemes, there is no provision to cover business risks of FPOs.

Inadequate Access to Market: Marketing of produce at remunerative prices is the most critical requirement for the success of FPOs. The input prices are largely fixed by corporate producers. The cultivators lose through the complex gamut of market processes in the input and output prices. There are more market opportunities if FPOs can identify local market needs of the consumers and have tie-up for sale of its produce. The linkage with Industry/ other market players, large retailers, etc. is necessary for long term sustainability of FPOs.

Inadequate Access to Infrastructure: The producers' collectives have inadequate access to basic infrastructure required for aggregation like transport facilities, storage, value addition (cleaning, grading, sorting, etc.) and processing, brand building and marketing. Further, in most of the commercial farming models, the primary producers are generally excluded from the value chain.

Lack of technical Skills/ Awareness: In most of the situation it was found that due to lower level of literacy, farmers are mostly unaware about the potential benefits of collectivization & non availability of competent agency for providing handholding support. Further, lack of legal and technical knowledge about various Acts and Regulations related to the formation of FPOs and statutory compliances thereafter.

Conclusion

FPOs tend to work on the principle of "*United we stand, divided we fall"*. Though many researchers have interpreted mixed results on the impact of FPOs, FPOs contribute significantly to improved bargaining power, efficient marketing, increased institutional and infrastructural support as well as improved scale economies. Collectivization and mobilization of farmers result in increased access to inputs, markets, finance, information, technology and extension services. Therefore, the formation and promotion of FPOs acts as an important tool to improve the overall efficiency of agri-value chains.

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Microbial Biofilms for Enhanced Crop Productivity and Soil Health

Article ID: 48855

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Summary
Microbial biofilms are communities of microorganisms attached to a living or inert surface in an aqueous environment and surrounded in a matrix of extracellular polymeric substances. Microbial biofilms help the plants to cope with stressful conditions and ultimately improve crop productivity and soil properties. Fungal bacterial biofilms can also be used as a potential solution to remediate soil polluted with heavy metal contaminants. Conjoint use of biofilm biofertilizers with chemical fertilizers play a significant role in replenishment of the depleted microbial communities affected by the chemical agriculture ultimately improving soil health. Thus, microbial biofilms serve multidimensional role as biofertilizers, growth promoters, stress busters, biocontrolling agents, bioremediators, and nutrient mobilizers to improve soil health and enhance agricultural productivity.

Introduction
By 2050, the global population is estimated to touch an astonishing figure of 10 billion, requiring an annual increase in agricultural production of 60 % to meet food and nutritional needs. However, human-induced climate change is adversely affecting crop health and productivity, resulting in a significant reduction in crop yield (Li et al. 2024). Climate change further exacerbates biotic (pathogens, weeds etc.) and abiotic stresses (drought, waterlogging, extreme temperatures, salinity, etc.) ultimately affecting plant and soil health. These occurrences if continue to occur can create a vicious cycle, contradicting the concept of sustainable development and causing significant economic losses. Collectively, all these factors pose a serious concern to nutritional and food security challenging the soil health and environmental sustainability. However, fertilizer use is the most commonly adopted method to arrest yield reduction caused by extreme environments, successfully increasing food production by about 50 % (Seneviratne et al. 2011). But, over-application of chemical fertilizers, have contributed to soil contamination and a decline in microbial diversity, further threatening soil health and environmental sustainability. In response to these challenges, a biorevolution focusing on harnessing biological inputs to enhance soil health and crop productivity is required. Microbial biofilms, naturally occurring in the soil, hold a promising solution.

Why Microorganisms Form Biofilms?
Bacterial biofilms mainly consist of water and the bacterial cells, followed by the matrix made of exopolysaccharide. As compared to freely swimming planktonic stage cells, microbial cells residing in biofilms get many advantages, and that's the reason for them to prefer the biofilm mode of. Some of these potential advantages are:

1. Microorganisms existing in biofilms are protected from environmental stresses such as extreme pH, oxygen, osmotic shock, heat, freezing, UV radiation, predators, and antibiotics.

2. Bacterial exopolysaccharides (EPS) secrete extracellular polymeric matrices, which increases the binding of water. It helps in protection against a common stress condition of planktonic cell due to decrease in dehydration (desiccation) of the bacterial cells.

3. Biofilms are resistant to phagocytosis.

4. The adherent nature of microbial cells in biofilms allows rapid exchange of nutrients, metabolites, and genetic material. As compared with planktonic cells, process of conjugation has been demonstrated in bacteria existing in biofilms.

Steps in Biofilm Formation

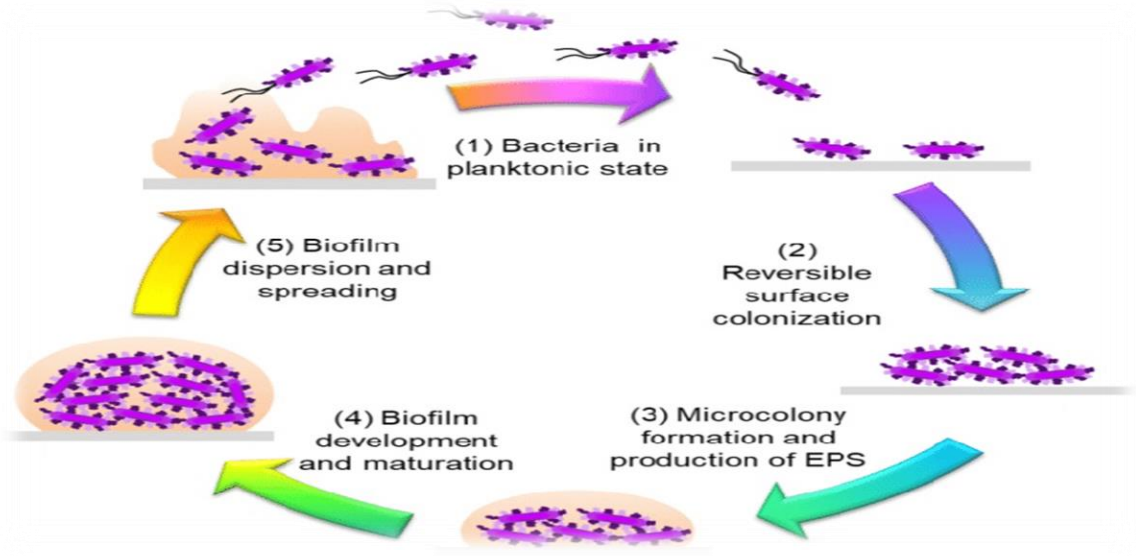

Figure 1. Steps in biofilm formation

Planktonic bacteria, free in a medium (1) bind reversibly to a surface (2). They secrete adherent proteins as well as EPS resulting in irreversible attachment and form a microcolony (3). The biofilm grows and matures (4) until, after an event, the bacteria in the biofilm revert to a planktonic lifestyle (5).

Role of Microbial Biofilms in Soil Health

Microbial biofilms can not only promote plant health but also maintain soil architecture and improve water retention capacity by forming soil aggregates, nutrient composition, nutrient solubilization, and availability, carbon sequestration, nitrogen fixation, and soil fertility enhancement. With increasing concern of heavy metal contamination in arable soils, bioaugmentation could serve as an effective strategy for improving metal toxicity. For instance, co-inoculation of sunflower with bacteria *Pseudomonas libanensis* strain TR1 and arbuscular mycorrhizal fungus (AMF) *Claroideoglomus claroideum* strain BEG210 increased plant biomass and promote phytoremediation of nickel (Ni) from contaminated saline soil. Increased production of ACC deaminase, IAA, and siderophore by these microbes might help in efficient uptake of Ni^{2+} ions from the soil.

Plant mucilage and microbial EPS play important role in binding soil units together and increase organic matter content. Several studies have shown that the application of microbial EPS resulted in stable soil aggregation and substantially increased nutrient uptake by plants. For instance, root adhering and EPS-producing Rhizobium spp. strain YAS34 significantly increased soil macropore volume of up to 12–60 µm in diameter after inoculation in soil and increased sunflower shoot and root dry mass up to 50 and 70%, respectively (Alami et al. 2000). Species richness of bacteria, fungi and cyanobacteria, and abundance of bacteria were reported to increase in maize rhizosphere with conjoint application of 50% chemical fertilizers and biofilm biofertlizers (*Aspergillus* sp., *Azorhizobium* sp., *Rhizobium* sp., *Acetobacter* sp., *Azotobacte*r sp, *Azospirillum* sp.) when compared to chemical fertilizers alone (Buddhika et al. 2011).

Microbial biofilms also play an important role in maintaining carbon (C) cycling via sequestration of atmospheric CO_2 in soil, providing the potential for large-scale C sinks. Thus, it can aid in the possible management of leading global problems such as global warming and soil conservation. Abiotic stress like imbalance of nutrients in soil cause significant reduction in productivity of crops utlimately challenging the soil health. Application of *Trichoderma viride* and *Azotobacter chroococcum* as a biofilm in integration with chemical fertilizers led to significant improvement in soil organic carbon, primary nutrient and micronutrient content of soil, besides improving plant antioxidant and defense enzymes activity, as compared to their individual inoculation and recommended dose of NPK fertilizers in chickpea (Velmourougane et al. 2017).

Role of Microbial Biofilms in Plant Health

Most of the functional attributes influenced by beneficial microbes include enhanced nutrient solubilization and uptake, fixation of atmospheric nitrogen by nodules formation, sequestering iron via the production of siderophores. These actions positively affect plant growth parameters such as (1) increase in root and shoot length, (2) seed germination, and seedling vigor, (3) increase in grain production, and overall plant biomass. Change in the level of two phytohormones—IAA and ethylene both related to plant growth is influenced by microbial biofilms. Many plants growth-promoting bacteria such as Rhizobium leguminosarum, Pseudomonas spp., *Azospirillum* spp., and *Burkholderia unamae* synthesize the enzyme ACC deaminase, which converts ACC (a precursor of ethylene biosynthesis) into ammonia and α-ketobutyrate. As a result, the level of ethylene decreases, and therefore the plant growth inhibitory role of the hormone could be overcome). Thus, these microbes modulate phytohormone pathways to influence plant growth parameters and enhance plant biomass. Also, combined application of microbial consortia (Mb 4 and Mb 7 of PGPR and Cb 4 and Cb 9 of compost inhabiting bacteria) on *Fusarium* infested soil has proved effective in suppressing fungal pathogen and improving growth and yield of maize when compared to their individual inoculations (Akhtar et al. 2018).

Rhizobacteria *Paenibacillus* spp. could potentially be used as a biocontrol agent due to its dual role as an antifungal and nematicide against Fusarium wilt and root gall disease caused by *Meloidogyne incognita*, respectively (Son et al. 2009).

Conclusion

It can be concluded that biofilms have a key role in maintaining the soil health and enhancing crop productivity. As microbial biofilms are naturally present in the soil, but their numbers and efficacy is insufficient to support optimal plant growth and soil health which necessitates the application of microbial biofilm biofertilizer. Thus, balanced application of chemical fertilizers along with biofilm biofertilizers needs to be promoted.

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Propagation Methods in Bael

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Bael (*Aegle marmelos* Correa) is an underutilized fruit indigenous to India. It belongs to the citrus family Rutaceae, and it is also known as Bengal quince. Its medicinal properties have been described in the ancient treatise like Charaka Samhita, Upvana Vinod and Yajur Veda, and it has also been portrayed in the paintings of Ajanta Caves.

Bael is usually propagated by seeds. The seeds are recalcitrant and cannot be stored for longer periods under normal storage conditions. Budding, patch or shield on seedling rootstocks in June or July gives very good success. Air layering is also successful under humid tropical conditions. In vitro propagation has also been standardized but it is not feasible commercially.

Seeds germinate in 8-15 days after sowing during summer under rainfed semi-arid conditions (Singh *et al*. 2011a) Sometimes seeds germinate while fruits are kept on tree for longer duration after ripening of tree (vivipary) (Singh *et al*. 2018).

Patch budding is the commercial method of multiplication of bael (Singh *et al.* 2014a). This method is very useful for transportation of sapling to the distant places (Singh *et al*. 2018a). Patch budding and softwood grafting were found to be successful when performed in the month of May-June.Under arid conditions of Bikaner, Rajasthan; more than 90% success was obtained through patch budding on polybag raised rootstocks in July (Saroj *et al*. 2006).

Vegetative Propagation

Patch Budding: Rectangle incision is made on the rootstock by placing the bud on the rootstocks to mark the exact size of the bud on them and after removing the bark of the rootstock and tying with white polythene strip (200-gauge thickness and 2 cm wide). The rootstock is cut about 10 cm above the bud to facilitate bud sprouting. The time of budding influences the survival of plant in different varieties. Singh *et al*. (1976) reported 100 % bud take during the month of June or July. Effect of scion genotypes on patch budding in bael has been reported by Mishra and Jaiswal (2001).

In Situ Patch Budding: In arid and semiarid regions, in situ budding is the most successful method for establishing a bael orchard. This is done by sowing 2–3 seeds directly in the field or by planting seedlings. After one year, budding is done in the field. In bael, the tap root system is very vigorous and if disturbed during the process of planting of grafts, it ultimately affects growth and establishment adversely in the field conditions.

Softwood Grafting: Shoots of 3–4 months old are defoliated 10–12 days prior to grafting operation. For this, seedling rootstock is cut at 10–15 cm height. With the help of a knife, a 5 cm long vertical downward incision is made in the center of the rootstock. A sharp cut of 5 cm is made on both sides on the base of the scion shoot to make wedge shape, and the graft is tightly secured using a 200-gauge thick and 2 cm wide polythene strip.

In Situ Softwood Grafting: The desi rootstock is raised at desired spacing directly in the field; the seeds should be sown directly in the field during rainy season under rainfed condition. In situ softwood grafting through wedge method is done in the months of June–July on a 1-year-old seedling. The bud sprouts within 15–20 days of grafting and polythene strips are removed after the union. The plants are given support with the help of stakes to protect them from stormy winds. High temperature and relative humidity during June–July have helped in early sprouting and better graft success, because of fast establishment of vascular connection with rootstock.

Root and stem Cuttings: Bael can be propagated successfully by root cutting during monsoon. To ensure establishment, suckers are planted in nursery beds for about 2 years after uprooting and are then shifted to the main field. Ray and Chatterjee (1996) reported that growth regulator and etiolation treatments were significantly effective in inducing roots in ringed stem cuttings of *A. marmelos*.

Layering: Air layering is very successful in bael provided that mother trees are given invigoration treatment by heading back to few of the thick branches during April. Air layers are prepared in the second week of August by bark ringing and application of IBA at 10,000 ppm in lanolin paste.

Micropropagation: True-to-type and disease-free plants can be generated from a very small piece of plant in aseptic conditions in artificial growing medium rapidly throughout the year. Regeneration can be done from explant nucellus (Hossain *et al*. 1993) and cotyledons leaf (Islam *et al.* 1993).

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Overview of Maize Production in UT of Jammu and Kashmir, India

Article ID: 48857

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Summary

Jammu & Kashmir, one of the Himalayan states of India, is the traditional maize growing region in the country. Augmentation of maize productivity is imperative for uplifting smallholder farmers in the state. R&D institutions have developed a number of varieties and input technologies for the development of maize sector of the state. Besides, the state government also promotes composite seeds through State Seed Corporation and the promising varieties are generally procured from the private sector (Sood, 2011).

However, there are apprehensions about the stagnant or declining productivity of maize in the state. Maize is one of the important crops grown generally under rain-fed conditions in temperate region (Kashmir) of Jammu & Kashmir. Maize production in J&K touched about 5.2 million quintals in 2015-16 and has experienced a meagre increase since 1980-81. The area, production and yield of maize in J&K during the last three decades is reported in Table 1. The area under maize has expanded by about 19 thousand hectares since mid-1980s' and has an allocation of about 2.9 lakh hectares in 2015-16. In Kashmir regions of J&K, maize is cultivated on 0.77 lakh hectares which comprise over 26 per cent of total maize area in the state.

The crop is grown in all districts of Kashmir valley though maximum area under maize falls in Baramulla with 20.57 thousand hectares followed by Kupwara and Budgam districts. Owing to predominance of horticultural system, Shopian has relatively less area under maize. Over the years, with the transformation process there has been a drastic change in the cropping pattern and area allocation under maize in the valley. The increase in the production of maize was exclusively because of area expansion in this crop. Since 2007-08 there has been an increase in the area under maize in Budgam i.e. 1.8 thousand hectares. Area under maize in Bandipora has also shown an increase in the said period. Of the 10 districts of Kashmir, 06 districts have experienced an unfavorable decrease between 2007 and 2015. The unplanned switch to horticultural crops like apple has to be checked and a policy advisory on this account should be extended to the stakeholders for desirable outcomes.

Table 1: Area, production and yield of maize in J&K:

Year	Area (000 ha)	% of TSA	Prod. (000 q)	% of FGP	Yield (q/ha)
1980	275	28.3	4933	37.8	17.93
1990	295	27.6	4440	32.5	15.06
2000	330	29.6	5258	47.0	15.92
2010	308	27.0	5277	34.7	17.12
2015	294	25.4	5237	30.1	17.82

TSA = Total sown area and FGP = Food grain production.

In terms of production and yield, Kupwara stands first among the maize producing districts. The state has also witnessed maximum increase in maize area except Leh and Kargil districts. Taken as breakfast food and in the afternoon working tea, it is the staple food of Gujjars and Bakarwals, living in the Kandi and hilly areas. Moreover, the grains form an important cattle food, being fed to farm cattle and horses.

Cropping Pattern

In the Jammu province, there are usually two crops Rabi (wheat, barley) and Kharif (rice, maize, millet). Rotation of crops includes maize followed by wheat, toria or barley and mustard, or by some fodder crops.

In Kashmir province, land usually produces one crop a year; therefore, it is known as Ekfasli. Some farmers produce more than one crop in a year. Maize, rice and other Kharif crops are harvested in September and October. In November and December, ploughing for oats, wheat and barley is undertaken. During October-November, r i c e and maize as well as other autumn crops are threshed/shelled. In Ladakh, like Kashmir, no customary rotation of crops is followed. In J&K, among the food grains, the main crops are rice (29.06 per cent), maize (31.90 per cent) and wheat (23.31 per cent) accounting for 84 per cent of the total cropped area whileas the balance 16 per cent is shared by inferior cereals and pulses. The commercial crops of significance grown in the state are apple and saffron. The consequence of such a cropping pattern is that the bulk of the cultivators have little to spare for buying other necessities of life.

Production Issues for Maize in J&K

Cultivation of land races, non-availability of critical inputs, scattered land holding and cultivation of maize over a wide range of environmental conditions ranging from approximately 1650 m to above 2,600 m amsl, mostly under rainfed environments are the major constraints for maize cultivation. Climatic risks like drought and sometimes heavy rainfall and edaphic constraints like poor water and nutrient retention capacity, low soil organic matter (SOM) make maize farming highly vulnerable.

Good Management Practices for Temperate Maize

In the State of Jammu and Kashmir maize area is around 3.1 lakh hectares with the production of 52.7 lakh quintals and productivity is around 1.7 tons per hectare (Anonymous, 2015). It is the second most important crop after rice and is a staple food of some tribal areas such as Gujar and Bakarwall (nomadic race). Maize is generally grown under rain fed conditions and on marginal lands particularly in hilly terrains of the Kashmir valley invariably as an intercrop with pulses. Optimum plant population, suitable cultivar with adequate amount of precipitation are the important factors for higher productivity, by virtue of which there is efficient utilization of underground resources and also harvesting maximum solar radiation which in turn results in better photosynthesis.

Procedure for Maize Crop Production

1. Field Preparation:

a. Irrigated maize: Fields are to be pulverized three to four times and properly levelled. Incorporation of crop residues/FYM in the soil by deep ploughing. Land should be ploughed to a depth of 12-15cm so that farmyard manure/ crop refuse/ compost is fully incorporated. Then after 2-3 ploughings should be given. Then planking is followed to conserve moisture and improve germination.

b. Rainfed maize: In Karewa conditions one deep ploughing before winter is followed in order to conserve moisture. Before sowing 2-3 ploughings across the slope may be given followed by proper levelling for better germination and establishment.

2. Application of FYM Or Compost and Fertilizers: For good yields and higher benefits, the fertilizers should be matched with the soil supplying capacity and plant demand. However, if soil testing is not available, then nutrients mainly NPK should be applied at the following rates.

Fertilizers	Maize under irrigated conditions				Maize under Rainfed conditions			
	Hybrids		Composites		Hybrids		Composites	
	Per hectare (kg)	Per kanal (kg)	Per hectare (kg)	Per kanal (kg)	Per hectare (kg)	Per kanal (kg)	Per hectare (kg)	Per kanal (kg)
Urea (basal)	100	5	80	4	60	3	48	2.4
DAP (basal)	163	8.15	130	6.5	98	5	87	4.35
MOP (Basal)	67	3.35	50	2.5	33	1.7	33	1.65
ZnSO4 (basal)	20	1	20	0.75-1.0	15	0.75	10	0.5

Urea as top dose in 1st split	80	4	65	3.25	50	2.5	40	2
Urea as top dose in 2nd split	80	4	65	3.25	50	2.5	40	2

Apply well decomposed compost or FYM uniformly @ 15-20 t/ha and should be incorporated in the soil at the of land preparation.

3. Ridging/Earthing up: Ridging and Earthing up should be done at knee high stage (35-40 DAS). Ridging helps for root establishment and to prevent lodging. It improves drainage in waterlogged areas and is helpful in conserving the rainwater under dry land situations.

4. Weed management: Timely weed management is needed for achieving higher yield. Two to three weeding/hoeing should be given, first at 30 DAS and second at 45-50 DAS. At the time of last hoeing earthing up should be done properly. For chemical weed management apply atrazine @1-1.5 kg a.i/ha in 600 lit. of water.

5. Irrigation: Most of the maize area is rainfed. If possible, give three irrigations at knee high, silking and grain filling stage.

6. Harvesting: Cobs are harvested at 16% grain moisture when leaves turn completely brown and silk dries in case of normal maize.

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Carbon Sequestration

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Growing concerns regarding global warming and carbon emissions have spurred interest in techniques for carbon sequestration, aimed at capturing and storing carbon released from the burning of fossil fuels. Human activities already have a significant impact on almost half of the terrestrial biological carbon cycle (Hughes and Benemann, 1997). Effectively managing this cycle could make a substantial contribution to CO_2 mitigation (Farrelly et al., 2013). A significant portion of the carbon dioxide (CO_2) emissions generated by human activity stems from the combustion of fossil fuels for energy production. The adverse effects of elevated CO_2 levels in the atmosphere on the environment are widely acknowledged. Consequently, we are progressively increasing the concentration of carbon in the atmosphere, which ultimately leads to global warming and climate change (Soon *et al*., 1999; Farrelly et al., 2013). Various approaches can be explored to reduce carbon in the atmosphere and mitigate the negative impacts of climate change. One such approach is carbon sequestration, which can range from being affordable and straightforward to expensive and intricate. This includes natural carbon sequestration as well as geological carbon sequestration.

Carbon Sequestration

Carbon sequestration is a fundamental process aimed at mitigating climate change by capturing carbon dioxide (CO_2) emissions from the atmosphere and storing them in long-term reservoirs. This process assumes great significance due to the role of CO_2 as a primary contributor to global warming. Lal (2007) defines soil carbon sequestration as the process of capturing atmospheric CO_2 and securely storing it within the pedosphere, thereby enhancing its mean residence time (MRT) while minimizing re-emission sources. It is widely acknowledged that carbon sequestration plays a crucial role in the battle against climate change. However, to achieve substantial reductions in atmospheric CO_2 levels, a combination of diverse methodologies may be necessary. Ongoing research and development efforts in the field of carbon sequestration technologies remain indispensable in meeting the challenges posed by climate change.

Important Sources and Methods of Carbon

1. Forests as a carbon sink: Afforestation, reforestation, plantation, and agroforestry are all practices that contribute to carbon sequestration. These approaches involve the uptake of atmospheric carbon through photosynthesis, which is then stored in the form of biomass or wood. The success of carbon sequestration in these practices relies on ensuring that the carbon does not return to the atmosphere through burning processes.

2. Wetland restoration: Wetland soils serve as significant natural carbon pools or sinks. Globally, wetlands retain approximately 14.5% of the soil carbon, despite covering only 6% of the Earth's land area.

3. Oceans as a carbon sink: Oceans act as absorbers of carbon dioxide from the atmosphere, primarily due to the higher concentration of CO_2 in the atmosphere compared to that in the oceans. The difference in CO_2 partial pressure between the atmosphere and oceans leads to the absorption of CO_2 into the world's oceans (Raghuvanshi et al., 2006).

4. Subterranean injection or geological sequestration: Carbon dioxide can be injected into depleted oil and gas reservoirs, geological formations, or deep ocean regions, a process known as subterranean injection. This method of carbon sequestration involves selecting appropriate sites for injecting CO_2, such as depleted oil and gas reservoirs, to securely store the carbon dioxide (Dhanwantri et al., 2014).

These scientific approaches contribute to the understanding and implementation of carbon sequestration strategies, playing a crucial role in mitigating the impacts of carbon emissions and addressing climate change.

The Key Reasons why Carbon Sequestration is so Important

1. Mitigating greenhouse gas emissions: Carbon sequestration plays a vital role in mitigating greenhouse gas emissions, particularly by reducing the concentration of carbon dioxide (CO_2) in the atmosphere. By effectively removing CO_2 from the atmosphere, carbon sequestration contributes to mitigating the impacts of climate change, such as rising global temperatures, altered precipitation patterns, and increased frequency of extreme weather events. This is essential for safeguarding ecosystems, reducing vulnerabilities, and preserving biodiversity.

2. Advancing sustainable land management: Numerous carbon sequestration methods necessitate changes in land use, such as afforestation, reforestation, and sustainable agricultural practices. These land management strategies not only facilitate carbon capture but also promote sustainable land use practices. They help protect and restore ecosystems, enhance soil quality, preserve water resources, and support the livelihoods of local communities. By integrating carbon sequestration into land management practices, we can achieve multiple environmental and socio-economic benefits.

3. Enhancing soil fertility and productivity: Soil carbon sequestration enhances soil health, which has direct implications for plant growth, nutrient cycling, and overall agricultural productivity. Increased carbon content in soils improves soil structure, water retention capacity, and nutrient availability, fostering optimal conditions for plant growth. By enhancing soil fertility, carbon sequestration practices contribute to sustainable agriculture, food security, and the resilience of agricultural systems in the face of climate change.

4. Fostering technological innovation: Carbon sequestration is a rapidly evolving field, constantly exploring new technologies, methodologies, and monitoring techniques. Investing in carbon sequestration research and development promotes technological innovation, driving advancements in carbon capture, storage, and utilization. This fosters the growth of a green economy, stimulates job creation, and catalyzes the emergence of novel solutions for addressing climate change challenges.

5. Meeting international climate targets: Carbon sequestration constitutes a critical component of international climate agreements and commitments, such as those outlined in the Paris Agreement. By actively implementing carbon sequestration strategies, countries can contribute to achieving their emission reduction targets, promoting sustainable development, and transitioning towards a low-carbon future. The integration of carbon sequestration into climate policies and strategies strengthens global efforts to limit global warming and mitigate the impacts of climate change.

The Objectives of Soil Carbon Sequestration Encompass Various Scientific Considerations, Including

1. Offsetting anthropogenic emissions: Soil carbon sequestration aims to counterbalance carbon emissions originating from activities such as fossil fuel combustion, cement production, and deforestation. By capturing and storing carbon in the soil, it mitigates the net increase in atmospheric CO_2 concentration and helps maintain carbon equilibrium.

2. Reducing atmospheric CO_2 concentration and pool: An important objective of soil carbon sequestration is to curtail the rise in atmospheric CO_2 levels, which surpassed 400 parts per million by volume (ppmv) in 2013. Additionally, efforts are directed towards expanding the soil carbon pool, which currently stands at approximately 800 petagrams of carbon (PgC).

3. Enhancing soil organic carbon concentration: Soil carbon sequestration endeavors to elevate soil organic carbon (SOC) concentration above the critical threshold range of 1.5-2.0%. Higher SOC levels promote soil fertility, augment nutrient cycling dynamics, and improve water retention capacity. These enhancements contribute to enhanced soil quality and bolster ecosystem functions.

4. Restoring soil quality and ecosystem functions: Soil carbon sequestration initiatives prioritize the restoration of soil quality and the associated functions and services it provides. This includes the preservation and promotion of biodiversity, heightened nutrient retention capabilities, improved water infiltration rates, and the reduction of soil erosion and nonpoint source pollution.

5. Improving water and nutrient retention capacity: An objective of soil carbon sequestration is to enhance the soil's ability to retain water and nutrients. This improvement increases the efficiency of resource utilization in managed ecosystems, leading to sustainable agricultural practices with reduced losses of valuable inputs.

6. Creating climate-smart soils and agroecosystems: Soil carbon sequestration contributes to the development of climate-smart soils and agroecosystems. These systems exhibit resilience to climate change, actively mitigate greenhouse gas emissions, and enhance carbon storage while ensuring sustainable food production.

7. Increasing productivity and advancing food security: By implementing effective soil carbon sequestration practices, it is possible to augment and sustain agronomic productivity. This achievement has far-reaching implications for food security, particularly in regions where agricultural productivity is hampered by degraded soils.

In summary, soil carbon sequestration aligns with a range of scientific objectives. By offsetting anthropogenic emissions, reducing atmospheric CO_2 concentrations, enhancing soil organic carbon levels, restoring soil quality, improving resource efficiency, fostering climate resilience, and promoting food security, it emerges as a scientifically informed approach to address climate change and foster sustainable development.

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Impact of Entomophilic Nematodes on Insect-Pests

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Abstract
Entomophilic nematology is the branch of parasitology that deals with nematodes associated with insects. The association may be one in which insects serve as intermediate hosts or definitive hosts. "Skeeter Doom" is the popularized product which can parasitizes Mosquitoes. An entomophilic nematode, *Beddinga siricidicola* completely parasites Sirex wood wasp. Entomophilic nematodes were not popularized because of several Physical, Chemical and Biological factors limit the survival of entomophilic nematodes.

Introduction
Entomophilic nematodes were found in about 27 families of eight orders viz., Rhabditida, Tylenchida, Aphelenchida, Strongylida, Oxyurida, Ascaridida, Spirurida and Mermithida. Insect nematode associations can be grouped into three basic types- Phoretic relationship (insect associated), facultative parasitism and obligate parasitism. *Romanomermis culicivorax*, *Mermis nigrescens*, *Agamermis decaudata*, *Leidynema appendiculata, Thripinema fuscum*, *Sphareularia bombi*, *Beddinga siricidicola*, *Heterotylenchus* spp are the important entomophilic nematodes. Some entomophilic nematodes were formulated and commercialized in the market.

Insect Nematode Associations can be Grouped into Three Basic Types
1. Phoretic relationship (insect associated).
2. Facultative parasitism.
3. Obligate parasitism.

Significant Findings
1. Mass multiplcaion of *Beddinga sircidicola*
2. Mass multiplicaion of *Romanomermis culicivorax* – Skeeter Doom (Petersen and Willis, 1972).

Recent Reports
1. The fall armyworm *Spodoptera frugiperda* (J.E. Smith), a new pest of maize in Africa: biology and first native natural enemies detected - *Hexamermis* sp. Parasitism 13.7% (Tendeng *et al.*, 2019).
2. Studies on pests and diseases of bumble bee (*Bombus haemorrhoidalis smith*) in India. (Chauhan *et al.*, 2014).

Commercial Availability
The entomophilic nematode formulations are not available commercially. However, their egg stage can be stored and applied as a suspension in water, so if economic artificial rearing techniques could be developed it might make a useful augmentative biological control tool.

Conclusion
Mermithids offer the most promise, and there is a need to consider – the possibility of mass culture and dissemination. *R. iyengari* can be easily used as component in integrated mosquitoes control program. There have been no other field trials for other entomophilic nematodes. *Beddingia siricidicola* is successful biocontrol agent against sirex wood wasp because of having two parasitic forms.

Future Prospects
We are deficient in our knowledge of the biological competitiveness of nematodes when they are introduced into a pest population. The commercial and economic competitiveness between the production of chemical

pesticides and the mass culturing of pathogenic nematodes is a significant obstacle. Seasonal coincidence and Ecological coincidence host with parasite. We know that these nematodes cause insect mortality in field populations and exert some control over insect populations, but it is difficult to determine accurately the effect on an insect population.

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Know more about Seed Spice - Coriander: Species and Breeding Objectives

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Seed spices are basically defined as vegetable products or mixtures thereof, free from extraneous matter, used for imparting aroma in foods. These are annual crops of which seeds are consumed as a spice. Seed spices are important ingredients in any Indian and Asian cuisine. It imparts aroma and pungency to the dishes and provides a peculiar taste to the finished foods. Besides their importance in the food industry, seed spices are used in various pharmaceutical preparations and also in the cosmetic industry. Indian seed spices are preferred in the international market because of their good fragrance, luster and appearance. Seed spices occupy a prominent place in the total export basket of spices. Seed spices are annual herbs, whose dried seed of fruits are used as spices.

Coriander *(Coriandrum sativum L.)* is an important seed spice; belongs to an annual herbaceous plant of family Apiaceae with chromosome number 2n=22. It is a cross pollinated entomophilous crop, honeybees as the major pollinating agent. In India, coriander is cultivated for seed as well as for leaves. Coriander is used as a spice, in culinary, medicine and in perfumery, pharmaceuticals and food industries. Dried ground fruit is the major ingredient in the preparation of curry powder. The whole fruit is also used to flavor foods like sauces, pickles, pastry, cakes, biscuits, liquors and confectionary. The young plants and leaves are used in the preparation of chutney and seasoning in curries, sauces and soups. Tamil name: Kothamalli / malli. The fruit size and weight have for a long time been recognized as an important characteristic dividing the species into two subspecies (small-fruited vs. large-fruited), which have different geographical origin and agronomic properties.

1. *C. sativum L.var. microcarpum* (the small fruited) and
2. *C. sativum L.var. vulgare* (the large fruited)

Small, seeded types are highly aromatic and fetch better price. English, German and Russian varieties are of this type. Besides, they are hard to break, which reduces breakage during handling, transport and storage. Small, seeded types are normally cultivated in irrigated areas. Bold seeded types are usually less aromatic and fetch comparatively low price. These types are cultivated in unirrigated areas.

Small Seeded Type	Bold Seeded Type
C. sativum. var. microcarpum	*C. sativum*. var. vulgare
More aromatic	Less aromatic
More essential oil (0.8- 1.8%) more market price	Less essential oil (0.1- 1.35%) less market price
Temperate region	Tropical and sub- tropical region
Hard to break, which reduces breakage during handling, transportation and storage.	Less hard comparatively
Normally cultivated in irrigated areas	Unirrigated areas
Ex. Karan, CS 287 (TNAU)	Ex: RCr-436, UD-20

Breeding Objectives

1. Breeding for seed purpose: When seed production is the objective, seed yield will be the breeding objective of highest relevance. The physical properties of the fruits are important. Only fully matured fruits have optimal quality, and desiccation to accelerate maturation or to obtain even maturity may reduce the fruit quality. Spontaneous shattering of the mature fruits needs to be reduced by breeding. Genotypes with fruits that do not separate spontaneously into the two single seeds are preferred because round fruits that maintain their integrity are easier to clean and optically more appealing. In entire fruits, the oil channels inside the fruits are less exposed to physical damage, so the essential oils are better protected from being lost.

The aromatic properties of the mature fruit are based on monoterpenes, of which coriandrol is the dominating component. Other monoterpenes and aldehyde components may occur in lower quantity, and some can cause distinct favors that are not desired, such as camphor.

2. Breeding for leaf purpose: The breeding objectives for leaf use (cilantro) are very different from those for fruit use. The term slow bolt coriander refers to types suitable for leaf usage indicating that the plants have a prolonged juvenile phase in which they produce a sedentary rosette of basal stem leaves, which are soft and aromatic. The aromatic qualities of the leaves of coriander are due to essential components that are chemically different from the essential oil of mature fruits. For commercial purposes, the shape, colour, texture and flavour of the leaves must be appealing to the consumer.

3. Breeding for biotic stress:

a. Powdery mildew: Co 3, Gujarat Coriander 1, Gujarat Coriander 2, RCr 41,
b. Stem gall: Rajendra Swati, RCr 20, Hisar Sugandh, Pant haritima
c. Wilt: Co 3, Co 4
d. Grain mould: Co 3, Co 4

4. Breeding for abiotic stress

a. Drought: Co 2, Sindhu
b. Lodging: Gujarat Coriander 2, Hisar anand
c. Frost: Hisar surabhi

Institutes Dealing with Coriander Research

1. Department of Spices and Plantation Crops, TNAU, Coimbatore.
2. National Research Centre on Seed Spices, Ajmer
3. Regional Research Centre, Lam (APAU), Guntur, AP
4. Regional Research Centre, Rajendra Agricultural University, Bihar
5. CCS, Haryana Agricultural University, Hisar.
6. Sri Karan Narendra Agriculture University, Jobner (Rajasthan)

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Role of Social Media in Marketing of Silk Products of Assam

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Introduction

Social media is a form of electronic communication, referring to websites (*viz*. Facebook, twitter, YouTube, LinkedIn, etc.) and applications which help users to share or create content or engage in social networking. Social media, an online communication platform has gained immense popularity in recent times, turning this vast world into a small global village. Researchers like to conclude that social media resembles an umbrella for the people who gather online to exchange and share information, opinions and knowledge using communicational media (Singh, 2018). One of the significant advantages of social media is marketing strategies and advertisement of finished products on platforms like Facebook, Instagram, YouTube etc. Social media platforms not only increase the vicinity between customer and producer but also are cost effective.

Role of Social Media

Marketing of the silk products plays an important role in easy distribution of the products to the customer. Assam, being homeland for all the four varieties of silkworm *i.e* eri, muga, mulberry and tasar accounts for the highest production of muga and eri in the country. Assam enjoys world monopoly in the production of muga silk, occupying 80.84 per cent of India's production whereas eri silk accounts for 74.66 per cent of the national production. Assam is the proud owner of Geographical Indication tag for muga silk (Anonymous, 2023). Assam occupies the 3rd position among the traditional sericultural states of the country. Though the state is endowed with rich tradition of sericulture and is famous for its cultural heritage yet public in general are not aware of the various artistic, cultural and scientific significance of the sericulture products. Muga and eri silk has always been closely associated with the rituals and tradition of Assamese culture and its folklore and has remain an important household activity. The Sericulture industry of Assam has received enormous scope for expansion in the 21st century. Proper marketing of silk products will benefit the poorest of the poor of society which will help to contribute to the country's economy. This also helps in women empowerment and achievement of the sustainable development goals. Therefore, the use of social media in the marketing of sericulture products will provide a market that will help in the economic upliftment of the Assamese society as a whole. It will boost the village economy as well.

Rearers, reelers and weavers must be equipped with sound marketing information for the development of market-oriented products. Provision of integrated marketing system through social media platforms in the rural areas will help in gaining profits of the products. India has a huge market potential due to its wide geographical area for silk market expansion. Development of proper marketing channel will not only help the producer and consumer but will also help the country in becoming a top leader in silk production.

Conclusion

Sericultural products were mostly produced in the rural areas of the state hence use of social media in the marketing of the sericulture products like mekhela chador, riha, saree, eri chawl etc. will provide a platform for buying and selling to both the producer and consumer which were otherwise difficult to access. Lack of proper knowledge and needs of the customer by the producer leads to production of inferior quality products. Use of social media will cut down the transportation cost and minimize the involvement of the middlemen in the silk industry. Customers can directly visit through social media at any time to get the information according to their needs or requirement.

In the contemporary era, social media platforms such as YouTube and Instagram have assumed a pivotal role in the direct selling of sericulture products. Content creators on these platforms advertise their products through the utilization of audio-visual media and infographic displays, providing detailed information about the merchandise. Customers can then directly engage with the sellers, negotiating the prices through Whatsapp communication and furnishing their delivery address details to receive the products. This emergent trend in the sericulture industry represents a significant shift in the marketing and distribution strategies employed by producers. The seamless integration of social media platforms with direct-to-consumer sales channels has enabled sericulture entrepreneurs to bypass traditional intermediaries, fostering a more intimate and responsive relationship with their target audience.

Muga silk products of Assam have very high demand in the global fashion industry. Social media platforms will enable designers from around the globe to reach out to the producers with a click of the mouse. In the global textile parlance Assam will get high recognition of its first Geographical Indication (GI) products *i.e* Muga Silk with the use of social media platforms. It will also help in earning foreign exchange as a result of which it will elevate the social status of the rural populace as well as attract more unemployed youth to adopt sericulture as their mode of livelihood.

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Post Harvest Practices to Improve Quality and Shelf life of Banana: A Review

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Abstract

Bananas are recognized as the fourth largest food crop for their extensive cultivation and rich nutrients. Bananas are highly perishable fruit and need intensive care after harvesting. In this study, it is revealed that the postharvest quality and shelf life of the fruit depends upon postharvest handling practices carried out after harvesting of the fruit. Handling practices like harvesting, precooling, cleaning, sorting and grading, packaging, storing, transportation plays an important role in maintaining quality and extending the shelf life. Failure to provide these practices will result in a high amount of loss.

Keywords: Banana, Shelf life, Storing, Precooling, Artificial ripening, Cable transportation, Maturity indices.

Introduction

Banana (Musa spp.) is one of the most widely cultivated and extensively consumed horticulture crop globally. Banana is an antique fruit crop of the world is known as 'Apple of the paradise'. Cooking and plantain banana are major starch staple crop of importance for developing countries. It ranked 4th after rice, wheat, maize as important staple food in the world (Hossain,2014; Diedhiou et al., 2014). It is a cheaper source of carbohydrate and rich in minerals such as, potassium, calcium, oligosaccharide, and various other bioactive compounds. Bananas are used in place of food in some countries suffering from food shortage (Li, J., Yang, Z. Wang and W.Z. Wang, 2011). It is highly nutritive and also a rich source of energy (89 kcal/100g) (Sidhu and Zafar, 2018). Worldwide 113,212,452 tonnes of banana is produced per year. India is the largest banana producer in the world with 29,124,000 tonnes. By area, banana rank 3rd only to mango and citrus but in production it ranks 1st among all horticultural crops (FAOSTAT 2021). Major banana producing states are Tamil Nadu, Maharashtra, Gujrat etc. Banana can be consumed in various ways. It can be used as infant food, functional food, dessert, carbohydrate staple food etc (Aurore et al., 2009; Mohapatra et al., 2009). Bananas are rich in vitamin A, C, E, B-6, lutein, potassium and antioxidants that helps to keep vision healthy. It also plays an essential role in digestive health; soluble fibres help to control blood sugar level and reduce cholesterol level. In regions where it is cultivated and consumed, it plays very essential part of people's diet. The variable uses of banana can be one of the factors to its widespread production in all over the world. Banana production has increased from 2000-2017, global production of banana grew at compound annual rate of 3.2% reaching a record of 114 million tonnes in 2017, from 67 million tonnes in 2000 (FAOSTAT 2017). Research in the production aspect of the value chain in banana production has resulted in improved cultivars which have high yield and resistant in both biotic and abiotic stress. This made banana production increase in recent years however, the postharvest loss is a major challenge hampering banana production in most developing countries. The gross postharvest losses of banana from harvesting to consumption ranges from 25-40% (Raja and khokhar,1993) and even more (Iqbal,1996) during transporting and marketing due to adverse physiological changes, softening of the flesh, and lack of resistance capacity against microbial attack (Akter et al., 2015). Banana is a perishable crop and has short shelf life of 3-5 days, which limits strategic selling. Under these circumstances banana growers fail to get optimum return and also fail to reduce the postharvest losses during peak season. Specialised postharvest handling practices are needed in order to extend the shelf life of the crop after harvest. Failure to provide these specialised handling practices results in high amount to loss. The purpose of this article is to focus on major post-harvest handling practices that globally used for better shelf life and quality.

Harvesting

The physiological maturity of any fruit at harvest has an important effect on postharvest quality of that fruit (A.A. Kader, 2005). The dwarf cavendish bananas are ready to harvest within 11-14 months after planting whereas tall cultivars take about 14-16 months to harvest. The maturity of banana is indicated by drying of leaves, change in colour of fruits from dark green to light green, tendency of the floral end of the fruit to fall by slight touch by hand and angularity of the fruits.

Variety of banana	Maturity indices
Dwarf cavendish	Days to harvest: 11 to 14 months. Drying of leaves, changes in colour of fruits, changes in angularity of fruits
Martaman	The peel transitions from green to yellow as they mature. They develop brown spots on the peel
Red banana	The peel transition from green to yellow to deep red or marron as they mature. The banana consisting of a red peel with little to no green or yellow remaining is considered mature and ready to eat
Poovan	Pale yellow colour with minimal green remaining on the peel Usually harvested when they are firm and slightly underripe.

Banana being a climacteric fruit can be harvested at pre climacteric stage and allowing ripening and senescence to occur during the postharvest period of the fruit. Producers targeting distant market should harvest the bananas in pre climacteric stage which will not only give producers ample time to prepare the fruit for market but also prevents from mechanical injuries during harvesting. The harvesting standards varies from place to place, season, transport distance and the end use of the fruit. For local use, the fruits are harvested fully matured stage, for short distance transport, the fruits are harvested at 90% maturity level and for long distance, the fruits are harvested at 75% maturity level. In cooler season, the fruits are harvested after 105 days of flowering, but during hot season the fruits can be harvested between 98-115 days (Robinson, 1996).

Bananas are always harvested by hand by using a two people team. One people cuts and the other carries the bunch away (B.C.V. Gustavo, F.M. J. Juan, 2003). In very hot weather, banana should be harvested during the coolest part of the day. Banana should be carefully handled at all stages of the harvesting and packaging process. Improper handling can result damage that does not become evident until it reaches to market which decrease the quality and value of the produce. (Include information on banana latex which blemish the fruit).

Artificial Ripening

Bananas are highly perishable climacteric fruits usually harvested at its green mature stage to increase its shelf life during transportation. Banana fruit is artificially ripened by applying different ripening agents including, ethylene gas treatments, acetylene treatment, ethephon treatment, and others like ethylene glycol, smoking, methyl jasmonate, propylene, ethanol, methanol, gibberellic acid, 6-benzylaminopurine, etc. Use of chemical agents such as calcium carbide, ethylene glycol, calcium chloride and inducing ripening by fumes from kerosene is highly hazardous and may be fatal if consumed. Most of the ripening agents are poisonous and their utilization can cause severe health problems, such as heart disease, lung failure, skin disease and kidney failure. However, use of ethylene is safe. Ripening using ethylene is commercially accepted method of ripening.

Some Post-Harvest Handling Practices for Banana

Like other fruits and vegetables improper handling of bananas during harvesting and post-harvest operation causes mechanical injuries which affect the postharvest quality and shelf life of fruits. Mechanical injury helped to enter pathogenic microbes which effect on final shelf life and quality. Some of the handling practices are harvesting, precooling, cleaning and disinfecting, sorting and grading, packaging, transportation and storage (Li, J., H.Z. Lu, Z. Yang, Z.L. Chen and J.C. Huang,2013) are discussed below.

Precooling after Harvesting

After harvesting precooling is the most important step for good temperature management. Precooling is practised to remove field heat from the fruits (J. Bachmann and R. Earles, 2000) which otherwise increase in metabolic activity including respiration. (Mohapatra et al., 2010). It also limits the growth of microorganisms, metabolic activity and ethylene production. Precooling should be done within 10-12 hrs of harvesting of banana bunch. The fruits packed in boxes can be pre-cooled by forced air cooling at 13 c and 85-90% RH. It may take 6-8 hours to bring the fruit pulp temperature at 13°C from field temp of 30-35°C. A cheap but effective way of removing heat is hydro-cooling, which is be done by rinsing, spraying or dipping the banana bunches in cold water for an effective heat removal (Piriyanphansakul and Kahlayanarat 2010). Banana producers assemble their harvested produce under tree shade in an attempt to reduce field heat. Tree shade, however, is not a reliable and effective way of reducing field heat in harvested produce. Arah et el.(year?) therefore suggested that the adoption of a simple on farm structure like a small hut can be very beneficial in precooling of harvested bananas.

Cleaning and Disinfecting

The banana hands, cut out from the bunches are washed in clean and flowing water to remove the accumulated dirt as well as the latex that exudes from the cut surface of crown. Immersion cleaning is used in most of the banana producing countries in which the banana are soaked in aqueous solution containing chemical fungicides such as iprodione (Muellar, S., C. Weder and E.J. Foster,2014), imazalil (Norman, N. and J.H. Potter,2011), potassium permanganate (Ping, Y.H. and Y.S. Chen,2010), acetic acid(Qi,Z., B.G. Li, X.M. Wang, X. Meng and Y.Q. Wu,2006), alum (Rannestad, O.T., A.P. Maerere and T. Torp,2013) and other substances for the initial cleaning and then immersed in bleaching solution for the second cleaning. Since this method of cleaning using chemical is health hazardous and could cause potential treat to ecology. (Rannestad, O.T., A.P. Maerere and T. Torp,2013). Globally researchers have been developed various ecofriendly method of cleaning. In japan, Tauchi method for cleaning bananas was designed and developed using recoverable pure water (Jian Feng Sun, Zhou Yang and Jia Long Liu, 2015). Cleaning, delatexing and fungal control is also be done using hot water at 50°C for 20 minutes, which is quite effective in controlling the crown rot diseases (Reyes et al., 1998). Hot water treatment also prevents peel blackening of the bananas going for successive cold storages (Promyou et al., 2008).

Sorting and Grading

Another important process in packaging and marketing of banana is sorting and grading (O.O. Arjenaki, P.A. Moghaddam and A.M. Motlagh, 2013). These two processes are vital in maintaining post-harvest shelf life and quality of harvested bananas. Sorting of banana includes removal of small, cut fruit from hands which limits the spread of saprophytic microorganisms during postharvest handling of bananas. Grading of banana is based on uniformity of size, colour and maturity level. Commercial banana producers normally use sophisticated systems that require precise sorting and grading standards for their produce. Small-scale producers and retailers in developing countries in contrast may not use written down grading standards; however, the produce must still be sorted and sized to some degree before selling or processing it.

Packaging

Packaging as a postharvest handling practice in banana production is essential in putting the produce into sizeable portions for easy handling. However, using unsuitable packaging can cause fruit damage resulting in losses (P.A. Idah et al., 2007). Some common packaging materials used in most developing countries include wooden crates, cardboard boxes, woven palm baskets, plastic crates, nylon sacks, jute sacks, and polythene bags (P.A. Idah et al., 2007). Most of the above-mentioned packaging materials do not give all the protection needed by the commodity. The majority of these packaging materials like the nylon sacks do not allow good aeration within the packaged commodity causing a build-up of heat due to respiration, others like the woven basket have rough surfaces and edges which cause mechanical injuries to the produce. The wooden crate and the woven palm basket are some of the common packaging materials used in many developing countries. The major shortcoming of the wooden crate is in its height which creates a lot of compressive forces on fruits located at the base of the crate. These undesirable compressive forces cause internal injuries which finally result in reduced postharvest quality of the Bananas. There have been suggestions of modifying the wooden crate to make it more suitable for packaging Banana. Kitinoja has therefore suggested that the depth of the crate should be reduced considerably to reduce the build-up of compressive forces which can cause mechanical injuries to fruits at the base of the crate after packaging (L. Kitinoja, 2008). The palm woven baskets used by Banana handlers have sharp edges lining the inside which puncture or bruise the fruit when they are used. It has also been recommended by (Idah et al., 2007) that woven palm baskets should be woven with the smooth side of the material turned inward.

Storage

Banana has very high moisture content and therefore is very difficult to store at ambient temperatures for a long time. Meanwhile, storage in the value chain is usually required to ensure uninterrupted supply of raw materials for processors. Storage extends the length of the processing season and helps provide continuity of product supply throughout the seasons. For short-term storage (up to a week), banana fruits can be stored at ambient conditions if there is enough ventilation to reduce the accumulation of heat from respiration (Basel et al., 2002). For longerterm storage, ripe bananas can be stored at temperatures of about 10–15°C and 85–95% relative humidity. At these temperatures, both ripening and chilling injuries are reduced to the minimal levels. These conditions are also difficult to obtain in most tropical countries and therefore losses of appreciable quantities of harvested bananas have been reported. This is consistent with the claim that the quality of banana is compromised when exposed to high temperatures and high relative humidity. Very low temperature storage too is detrimental to the shelf life and quality of many tropical fruits like Banana. For instance, refrigerating a Banana will reduce its flavour, a quality trait of Banana which is largely determined by the total soluble solids (TSS) and pH of the fruit. An understanding of the correct temperature management during storage of Banana is vital in extending the shelf life of the fruit whilst maintaining fruit qualities. Banana handlers in tropical countries can store Bananas for short to intermediate time by using evaporative cooling system (Hassan A, 2004).

Transportation

Banana bunches after harvest, are transported to the packing shed on padded trailers or on an overhead cable system. De-handing can be performed in the field, with the hands transported to the packing shed on padded trailers. Care is essential in these steps to avoid any mechanical injury (Nakasone and Paull, 1999). De-handing plantains in the field and the use of plastic foam is recommended to protect bunches of plantain during harvesting and transportation to the packaging site in the same manner. This reduces mechanical damage and avoids reduction of fruit quality of plantains for export (Chang et al., 2000). The utility of this packaging is not obvious in many producing countries as peasants and intermediate wholesalers are accustomed to bunch. In addition, they are not prepared to bear additional costs or extra investment to buy plastic cages for local sales but the loss from mechanically damaged fruits was far higher than the cost of plastic cages (Chang et al., 2000) [8]. In most countries, markets located in the production area, the bunches of plantains bought from the villages are piled up on one another then loaded in bulk in trucks or vans for travel to big distribution and consumption centres situated at times hundreds of kilometres away. The bunches are piled up to maximize loading and to expedite transportation. They are unloaded without caution at the destination. These different modes of packaging and transportation expose the fruits to damage and low market quality (Chang et al., 2000). Modern means of combating the organisms that cause such problems, as well as better systems of handling and transport, quality control, and good container design, have made carton packing not only feasible but necessary. First, the hands are graded for size and quality and then packed in layers in special ventilated cartons with plastic padding to minimize bruising (Morton, 1987). There are several advantages of boxing over naked bunch transport. Transport of hands in boxes has compelled growers to produce size of bunch. This has also avoided more handling and export of waste material (Salunkhe and Kadam, 1995).

Cable Transportation

Application of improper practices from piking of banana bunches to disposal of those bunches in market passes through different stages which deteriorates the overall quality of the bananas. The existing banana transportation in market are highly time and labour intensive which severely shorten the storage and leads to mechanical injuries which reduces the economic value of banana. To reduce the mechanical damage at present the most common semi mechanized banana transportation method is cable transportation. The cable transport ropeway directly hangs the pulley on the steel cable, with high transport volume, manual pulling strength, efficiency which make it less labour and time intensive. During the whole transportation procedure, the banana bunches do not touch the ground, which can effectively reduce mechanical damages, improve work efficiency, increase bananas commercial value and improve the economic benefits of the banana. Compared with the traditional mode of carrying banana manually, cable transportation greatly reduces labour intensity, improves work efficiency and reduces labour costs.

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Postharvest Facts and Practices in Muskmelon

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Introduction

Muskmelon (*Cucumis melo L*) is a fruit crop widely cultivated by farmers in India particularly during summer season. In India, Muskmelon cultivation area is 0.70 lakh hectares with a production reported as 15.10 lakh MT (National Horticulture Board, 2021-22). India is the 3rd largest producer of muskmelon in the world after China and Turkey. Top muskmelon producing states are Uttar Pradesh, Andhra Pradesh, Punjab, Madhya Pradesh and Karnataka. It is commonly known as *Kharbooja* in Telugu and musk melon or cantaloupe in English. This fruit is a warm season crop known for its unique flavour, taste and heat quenching. Muskmelon is popular for its high-water content and cooling effect on human body. Nutritionally this melon is rich in Vitamin A and C having soothing effect in gastrointestinal system. In some regions immature fruits are used as vegetables and their seeds are as dry seeds to add fibre in diet and it is also used for garnishing sweets.

Popular Varieties of Muskmelon in India

Pusa Sharbati, Hara Madhu, Durgapura Madhu, Arka Rajhans, Arka Jeet, Madhuraraja muskmelon, Urja kajri muskmelon, Mridula muskmelon etc. are some of the muskmelon cultivars grown in India.

Stages of Muskmelon, Physical Changes and its Harvesting

Half-slip stage: Fruits are not fully ready for table use but are good for distant market use. Slight pressure is required to harvest fruit from the stem. This stage of harvest is recommended for long distance transportation to acquire distant markets.

Full –slip stage: Fruits are completely ready for table use and best for local market. Gentle pressure is sufficient to separate fruit from the stem. This stage fruits require additional attention to handle then during transportation and marketing. The fruits look creamy colour with glittering netty structure on the surface of the fruit.

Musky flavour: On ripening, the fruits produce a pleasant musky flavour also release a dull, low pitched thud when tapped.

Change in colour: At the fruit ripening stage, the rind becomes soft, fruit skin colour changes from green to yellow. The melons rind looks thick or thin and exhibits different textures ranging from smooth, rough, netted, to scaly.

Full netting: On the fruit surface, a net-like structure is developed.

Post-Harvest Handling

Scientific postharvest handling is necessary to reduce postharvest loss of melon due its susceptibility to mechanical issues. In India, major post-harvest losses are due to improper harvest, handling and transportation. Farmers are unaware about some of the scientific post-harvest operations leading to economic losses to farmers. Lack of grading techniques and distress for sales leads to lesser price of commodity in the market So these operations play crucial role in quality retention and long-term storage during transportation and marketing. Mechanical stress induced bruises and subsequent decay in the fruits leads to secondary infection in fruits. Delay in harvesting and loading may lead to rapid physiological processes resulting consequent loss. Hence harvesting melon at proper time retains aromatic compounds and sweetness. During dumping/unloading of fruits, proper care needs to be taken as fruits highly susceptible to surface injury and cracking.

Sorting and Grading

After harvest, fruits are transported to pack house or local markets or sales by farmers. Diseased, fungal attacked, cracked, damaged and overripe fruits should be sorted out on field. Grading of fruits should be done on the basis of size, colour and melon type will help in fetching good returns in competitive market.

Pre-Cooling

Muskmelon fruits precooled just after harvest from the field will improve its shelf life. It is an important postharvest operation used to remove filed heat of the produce assisting in lowering down of respiration rate and transpiration rate. If this heat is not removed, fruits can degrade prematurely leading to biochemical changes before reaching consumer. Room cooling, icing and forced air cooling are ideal methods of precooling of muskmelon and other melon crops. Force air cooling is more effective and commercial method which is done at 10-15°C. Packaged icing is practised only in cantaloupe melons due to their better returns.

Hot Water Treatment

Fungal rots are common problem during handling of muskmelon deterioration in the quality of produce. Several studies reported the efficacy of hot water treatment in reducing of surface fungal growth and incidence of other rot fungal diseases. It is observed that hot water treatment at 52°C-55°C for 2-3 minutes not only reduce the risk of fungal infection caused by Fusarium and fruit fly infestation but also enhance the storability of produce. A fungicide treatment with postharvest fungicides like imazalil may reduce the risk of fungal infections (Meena *et al*., 2018).

Sorting and Grading

Another important process in packaging and marketing of banana is sorting and grading (O.O. Arjenaki, P.A. Moghaddam and A.M. Motlagh, 2013). These two processes are vital in maintaining post-harvest shelf life and quality of harvested bananas. Sorting of banana includes removal of small, cut fruit from hands which limits the spread of saprophytic microorganisms during postharvest handling of bananas. Grading of banana is based on uniformity of size, colour and maturity level. Commercial banana producers normally use sophisticated systems that require precise sorting and grading standards for their produce. Small-scale producers and retailers in developing countries in contrast may not use written down grading standards; however, the produce must still be sorted and sized to some degree before selling or processing it.

Coating and Waxing

Waxing or coating is defined as covering of fruits with a thin layer of material to provide a barrier for moisture losses, improve appearance and maintain a waxy layer on the fruit surface. Muskmelon shrivels rapidly after its harvest subsequently reduces acceptability by consumers. Waxing or coating of muskmelon fruits is beneficial to maintain its freshness, firmness and colour. It also delays the ripening process and maintains shiny appearance attracting consumer's attention. Muskmelons can be coated with different coating agents like chitosan, aloe vera gel, natural bee wax, shellac wax etc. (with or without antimicrobial agents) by dipping into coating solutions for 10-20 min on the basis of type and nature of coating material (Meena *et al*., 2018).

Storage

Storage at optimum temperature is essential to prolong the shelf life of the fruits. At much higher temperature fruits respire rapidly resulting reduced shelf life. However, at very low temperature fruits are susceptible to chilling injury leading to textural loss. So, it is important to maintain an optimum storage temperature range to curtail storage losses. Muskmelons fruits can be stored in room temperature only for 2 – 4 days. But they can be stored in cold store at 2-4°C and 85 – 90% relative humidity for 2 – 3 weeks.

Transportation

Transportation of the fruits are conventionally by road for farm to market and within states transport. Train transport is used for interstate transport to get remunerative price. Trucks loaded with heaps of melon, aerated plastic cartons or gunny bags are practiced for local transport. To grade melons will be waxed, labelled and cushion packed individually for commercial markets.

Uses

Other than as table fruit, pulp is grind with water and sugar, or occasionally with milk and used as refreshing drink. It is also blended with in ice cream for making milk shakes which adds taste and flavour to drink. Medicinally, ripe fruits are considered good for diseases of the kidney and beneficial for chronic or acute eczema. During the hot summer, fresh ripe fruit consumed as dessert and having cooling impact on body temperature. Seeds are also having diuretic and cooling properties and beneficial for chronic or acute eczema.

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Unlocking the Power of Rootstock: A Fruit Grower's Guide

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Introduction

Rootstock is the lower portion of the graft which develops into the root system of the grafted plant. A rootstock may be seedling, a rooted cutting or layered plant. It is also described a plant which already has an established healthy root system on to which a cutting or bud from another plant is grafted. The plant part grafted on to the rootstock is usually called scion. Rootstocks are being used in plant propagation for more than 20 centuries. It may be a same or different species from the scion (Singh et al., 2021).

Types of Rootstocks

1. Seedling rootstock: These types of rootstocks are developed from the seed. These rootstocks are relatively simple and economical to produce. Root systems of seedling rootstocks are deeper. These are mostly used for tropical and sub-tropical fruit crops. Seedling rootstocks have an advantage that the plant doesn't retain viruses occurring in their parent plant. Seedling rootstocks have a disadvantage of genetic variation which may lead to variation in performance of scion (Goswami, 2017).

2. Clonal rootstock: Rootstocks propagated by vegetatively are known as clonal rootstocks. These also include those fruit crops which have azygotic seeds Viz., pathenogenetic, polyembryonic and apomitic seed. Each clonal rootstock is genetically same and has identical growth characteristics in given environment. Major disadvantage of clonal rootstock is that they retain the viruses occurring in the parent plants. Clonal rootstocks commonly used in temperate region fruit crops (Hartmann *et al.,* 2002).

Characteristics of an Ideal Rootstock

1. It should exhibit a high degree of compatibility with scion cultivars and give maximum life to trees.
2. It should be well adapted to climatic conditions of the particular region like frost, cold and heat.
3. Should be resistant to disease and pest prevalent in the concerned area.
4. Should be tolerant to adverse soil conditions like salt and drought.
5. Must exhibit favourable and positive influence on the performance, bearing and quality of scion variety.
6. Should possess good nursery characteristics like germination, high degree of polyembryony, ability to attain graft-able size in short period and free from excessive branching.

Role of Rootstocks in Mango

One of the most significant tropical fruits in the world, the mango is referred to as the "king of fruits" in India. The usage of polyembryonic varieties for vigour control, salinity and drought tolerance as well as to increase fruit production and quality are some of the initiatives undertaken to standardise the rootstocks for different scion kinds. Mango vigour management is crucial, particularly for high density planting and orchard management strategies for canopy control, harvesting, and plant protection. When compared to other polyembryonic rootstocks, the 'Dashehari' mango's growth and bearing habits indicate the most robust nature and maximum yield.

Fruit quality is a crucial factor, and research on it have been conducted in several nations. No discernible impact of rootstocks (Vellaikulumban, Bappakai, Chandrakaran, Kurukan, Muvandan, Mylepelian and Olour) on the fruit quality of the "Alphonso" mango was found in a 21-year rootstock study performed at IIHR, Bangalore. The polyembryonic cultivars "Olour" and "Bappakai" were able to survive greater saline levels, according to testing of mango rootstocks, and "Olour" was shown to be the best salt-tolerant rootstock when compared to "Kurukan." Mango cultivar '13-1' was chosen as a polyembryonic (3-6 embryos) rootstock for irrigation with salt water or calcareous soils. Chadha, K. L. (2019). Three more cultivars on '13-1' rootstock exhibited strong growth on sandy soil with 10–20% lime, indicating the superior capacity of 'Gomera-1' rootstock to saline conditions. Mango trees on '13-1' rootstocks indicated outstanding performance on soil with 20% lime. With much greater survival rates, germination rates, and growth metrics, seedlings from stone of the 'Kesar' variety were determined to be superior.

Role of Rootstocks in Grapes

Although grapevines may thrive in a broad pH range (4.5–6.5), highly acidic soils are problematic. *V. labrusca* cv. "Concord" and "Catawba," combined with rootstocks "SO4" and "3309C," and the hybrid cultivar "Seyval" are the cultivars most resistant to acidic soils; *V. vinifera* cultivars The most intolerable wines are "Chardonnay" and "White Riesling." It is strongly advised to utilise acid-tolerant rootstocks like "3309C" and "SO4". The grape rootstocks *V. champini* and *V. vinifera* are regarded as salinity tolerant. Shiraz grape cultivars grafted on 'Ramsey', '1103 Paulsen', and '140 Ru' produced wine with greater K+, pH, and colour hue than those grafted on their own seedlings. Researchers have also discovered that the rootstocks "Ramsey," "1103P," and "R2" promote the strong growth of the grape variety "Sultana." Different rootstocks were classified as sensitive (41 B, R. Lot, 110 R, 140 R, and 161-49), moderately tolerant (13-5 and Ramsey), and tolerant (196-17, CH-1, CH-2, and Superior) based on their tolerance to various salt concentrations (0, 50, 85, 120, and 155 mM NaCI. It is also mentioned that the drought resistance categorization of rootstocks may vary from country to country. Hybrids ('110R', '140Ru', and '1103P') from rootstocks *V. berlandieri X V. rupestris* may be utilised in drought-prone locations where water is a limiting factor for grapevine output. In a similar way, *V. berlandieri x V. riparia* hybrids are more drought tolerant. Only a few research have looked at how rootstock influences scion cold hardiness. The rootstock '3309C' possesses the most cold-resistant canes and buds; compared to 'K5BB' and 'SO4', it acclimates in the autumn more quickly and declines more slowly in the spring.

Role of Rootstocks in Guava

Guava is currently not propagated on uniform clonal rootstocks but rather on seedlings grown from open pollinated seeds. The rootstocks *P. cattleianum, P. guinesee, P. molle*, and Philippine guava were all determined to be appropriate. The trees on *P. cattleianum* were the tallest and produced the most fruit. Although the *P. pumilum* rootstock had a dwarfing effect, the fruits grown on it produced the most seeds, greatest TSS, and highest total sugars. The biggest, ascorbic acid-rich fruits, however uneven and with rough skin, were produced by trees on *P. cujavillis*. Except for "Allahabad Safeda," all rootstocks were free of the wilt disease (*Fusarium solani /Macrophomina phaseoli*). 'Allahabad Safeda's' plant height, plant spread, and tree volume are all dwarfed by rootstock aneuploid No. 82. Additionally, they saw a better yield with this rootstock.

Role of Rootstocks in Apple

The kind of material utilised to raise rootstock seedlings in apples varies greatly. In Himachal Pradesh, seedlings of 'Crab C' are utilised as rootstock, whereas in Kashmir, the wild indigenous 'Crab apple' called as 'Trel' is used.In 1937, the Red Delicious, Jonathan, and Rymer cultivars were used in the first apple rootstock experiment at Chaubattia, utilising the rootstocks Crab C, M 2, M 13, Merton 779, Merton 793, and "Local Selection" (seedling selection from "Ribbistin Pippin"). Extensive varietal cum-rootstock trials were started at Mashobra in 1967, Kotkhai in 1968, Chaubattia in 1969, and several locations in J & K in 1969 following the introduction of M and MM series of rootstocks during the early 1960s at Mashobra and Kotkhai in HP, Chaubattia in UP, and Shalimar in J & K. As a consequence, numerous viable rootstocks were found for various apple-growing locations in India, including Merton 779, MM 106, and M 13 for Uttarakhand, M 2, M 4, M 7, and M 9 for J&K, and M 7, M 9, and M 26 for Himachal Pradesh. The M 2 rootstock responds to 'Red Delicious', 'Jonathan', and 'Rymer' in early stages (5th and 10th years) in Chaubattia, where there was profuse bearing and excellent yield. Later years (20th and 25th years) saw maximum yields for "Merton 779" and "Crab C" rootstocks, however after the 35th year, Merton 779 and M 13 rootstocks generated better yields than other rootstocks. Chadha, K. L. (2019). The fruit set, yield, and yield efficiency of apple trees grafted on MM 106 rootstock were considerably greater than those grafted on M 7. These rootstocks were deemed to be more drought tolerant than M 2, M 7, M 9, M 25, M 26, and MM 109 because 'Starking Delicious' on MM 111, MM 106, MM 104, and M 4 rootstocks showed less reduction in growth, photosynthetic efficiency, and nutrient uptake, and had higher stomatal resistance, lower transpiration rate, more accumulation of proline, ABA, and carbohydrate under water stress (10 bar).

Role of Rootstocks in Pear

Pears have fewer options for rootstocks than apples do. In terms of vigour, hardiness, and compatibility, domestic pear seedlings (*Pyrus communis*) continue to be the rootstocks that are most suited for pear cultivars. However, fire blight may affect any pear tree growing on seedling roots. *Pyrus calleryana* seedlings may thrive in a variety of soil types and exhibit moderate development. Although it is resistant to fire blight, it isn't very winter hardy. *Pyrus betulaefolia* seedlings may thrive in a variety of soil types, and they can withstand harsh winters. The trees are robust, bigger than "Bartlett seedlings," and only somewhat fire blight resistant. *Pyrus ussurensis* may be utilised as a cold hardy, pear psylla, and fire blight resistant tree. Chadha, K. L. (2019).

Role of Rootstocks in Stone Fruits

In India, the cherry plants are cultivated on 'Paja' (*Prunus cerasoides*) seedlings whereas the stone fruits, such as peach, plum, apricot, and almond, are often propagated on its own seedling. 'Behmi (*P. mira*)' is often used as an almond rootstock. In three almond rootstocks exposed to soil salinity, the relative contribution of organic and inorganic solutes to osmotic adjustment revealed that salinity affected leaf water and osmotic potentials in GF677 and Bitter almond but less so in GN15, indicating a higher selectivity for K+ and Ca2+ against Na+ in this latter rootstock. As a rootstock for peach plantations, peach seedlings themselves are employed, along with plum, apricot, and almond seedlings. The majority of peach seedlings are nematode susceptible, while '*Nemaguard*' and 'Okinawa' demonstrated resistance to nematode assault. Additionally, some nurseries employ the 'Behmi' (*P. mira*) rootstock for peaches. Apricot may be used as a rootstock that is resistant to the root knot nematode. Almond, Nanking, and Western Sand Cherries are dwarfing rootstocks for peaches. For Plum (*P. domestica*), varieties like "Brompton" and "Common plum" from; "St. Julien," "Common Mussel," and "Damson" from *P. institia*; "Myrobalan" from *P. cerasifera*; and "*P. persica*," "*P. armeniaca*," and "*P. amygdalus*" are used as rootstocks in other nations. Peach, apricot, behmi (a naturally occurring cross between an almond and a wild peach), and plum seedlings are often used as rootstocks in India. In other nations, Hazard (*P. valium*) and Mahleb (*P. mahaleb*) seedlings are the most common cherry rootstocks, with Stockton Morello (*P. cerasus*) also being used on occasion. 'Paja' (*P. cerasoides*) is the most popular rootstock in Kashmir, Himachal Pradesh, and the Kumaon Hills of Uttar Pradesh in India, however older plantings are almost always on Mazzard or Mahaleb rootstocks. The seedlings of 'Russian sour cherries' may be utilised for *Prunus besseyi* if you want something very hardy.

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Physiological Disorders in Tomato Plants: Management Strategies

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Abstract
Tomato plants (*Solanum Lycopersicon*) are vulnerable to physiological disorders such as blossom-end rot, leaf roll, fruit cracking, and sunscald, which severely affect yield and quality. These issues arise from imbalances in water, nutrients, temperature, and hormones. Effective management is crucial for optimal cultivation. Integrated approaches, combining cultural practices, genetic resistance, and environmental control, offer promising solutions. Foliar applications of calcium and micronutrients, along with growth regulators, help alleviate symptoms and enhance plant resilience. Precision agriculture techniques enable early detection and prevention. By implementing these strategies, growers can mitigate the impact of disorders, ensuring sustainable tomato production.

Keyword: Tomato, physiological disorders, management strategies.

Introduction
Tomatoes are widely recognized as one of the most valuable "protective foods" due to their exceptional nutritional content. With a rich history in Indian cuisine, tomatoes are incredibly versatile and find application in numerous dishes, including soups, salads, pickles, ketchup, purees, sauces, and more. Additionally, they can be enjoyed raw as a salad vegetable. In the realm of value-added processing, few vegetables can rival the versatility and significance of tomatoes.

The quality of tomato fruit for fresh consumption is determined by various factors including color, shape, size, hardness, texture, dry matter content, organoleptic properties, and nutraceutical characteristics (Dorais et al., 2001). It is important for tomatoes to be free from physiological disorders not only for aesthetic reasons but also because these disorders can impact nutritional content and shelf life. Physiological or abiotic diseases are primarily influenced by environmental factors such as temperature fluctuations, moisture levels, imbalanced soil nutrients, excessive or insufficient specific soil minerals, extremes in soil pH, and poor drainage (Khavari-Nejad et al., 2009). Genetic factors also play a significant role. Common physiological problems affecting tomatoes include blossom-end rot, catface, growth cracks, sunscald, yellow shoulder, chemical damage, adventitious root growth, puffiness, blotchy ripening, gold spots/specks, and chilling injury. These disorders can severely reduce crop productivity. Below are descriptions of the symptoms, causes, and potential treatments for these disorders.

Blossom-End Rot
Blossom end rot is a prevalent issue affecting both green and ripe tomatoes. It manifests as a light tan lesion with a water-soaked appearance, which gradually enlarges, darkens, and develops a leathery texture. While blossom end rot initially causes localized damage, secondary organisms often invade the lesion, leading to complete fruit rot. This condition is particularly prevalent in tomatoes undergoing rapid development, especially during hot and dry weather conditions, with the earliest maturing fruit being the most susceptible.

Blossom-end rot arises from a localized deficiency of calcium in the distal end of the tomato fruit. Due to the low mobility of calcium within plants, even brief fluctuations in water supply can trigger this deficiency, particularly under conditions of moisture extremes. Factors like elevated salinity, ammonium nitrogen utilization, and high relative humidity further impede calcium uptake by plants, exacerbating the issue.

Rapidly growing plants are more prone to this disorder. Effective management involves proper fertilization, water regulation, and the utilization of blossom-end rot-resistant cultivars. Soil testing is recommended to assess calcium deficiency. Preventative measures include liming with high-calcium limestone several months before planting. In cases of calcium deficiency, foliar application of anhydrous calcium chloride can be beneficial (Masarirambi et al., 2009).

Fig. 1. Blossom-End Rot

Catface

The cat face tomato exhibits deformation at the blossom end, characterized by heightened scarring and the presence of holes. Any irregular growth condition during the flowering stage induces deformation of pistil cells. Subsequently, cells in the ovary's blossom end undergo necrosis, resulting in the formation of black, leathery patches towards the fruit's extremity. These abnormalities arise from exposure to cold temperatures during flower set, which disrupt and damage specific cells responsible for fruit development. This anomaly is primarily observed in newly formed fruit.

Fig. 2. Catface

Maintaining optimal soil moisture levels and adhering to recommended cultural practices are essential for managing cats facing tomatoes. In greenhouses, heating to prevent low temperatures can help reduce cats facing incidence. Temperature regulation during transplant growth for field planting is crucial. As warmer weather prevails, cat facing occurrences are expected to decrease (Babadoost, 2014).

Fruit Cracking/ Growth

Cracking on the surface of tomato fruit, particularly at the stem end, is a common occurrence, predominantly observed in fully ripe fruit rather than those at the mature green or breaker stage. Fluctuations in water supply, leading to rapid fruit growth and subsequent rupture, are primary contributors to this phenomenon, influenced by both genetic predisposition and environmental conditions. Two main types of cracking are typically observed: radial cracking, where fissures extend from the pedicel end to the stylar end, and concentric cracking, characterized by circular breaks around the stem scar, sometimes evident even in the green stage at the fruit's shoulder. This cracking is closely associated with swift fruit enlargement and significant fluctuations in water availability to the plant. Additionally, prolonged periods of drought followed by intense irrigation, as well as fluctuations in day-night temperatures and high humidity levels, can exacerbate cracking. Furthermore, a deficiency in boron, particularly in calcareous soil, has been identified as a potential contributing factor to fruit cracking (Masarirambi et al., 2009).

Fig. 3. Fruit Cracking/ Growth

Planting tolerant cultivars such as Crack Proof, Ohio 832, Sioux, Supersonic, Jetstar, Anagha, Manulucie, and others can help mitigate growth cracking in tomatoes. Resistant cultivars typically exhibit a thicker pericarp or cuticle, as well as a more flexible fruit skin with lower acidity. These varieties tend to have higher pectin content ranging from 0.8 to 1.6 percent, compared to 0.54 percent in susceptible varieties. Increased pectin content confers greater flexibility to the fruit. Additionally, proper water management, mulching, judicious nitrogen fertilization, and minimizing defoliation due to foliar diseases can aid in reducing fruit cracking. Application of borax to the soil at a rate of 15-20 kg/ha and 0.25 percent borax spraying during fruit development to ripening stages has shown to reduce fruit cracking by 2-3 times.

Sunscald

Sunscald is a condition observed in green tomato fruit upon exposure to sunlight, characterized initially by the appearance of a white, glossy blistered patch. As the fruit matures, the affected tissues undergo necrosis, resulting in a depressed area that may turn pale yellowish and wrinkled. Subsequently, secondary microbial colonization leads to fruit decay. Sunscald primarily occurs in fruit suddenly exposed to sunlight due to pruning, natural plant spreading induced by high fruit load, or loss of diseased foliage. Higher temperatures exacerbate the severity of the damage. Control measures involve prudent pruning and harvesting practices, foliar disease management, and the cultivation of cultivars with thick leaves to shield the fruit from sunlight exposure and minimize susceptibility.

Fig. 4. Sunscald

Yellow Shoulder

Yellow shoulder, alternatively termed yellow top or persistent green shoulder is a condition impacting tomato fruit subjected to sunlight exposure. During ripening, chlorophyll degradation in this region is delayed, leading to the development of a green or yellow patch instead of the typical red hue. The disorder can affect either the entire shoulder or a small portion of it. The outer pericarp of the affected area remains firm and whitish (Babadoost, 2014).

The precise etiology of yellow shoulder remains elusive. However, this condition appears to develop in fruits exposed to elevated temperatures during the maturation and ripening stages. Susceptibility to yellow shoulder varies among tomato varieties, with those exhibiting dark green shoulders being more prone than uniformly ripening types. Management strategies include planting resistant cultivars, minimizing fruit exposure to direct sunlight, and harvesting fruit at the breaker stage (initial pink hue) followed by maturation at room temperature.

Fig. 5. Yellow Shoulder

Fig. 6. Puffiness

Puffiness

Puffiness, also known as hollowness or boxiness, is defined as the presence of open spaces between the outer walls and the locular contents in one or more locules. Puffer fruit are disliked by customers because they lack gel in the locules and are difficult to transport due to their softness. Genotype and growth circumstances that result in incorrect pollination influence the amount of fruit impacted. Any factor that influences fruit set, such as insufficient pollination, fertilization, or seed development, may create this. Puffiness has been linked to extremes in temperature (low K and high N) as well as wet weather. Maintaining a constant temperature and spraying Borax at a concentration of 10-15 ppm during peak blooming period may help to decrease puffiness.

Chilling Injury

Chilling damage in tomatoes occurs within the temperature range of 0 to 12.5 degrees Celsius and can initiate in the field prior to harvest. Tomatoes exhibit sensitivity to cold if stored for over 2 weeks at temperatures below 10°C or for more than 6-8 days at 5°C (Suslow and Cantwell, 2009). The severity of damage correlates with the duration and degree of cold exposure. Symptoms vary based on fruit maturity, with green mature fruit being more susceptible than pink fruit. Freezing damage results in failure to ripen, inadequate color and flavor development, patchy coloration, premature softening, surface pitting, seed browning, and increased susceptibility to decay, particularly black mold caused by Alternaria spp.

Chemical Injury

Herbicides pose a significant risk of chemical damage to tomato plants, particularly phenoxy herbicides such as 2,4-D and dicamba. These herbicides, classified as hormone-type chemicals, are commonly utilized in weed-control formulations for various agricultural settings including lawns, pastures, and grain crops. Their application carries the risk of drift, where the herbicides may unintentionally move to non-target areas upon contact with water. Symptoms of phenoxy herbicide damage in tomatoes include deformation of new growth, typically observed following herbicide application. Affected young leaves display thinness and pointedness, often curling downward. To mitigate herbicide damage, precautions should be taken to avoid spraying when wind conditions may lead to spray drift towards tomatoes or other susceptible crops. Additionally, employing low-pressure coarse spray nozzles and directing spraying as close to the ground as feasible can help minimize the risk of herbicide damage (Babadoost, 2014).

Conclusion

Tomatoes are susceptible to two primary physiological disorders: blossom end rot (BER) and fruit cracking. In greenhouse tomato production, strategies to mitigate BER include avoiding excessive heat and light intensity, employing organic mulches to reduce the occurrence of calcium deficiency in soil-grown plants, implementing negative DIF (difference in day and night temperature) conditions, and utilizing far-red filters. Among these approaches, controlling humidity fluctuations, along with the first two methods for BER reduction, proves most effective in greenhouse settings. These measures are crucial for optimizing tomato cultivation in controlled environments, ensuring higher yields and quality.

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Rhinoceros Beetle, *Oryctes rhinoceros* (L.) Menace in Coconut

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Introduction

The coconut is *Cocos nucifera* is one of the important edible oil crops widely grown in the coastal tracts of subcontinent. Coconut is one of the components during worship and performing rituals irrespective of religion. The rhinoceros beetle, *Oryctes rhinoceros* (L.), is one of the major pests of coconut in all coconut-growing states. The rhinoceros beetle damage results in yield reduction (5-10 %) and mortality of seedlings, young and old palms in some situations. Rhinoceros beetle attack leads the subsequent attack of red palm weevil and complete death of coconut palm. This pest affects different stages of growth, viz. coconut seedlings, juveniles and adult bearing palms. Severe infestation of young plants leads to reduction in growth and death of the plant. It can also induce considerable yield reduction by the damage inflicted in unopened bunches in bearing palms.

Nature of Damage

The adult beetle alone attacks the palms. The adult rhinoceros beetle bores into the unopened fronds and spathes and the chewed fibres protruding from the holes. Central spindle appears as toppled or cut. The fully opened fronds show characteristic triangular cuts or diamond shaped cuttings.

Biology

The adult female beetle lays oval shaped creamy white colour eggs in manure pits or decaying vegetable matter at a depth of 5 to 15 cm. The fecundity of the female is 140 to 150 eggs. Grubs emerged from the eggs in 8 to 18 days. Grub is stout, sluggish, white "C"-shaped with pale brown head and found at a depth of 5 to 30 cm. Grubs pupates in earthen cells at a depth of 0.3 to 1 m. Adult beetle is stout, brownish black or black and has a long horn projecting dorsally from the head in male and female has short horn.

Management

1. In order to maintain garden sanitation all dead trees should be removed.
2. Collection and destruction of the various bio-stages of the beetle from the manure pits.
3. Spray green muscardine fungus culture (*Metarrhizium anisopliae* @ 5 x 10^{11} spores / m^3 spray 250ml *Metarrizhium* culture + 750ml water) in manure pits to kill the immature stages.
4. During harvest insert the iron hooks in crown region and kill the adults.
5. Keep three naphthalene balls (3.5 g) at the base of inter space in leaf sheath in the inner most leaves of the crown to prevent the colonization.
6. Apply mixture of either neem seed powder + sand (1:2) @150 g per palm or neem seed kernel powder + sand (1:2) @150 g per palm in the base of the inner most leaves in the crown
7. Set up light traps after the first showers in summer and monsoon period to attract and kill the adult beetles.
8. Keep small mud pots which contain 1 kg castor cake in 5 liters of water in the coconut gardens to attract and kill the adult beetles.
9. Installation of rhinolure pheromone trap @ 1/ 2 ha to attract and kill the beetles.

Conclusion

Early detection of rhinoceros beetle infestation, timely application of attractants to check the rhinoceros beetle incidence.

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<tr><td colspan="3">Damage symptom</td></tr>
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<tr><td></td><td></td></tr>
<tr><td>Egg</td><td>Grub</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Pupa</td><td>Adult beetle</td></tr>
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Effect of Heat Stress Indices on Quality of Oilseeds

Article ID: 48867

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Introduction

Oilseeds are ranked fourth in important food commodities after cereals, vegetables, melons & fruits and nuts, they occupy about 213 M ha of the world's arable land (OECD-FAO, 2020). Temperature induced heat stress is articulated as the shift in air temperature exceeding the threshold level for an extended period that could cause injuries or irreversible damage to crop plants in general (Teixeira et al., 2013). Heat stress may affect various agronomic characteristics, such as biomass production, phenology & physiology and yield-contributing traits in oilseed crops. Temperature limits of 35ºC are considered heat stressors in tropics and subtropics (Bita and Gerats, 2013; Awais *et al.,* 2017a; Ahmad *et al*., 2021a; Waraich *et al*., 2021a); however, temperatures above 25ºC are thought to be stressors in rabi (winter) crops (Wahid *et al*., 2007; Abbas *et al*., 2017). Heat stress had a negative impact on seedling growth, as seen by decreased proline content, antioxidant activity, survival rates, and vigor indices. High temperatures negatively impact grain development specifically after fertilization (Begcy *et al*). Due to the increase in heat, the growth and development during the cropping season of many of the crops are affected which results in a reduction in yields and a poor quality of seeds (Sehgal *et al*.). The most significant consequence of terminal heat stress is accelerated seed development, which leads to smaller seeds (Folsom *et al*.). Heat stress impacts a range of physiological mechanisms involved in plant growth (Hameed *et al*.). Processing has a significant impact on the quality of oil seeds, and oilseeds have a number of nutritional characteristics that need to be watched, including oil, moisture, protein, carbs, and fatty acids. Oil yield, seed diversity, seed viability, flavour, and aroma are additional crucial oilseed quality factors. Age, provenance, and color are just a few of the variables that can cause diversity in seeds.

Effect of Heat Stress in Different Oilseed Crops at Different Growth Stages

Heat stress damages plant morphology and is manifested by symptoms on vegetative parts such as leaf sunburn, scorching effects of heat on leaves, twigs, buds, branches, stems, and fruits, reduction in root to shoot ratio, affects plant meristems, and leaf senescence (De la Haba et al., 2014) with subsequent abscission and ultimate reduction in seed yield (Bita and Gerats, 2013).

As temperature increases, the plant development builds up to a certain extent and decreases afterward (Wahid *et al*., 2007). The impaired growth and development symptoms were observed in Brassica (Angadi *et al*., 2000), soybean (Piramila *et al*., 2012), and linseed (Gusta et al., 1997) under high-temperature stress. (Ahmad *et al*. 2021) reported that high temperature (35ºC) during anthesis reduces chlorophyll content, photosynthetic rate, and leaf water status leading to reduced plant growth and seed yield.

Reproductive stage is considered the most sensitive stage to be affected by heat stress in Brassica (Young et al., 2004; Ihsan et al., 2019). The first few hours of the reproductive phase are important in fertilization, as a small spell of heat stress occurs, which can be fatal to the whole process (Xi, 1991).

The disruption of the plant's metabolic functions due to high temperature is associated with a consequent reduction in light interception due to a shortening of the growth phases in terms of both size and time. It also has an adverse effect on carbon assimilation, leading to the formation of small and deformed organelles (Maestri et al., 2002).

Brassica plants have shown a poor seed set when exposed to heat stress (Angadi et al., 2000; Morrison et al., 2016). It has been observed that late flowering to early seed setting is the most susceptible growth stage to heat stress in groundnut (*A. hypogaea*) (Prasad et al., 1999).

The impact of heat stress on important oilseed crops at different growth stages is presented in the following table:

Oilseed	Heat stress/duration	Impact on plant	Growth stage	References
Soybean (*Glycine max* L.)	42/34ºC	Length between nodes and internodes decreased	Seed filling	Allen Jr et al.2018
	45ºC/6 days	Chlorophyll content and yield	Reproductive phase	Khan et al. 2020
	38ºC/8 hours	Decreased seed production	The appearance of the first flower	Cohen et al.2021
	40ºC/14 days	Reduced seed production and yield	Seed fill	Djanaguiraman et al.2011
	42/28ºC	Leaf weight, stomatal density, photosynthesis, and chlorophyll fluorescence	Reproductive phase	Jumrani et al., 2017
Sunflower (*Helianthus annuus* L.)	25ºC/7 days after first anthesis to physiological maturit	Decreased the size of the embryo	Reproductive stage	Chimenti et al.2001
	38ºC/3 weeks	Increased lipid peroxidation and hydrogen peroxide content	Reproductive stag	Razik et al. 2021
	35ºC/7 days	Decreased the seed weight per plant, decreased oil content	Seed fill stage/reproductive stage	Rondanini et al. 2003
	33ºC/6 weeks	Decreased the leaf growth in sunflower	Vegetative	De la Haba et al.2014
Groundnut (*Arachis hypogaea* L.)	34ºC/6 days	Reduction in number of pegs and pods	Reproductive	Prasad et al., 2000
	40ºC/6 days	90% reduction in pod formation	Micro-sporogenesis	Prasad et al. 2001
	40ºC	The photochemical efficiency of PSII decreased	Vegetative	Yang et al. 2013
	41ºC/18 days	Fatty acid profile	Flowering	Lwe et al., 2020

Effect on Storage

The lifespan of seeds in storage is influenced by numerous factors. These include the initial moisture content of seed going into storage, storage gas, temperature, relative humidity, initial viability, and stage of maturity at harvest. Elevated temperatures accelerate numerous enzymatic and metabolic processes, leading to accelerated degradation. High temperatures have a minimally detrimental effect on low moisture seeds but accelerate the deterioration of high moisture seeds by boosting the metabolic activity of hydrolyzed substrates and enzymes. Soybean seeds storing in humid tropical climates that are high in temperature and relative humidity tend to deteriorate quickly resulting in a decline in vigor and viability, which is what causes inadequate germination and a poor plant stand. Furthermore, according to their relative storability index, soybeans are categorized in the least storable group. Therefore, the moisture content of the seed is directly influenced by the relative humidity (RH) of a storage environment. For the majority of orthodox species, the seed's physiological transition point occurred at a comparable relative humidity. The ideal moisture content for storage was determined to be when the seed is in equilibrium with a relative humidity of between 19 and 27%. However, (Ellis et al.) proposed that seeds should be dried to moisture contents in equilibrium with a RH in equilibrium with 11% moisture content at a temperature of 20 °C. The moisture content at this RH was defined as the critical moisture content of a seed lot below which the viability equation was not applicable. Temperature has a significant effect on the thermodynamic properties of seed systems. At constant relative humidity, an increase in temperature causes an increase in water activity. High temperatures accelerate the rate of peroxidation of lipids and the absence of oxygen can inhibit the process.

Conclusion

One significant source of food for human consumption is oilseeds. The reactions of plants to heat stress can range from quantitative to symptomatic. However, the reproductive stage is particularly more vulnerable to excessive heat stress; the outcome of this stage represents the oilseeds' economic value. Plants exhibit several adaptive strategies in response to high temperatures. These mechanisms include a broad spectrum of morphological, physiological, and molecular systems that facilitate plant survival.

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Sulphur and Iron Interaction in Plants in Plants Under Iron Deficiency

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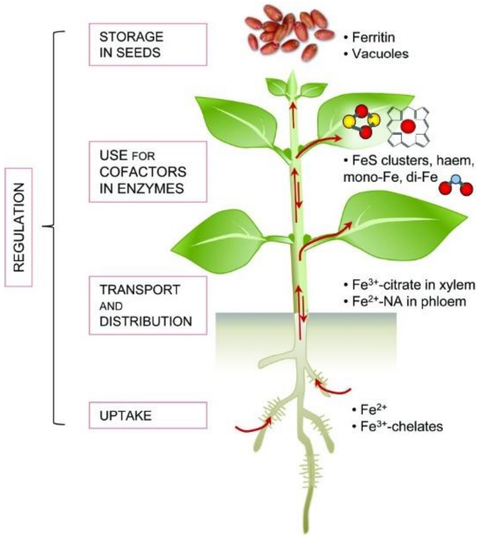
Introduction

1. Iron (Fe) is crucial for the proper functioning of metabolic processes such as respiration and photosynthesis.
2. Redox properties of iron make it an essential element for all life forms.
3. Biological activity of iron is low because it primarily forms highly insoluble ferric compounds at neutral pH levels.
4. It is abundant in the Earth's crust and presents in an oxidized form that is not easily accessible for plants.
5. Plants as primary producers are the gateway for iron to enter the food chain.
6. An imbalance between the solubility of iron in soil and the demand for iron by the plant are the primary causes of iron chlorosis.



Overview of plant iron homeostasis

Sulphur and Iron Interaction in Plants

1. It is well known that Sulfur (S) interact with a number of macronutrients, including N, P, and K, and a number of micronutrients, including Fe, Mo, Cu, Zn, and B.

2. Sulfur shares similar chemical properties with other elements such as Mo and Se, which makes it competitive in the acquisition and transportation process.

3. S-requiring metabolic activities depend on other nutrients or control how plants react to other nutritional deficits (Synthesis of ethylene and phytosiderophores is initiated by S-containing metabolites).

4. Sulphur directly interacts with other elements (like Fe) through the formation of chemical bonds and complexes, such Fe-S clusters.

5. Sulphur is a component of organic compounds, such as glutathione and transporters, that are essential to plants.

Role of Sulphur under Iron Deficiency

1. Sulfur-deficient plants showed a limited ability to accumulate Fe.

2. Barley plants showed that sulfate availability in Iron-deficient growing medium could affect phytosiderophores accumulation in root tissues.

3. Sulphur deficit reduces the rate at which phytosiderophores is released, preventing Iron accumulation in shoots.

4. Sulphur-deficient tomato plants, which restrict the uptake of Fe because Fe3+-chelate reductase is not induced.

5. Decreased iron translocation to the shoot, which is also linked to decreased Fe2+ transporter (IRT1) expression and activity.

6. The biosynthesis pathways for ethylene and NA require sufficient availability of Sulphur.

7. Sulphur-adenosylmethionine is the precursor of ethylene, biotin, polyamines, NA, and many other secondary metabolites, such as phytosiderophores.

8. Sulphur-Adenosyl methionine is the essential substrate for several enzymes and the methyl donor in the alteration of DNA and RNA.

9. Cysteine is also the precursor of the tripeptide glutathione (γ-glutamylcysteinglycin) and S-donor for Fe/S-cluster synthesis.

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Empowering Hill Communities in Manipur through Cassava/U-Mangra Chips: A Pathway to Economic Development and Entrepreneurship

Article ID: 48869

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Summary
Manipur has always been known for its culture, tradition, literature, sports, and cuisine taking into consideration the geographical landscape, location, weather, and connectivity as its serves as the gateway to the South Asian countries from India. The resource is abundantly available whether it may be fruits, vegetables or medicinal plants. And there is a use of all of these from generations in Manipur if they don't know the scientific reasons as to why it is beneficial for our health, nutrition point of view or even treated when someone is sick. So, amongst all the fruits and vegetables found in Manipur, Cassava is as such a crop which has lots of potential and can generate a wholesome of income for the cassava farmers. Cassava is mainly harvested and consumed as a source of carbohydrates from time immemorial which is either boiled or extract the starch and convert these in different forms like flour etc. So, this article will highlight the potential of cassava as a value-added product i.e. chips and cover various aspects of how one can get the basic awareness, technical knowledge, and processing ideas to build a self-stable, affordable, and at the same time profitable small-scale business. It will also empower the people specially the hill communities where they try very hard for their survival with the small farming and that lacks an income to feed their entire family.

Introduction
In Manipur, cassava is widely grown by farmers in a number of districts. Cassava farming is facilitated by the state's ideal agroclimatic conditions. Cassava is recognized for its versatility to many types of soil, and farmers in Manipur plant the crop using stem cuttings. Due to its adaptability, cassava is a valuable crop in Manipur for both commercial and subsistence farming, helping to provide cash for the local community and ensure food security. Manipur is an excellent place to cultivate cassava, especially in the hills. It may thrive in semi-arid regions with little water requirements. It's possible that people in Manipur once consumed cassava when there wasn't enough grain. In the past, it served as a source of carbohydrates and was eaten for lunch instead of rice by residents of hilly regions. Additionally, it's still typically consumed nowadays for both afternoon tea and breakfast in the morning. It is one of Manipur's principal tuber crops, and the soil in the hills is especially conducive to growing it. While cassava comes in a variety of types, farmers in the hill district are beginning to choose CAU Umangra1 variety. Umangra1 cassava, in contrast to conventional cassava, is larger, more flavourful, and simpler to grow. Compared to conventional cassava, they have a larger yield and are produced closer to the plant, thus they require less space when planted (Bijaya, 2021). This comprehensive article outlines a strategic initiative to empower hill communities in Manipur through the production and promotion of Cassava/U-Mangra chips as a value-added product. By leveraging the abundant cassava resources in the hilly regions of Manipur, this article also aims to generate additional income, support skill development, and foster entrepreneurship among the local population. Through collaborative efforts involving government agencies, NGOs, and community stakeholders, the proposed intervention seeks to create a sustainable economic ecosystem that enhances livelihoods and contributes to the overall development of Manipur's hill regions.

Rationale for Cassava Chips Production
Explanation of the value-added benefits of cassava chips, including extended shelf life, market demand, and higher profit margins compared to raw cassava is required for the hilly people who know less about the processing and value addition so that they can earn knowledge and at the same time profit.

Analysis of market trends and consumer preferences, indicating a growing demand for snack foods and processed products in Manipur and neighbouring regions is also required so that the demand and supply including the trends at present can be understand.

Strategies for Implementation

1. Capacity Building and Training: Establishment of training programs to enhance farming techniques, post-harvest handling, and cassava processing skills among hill farmers and entrepreneurs. Considering the large-scale cultivation of cassava in Ukhrul, Kangpokpi, and Kamjong the centre for tuber research is conducting vocational training, and formation of FPO in connection with promotion and popularization of tropical tuber crops (Sheela, 2021).

Collaboration with agricultural extension services, research institutions, and industry experts to deliver comprehensive training modules tailored to local needs.

2. Infrastructure Development: Investment in processing facilities, storage units, and transportation networks to support the efficient production and distribution of cassava chips.

Utilization of existing community centers or establishment of processing cooperatives to promote collective ownership and resource sharing.

3. Market Access and Promotion: Development of branding strategies and marketing campaigns to position Manipur's cassava chips as a premium product in regional and national markets.

Participation in trade fairs, food festivals, and promotional events to showcase the quality and diversity of cassava chip offerings from Manipur's hill regions.

4. Policy Support and Institutional Coordination: Advocacy for supportive policies and regulatory frameworks that facilitate cassava value chain development, including incentives for Agro-processing enterprises and small-scale farmers.

Collaboration with government agencies, NGOs, and private sector partners to streamline coordination, resource allocation, and monitoring of project activities.

Expected Outcomes and Impact

Economic Empowerment: Increased income opportunities for hill farmers and entrepreneurs through cassava chip production, leading to poverty alleviation and improved livelihoods. Adding value to low-cost cassava (tapioca) will double the agricultural income of the Manipur's farmer (Ngachan, 2016).

Skill Enhancement: Enhanced technical skills, entrepreneurship capabilities, and market orientation among hill communities, contributing to human capital development and employment generation.

Sustainable Development: Strengthened resilience of hill ecosystems and communities through sustainable agricultural practices, value addition, and market diversification.

Cassava Chips Production

First, the cassava roots were properly cleaned under flowing tap water to remove adhering dirt, soil, and undesirable materials. The outer thick skins were peeled out manually with the help of knife or it can be easily peeled off with hands. Peeled cassava roots were thoroughly washed again with clean water. The peeled cassava roots were then sliced in slicing machine with a thickness of 1-3 mm. The cassava slices were then blanched in hot water at a temperature under boiling point for 3-5 minutes to make slices soft and to inactivate the enzymes. It is also done to prevent unwanted color changes. After blanching the slices were transferred into a stainless-steel container filled with chilled water for around 2-5 minutes to stop the process of heat treatment. After cooling the excess water was drained out. Blanched cassava slices were then spread on muslin cloth one by one and kept under the fan to remove the surface moisture from the slices. They are then dried till desired moisture is removed from the slices. After drying, slices were fried using deep fryer in Palmolein oil at 160-180°C for 2-4 minutes. The fried casava chips were then taken out from the deep fryer and kept on tissue paper to absorb the excess oil. Finally, the cassava chips were seasoned with spices, salt etc. and packed in suitable packaging material like polypropylene, aluminum coated pouches etc.

Conclusion and Way Forward

Emphasis on the transformative potential of cassava chips production in driving economic growth, social inclusion, and environmental sustainability in Manipur's hilly regions. Call for continued collaboration, investment, and innovation to realize the full potential of cassava value chain development as a catalyst for holistic development and empowerment in Manipur.

Fig 1: Raw Cassava

Fig 2: Cassava Chips

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Role of Biofortification in Horticulture Crops

Article ID: 48870

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The increasing population, lack of proper nutrition, and hunger are the most significant challenges faced by many countries worldwide.

The deficiency of vitamins and minerals is of major public health concern. Vitamin deficiency, especially vitamin A deficiency (VAD), is dominant in many developing nations and is the leading cause of death in these nations. VAD leads to >600,000 deaths among women and children across the globe every year specifically the kids.

Conventional, and transgenic breeding methods. Biofortification is undertaken in many fruit crops like banana, cassava, beans, tomato, orange sweet potato (OSP), cowpea, pumpkin, and so forth. Also, few traditional and transgenic varieties have been released, while many varieties are in the development pipeline.

Need of Biofortification Vitamin A deficiency (VAD) is a major public health concern in developing countries, especially among children and women of reproductive age, with an estimated 600,000 fatalities per year among children under the age of five. According to data provided to the World Health Organization (WHO) by the Government of India, 62 per cent of all preschool-age children have VAD. Deficiencies in iron (Fe), zinc (Zn), and selenium (Se) are critical public health concerns as well as significant soil limits to crop productivity, especially in developing nations.

Biofortification Challenges Some of the challenges faced in biofortification and introducing biofortified food grains as part of the daily diet in India are discussed below. Due to the color changes in the grain, people hesitate to accept biofortified food as in the case of golden rice. Farmers also should adopt this technology on a large scale. The initial costs also could be a barrier for people to implement.

Worldwide Recognized Successful Bio Fortification Attempts in Fruit and Vegetable Crops Pro-Vitamin 'A' and Iron Biofortification in Banana The banana project, Banana21, has the key mission of "Alleviating micronutrient deficiencies in Uganda through biofortification of the staple food of Uganda, bananas". The initial targets for the project were a fourfold increase in pro-vitamin A and a threefold increase in iron. The concept is that the micronutrient enhanced bananas for Uganda will be generated in Uganda by Ugandans. B-Carotene Biofortification in Sweet Potato Orange fleshed sweet potato (OFSP) is orange coloured, β-carotene enriched variety of sweet potato, staple crop in Africa. OFSP cultivars i.e. Ejumula and Kakamega, were officially released in April 2004 in Uganda and proved to be one of the most successful examples of biofortified crop till date,

B-Carotene, Iron, and Protein Biofortification in Cassava BioCassava Plus (BC+) is a cassava biofortification project funded by the Bill and Melinda Gates Foundation for engineering increased accumulation of β-carotene, iron, and protein in cassava. β- carotene enrichment of storage roots in cassava is conferred by two transgenes: the Erwinia crtB phytoene-synthase gene, and the Arabidopsis 1-deoxyxylulose-5. phosphate synthase (DXS) gene. Increased iron content was achieved by the expression of the FEA1 gene, from *Chlamydomonas reinhardtii*, in cassava storage roots. In the transformed lines, the relative amounts of all-trans-β-carotene, the most nutritionally efficacious form of carotenoid provitamin A, were 85 to 90% of the total carotenoids content. Iron content in the GM events ranged from 30 to 40 µg/g dry weight in storage roots compared to 10 µg/g dry weight in the wild type (Sharma et al., 2017).

Iron and Zinc Biofortification in Beans: The high seed mineral, red-mottled common beans (Phaseolus vulgaris L.) i.e. NUA35 and NUA56 have been developed by the International Center for Tropical Agriculture (CIAT). The seed iron content was 18 and 23 mg/kg higher for NUA35 and NUA56, respectively while zinc content was 8 and 7 mg/kg higher, respectively, than CAL96, which is a commercial cultivar in Colombia and Uganda.

Iodine Biofortification in Pepper: Li et al., 2016 in their experiment with iodine biofortification with pepper (*Capsicum annuum* L.) revealed that the iodine content of the pepper fruits grown in 0.25–5.0 mg/L KI solutions can amount to 350–1330 g/kg FW, matching the 150 g d−1dietary iodine allowance recommended by WHO. Thus, pepper can be used as a candidate crop for iodine biofortification. In addition, low-moderate levels (0.25–1.0 mg/L) of iodine application improved the fruit quality by enhancing the ascorbic acid and soluble sugar contents, and by reducing the total acidity of pepper fruits as well.

Zn Biofortification in *Brassica oleracea* cv. Bronco: Results of the experiment conducted by Barrameda-Medinaa et al, 2017 indicate that supplementation of 80–100 M Zn is optimal for maintaining the normal growth of plants and to promote the major Zn concentration in the edible part of B. oleracea. Any further increase of Zn supply induced an accumulation of total amino acids, and increased the enzymatic activities involved in sulfur assimilation and synthesis of phenols, finally resulting in a foliar accumulation of glucosinolates and phenolic compounds. Thus, it could be proposed that the growth of *B. oleracea* under 80–100 M Zn may increase the intake of this micronutrient and other beneficial compounds for human health.

Conclusion

Biofortification is a reasonable alternative to reach malnourished populations in relatively remote rural areas, for delivering naturally fortified foods to people with limited access to commercially marketed fortified foods, which are more readily available in urban areas. To achieve more biofortified food items in daily diet of common people, it is very essential to combat the obstacle in the biofortification process with collaborating effort of scientist from all three essential sector i.e. Horticulture, nutrition science and molecular breeding.

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Estimate the Share of Agricultural Export to Total Exports During the Post Reform Period

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Introduction

The goal of the current study was to estimate the share of Agricultural exports to total export during 1990–1991 to 2019–2020. The entire study period was divided into three decades: decade I (1991-2000), decade II (2001-2010), decade III (2011-2020).

This makes this time period a special time for the present study. The periods were classified as below.
Period I: 1991 to 2000
Period II: 2001 to 2010
Period III: 2011 to 2020
Overall Period: 1991 to 2020.

Results and Discussion

Table.1. represents the Percentage of Agricultural exports to total national exports during post reform period 1991-2020.

Table.1. Percentage of Agricultural exports to total national exports during post reform period 1991-2020.

Year	Agricultural exports	Total National exports	% share of Agricultural exports
1990-1991	6012.76	32527.28	18.49
1991-1992	7838.13	44041.81	17.80
1992-1993	9040.3	53688.26	16.84
1993-1994	12586.55	69748.85	18.05
1994-1995	13222.76	82673.4	15.99
1995-1996	20397.74	106353.4	19.18
1996-1997	24161.29	118817.3	20.33
1997-1998	24832.45	130100.6	19.09
1998-1999	25510.64	139751.8	18.25
1999-2000	25313.66	159095.2	15.91
2000-2001	28657.37	201356.45	14.23
2001-2002	29728.61	209018.97	14.22
2002-2003	34653.94	255137.28	13.58
2003-2004	37266.52	293366.75	12.70
2004-2005	41602.65	375339.53	11.80
2005-2006	49216.96	456417.86	10.78
2006-2007	62411.42	571779.28	10.92
2007-2008	79039.72	655863.52	12.05
2008-2009	85551.67	840755.06	10.18
2009-2010	89341.5	845533.64	10.57
2010-2011	111019.99	1142922.92	9.71
2011-2012	180528.60	1465959.39	12.31
2012-2013	223618.24	1634318.84	13.68
2013-2014	262778.96	1905011.09	13.79
2014-2015	239681.04	1896445.47	12.64
2015-2016	215396.55	1716378.05	12.55

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2016-2017	226651.91	1849433.55	12.26
2017-2018	251563.94	1956514.53	12.86
2018-2019	274571.28	2307726.19	11.90
2019-2020	252976.05	2219854.17	11.40

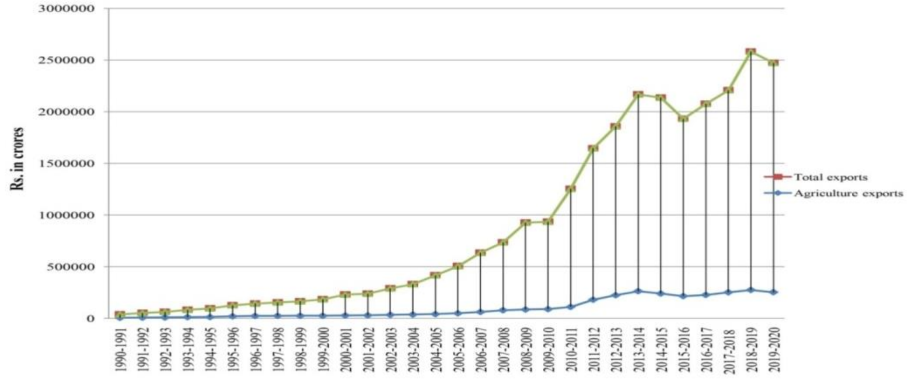

FIG 1. Agricultural exports in total exports

Table.2. Commodity Wise Share of Agricultural Exports in India During Post Reform Period 1991-2020 in Percentage:

Commodities	1991-2000	2001-2010	2011-2020
Basmati rice	11.35	9.09	12.6
Non-basmati rice	24.8	13.9	8.8
Sugar	3.18	3.78	8.2
Ground nut	1.59	7.05	7.8
Cashew	12.5	5.6	3
Tobacco	5.47	1.99	3.8
Oil meals	14.8	5.9	6.5
Fruits/vegetable seeds	19.2	17.2	6.5
Pulses	1.41	2.03	8.7
Wheat	1.7	2.6	2.9
Tea	16.4	5.2	2.6
Spices	13.2	9.8	7
Castor oil	4.39	2.6	1.3
Marine products	18.74	4.94	11.1
Shellac	0.55	0.25	0.17
Sesame seeds	2.05	1.63	0.88
Cotton	4.7	5.8	7.9
Guar gum	2.76	1.67	8.99
Cashew nutshell liquid	0.022	0.021	0.011
Coffee	10.2	3.7	5.4
Livestock products	16.09	6.07	11.97

From 1991 to 2020, the share of Agriculture exports in total exports declined from 18.49 percent to 11.40 percent. This is because of mainly,

1. India began utilizing its agricultural output as a source of raw materials for its domestic industry.
2. Decline in the percentage share of its traditional products, such as food grains and tea.
3. An increase in the proportion of manufactured goods.

Conclusion

On the basis of the discussion above, it can be concluded that share of Agricultural export to total export is high in 1996-1997 with 20.33 per cent, but overall, it was decreased from 1990-1991 to 2019-2020 with 18.49 per cent to 11.40 per cent because of low commodity prices on the global market. Individual commodities share in decade I, II and III is more among the Basmati rice, non-basmati rice, tea, spices, cashew kernel, fruits/vegetables, others.

Policy Suggestion

India needs to entice private capital for its infrastructure and export-focused projects. The secret to increasing agricultural exports will be private industry-led agricultural research and development (R&D) and increased government spending on infrastructure.

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Role of Women in Agriculture and Allied Fields

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The expansion of the agriculture industry and other related sectors has been greatly aided by women. Region-to-region variations exist with regard to women's engagement in agriculture. Historians claim that women were the first to tame the crop and establish the art and science of farming. In most poor countries, including India, women are thought to contribute more to post-harvest operations than to other agricultural jobs. Post-harvest activities like as packing, grading, cleaning, storage, and drying are mostly performed by women.

Women do all aspects of agriculture, including clearing land, planting, maintaining nurseries, transplanting, weeding, irrigation, applying fertilizer, protecting plants, harvesting, and winnowing, storing, and other tasks. Rural women might augment their income by selling milk and cattle. Women have a vital role in the management of animals, particularly goats, poultry, dairy, piggeries, fishing, and the rearing, processing, and selling of goats. They are also responsible for providing care, gathering feed, and attending births.

Women are considered as being highly involved in the agricultural and allied sectors, whether by traditional or contemporary means. It is imperative that the contributions made by women to agriculture and related industries be acknowledged. Women farmers perform over 80% of the field work in agriculture, including dairy management, post-harvest handling, and planting to harvesting. The woman's production and productivity are low due to the tedious work and her lack of knowledge about the newest technological advancements. It is imperative to alleviate the menial work of female farmers and render their endeavors productive and cost-effective.

Statistics of Women Participation in Different Crops and Allied Sectors

1. Women role in Agriculture: According to annual periodic labour force survey 2021-2022, 78 per cent of female labour force participates in agri sector which is supposed to be the highest figure compared to participation in other sectors. For many years, Indian rural women have contributed to this industry, but mostly as laborers on their own fields rather than as "farmers."

2. Women role in Diary management: Nearly, (70%) of woman are involved in various Diary farming activities such as cleaning animal shed, utensils used for milking and feeding purposes, watering and feeding the livestock taking care of newborn calves, milking of animals, processing and preparation of the milk value added products

3. Women contribution in Pisciculture /Fish farming: The 72 per cent of women perform different activities like sorting of fish, cleaning, drying, curing and packing by standing for long hours to complete the task .

4. Women contribution in Horticulture: About, 80% of women involvement is more in various activities related to horticulture like plantation, fertilizer application, weeding, harvesting, sorting, grading packing and selling the produce in local market

5. Women role in Poultry management: Women (88%) involved in poultry management are mainly responsible for taking care of poultry like feeding watering, egg gathering, hatching and various cleaning operations performed at back poultry.

6. Women role in Miscellaneous Activities: Women play a major role in rural and tribal areas to collect Fodder and fuel wood. Kitchen gardening (90%) collection of water and selling of produce and post harvesting processing.

Challenges that Female Farmers Encounter

1. Unpaid labor force: Female farmers in India work about 3,300 hours planting and harvesting fields during the harvest season, more than double the 1,860 hours of their male counterparts. Despite this, the government underestimates and ignores their efforts to feed their families and the country. In India, one-third of women farmers work for free on family farms owned by their parents, husbands or in-laws. (Humera, et al., 2009).

2. No title, no money: Women who own significant property and inheritance rights earn nearly four times more than males, but most of the women don't own lands on their names.

3. Limited access to justice: Women's access to the judicial system is restricted in India. But if agricultural firms filed a claim in a distant jurisdiction in the future, it would put female farmers, who lack the means of transportation and money to travel, at an even greater disadvantage.

4. Inequality in market access: The open markets enable farmers to purchase or sell agricultural goods anywhere in the nation, yet gender discrimination has made female farmers in India significantly less mobile than male farmers, who may have restriction their access to marketplaces.

Strategies to Encourage Women to Work in Agriculture

Developing women's leadership in agriculture calls for diversified strategies. Numerous techniques and approaches have shown to be successful in encouraging their economic empowerment and active participation:

1. Obtaining Ownership of Land: Promoting land titles for women are essential. Legal recognition of their property rights ensures access to financial resources and government benefits.

2. Instruction and Practice: It is essential to support women's education in contemporary farming methods, agriculture, and money management.

3. Monetary inclusion: Access to credit and other financial services, particularly in the countryside, allows women to build their own farms and businesses.

4. Market Links: It is imperative that women farmers have fair pricing mechanisms and market access. This guarantees that the fruits of their labor will be financial gains.

6. Adoption of Technology: Productivity can be increased by encouraging the use of contemporary agricultural technology, such as mechanized equipment and irrigation systems.

7. Policies: Promoting gender-sensitive programs and policies that deal with the unique difficulties of those women in agriculture face.

8. Women's Cooperatives: Women's agricultural cooperatives can help pool resources and increase their negotiating power in the marketplace by being encouraged to form.

9. State-sponsored Projects: Recognizing and supporting government programs and schemes that empower women in agriculture.

10. Awareness and Advocating: Promoting gender equality in rural areas and increasing awareness of women's rights in agriculture.

Therefore, women's participation in agriculture is essential to India's rural development, food security, and economic empowerment of women. Notwithstanding various obstacles, women maintain their crucial role in the agricultural industry. Although their contributions are frequently overlooked, it is critical to acknowledge their importance and solve the difficulties they encounter. An all-encompassing strategy that includes financial inclusion, education, legal rights, and supportive policies is needed to empower women in agriculture.

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Hi-Tech Nursery for Quality Transplant Production

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Hi-Tech Nurseries

High Tech Nursery is a combination of poly green house and agrinet house. Vegetative reproduction is used in such nurseries to ensure genetic similarities with the source. These nurseries grow plants in greenhouse, building of glass or a plastic tunnel, designed to protect young plants from harsh weather, while allowing access to light and ventilation. Modern greenhouses allow automated control of temperature, ventilation, light, watering and feeding. Some also have foldback roofs to allow "hardening-off" of plants without the need for manual transfer of plants to the outdoor beds.

Selection of Vegetable Varieties and Hybrids for Raising the Quality Transplants

Enhanced and quality production of vegetables greatly depend upon selection of promising varieties and hybrids that are better adapted to ecologically based production Egg plant, 63.40% Cabbage, 100.00% Cauliflower, 86.40% Chilli, 83.70% Gourds, 73.50% Melons, 89.20% Okra, 92.40% Tomato, 99.30% Beans, 62.20% Onion, 87.30% Peas, 93.50% practices than those currently available, which were bred for high-input agriculture. Selected varieties/ hybrids should use nutrients and water more efficiently, have greater resistance to insect pests and diseases, and are more tolerant to drought, flood, frost and higher temperatures.

Types of Nurseries

Based on time duration:

Temporary nursery: This type of nursery is established in or near the planting site. Once the seedlings for planting are raised, the nursery becomes part of the planted site. There are sometimes called "flying nurseries". This type of nursery is developed only to fulfil the requirement of the season or a targeted project. The nurseries for production of seedlings of transplanted vegetables and flower crops are of temporary nature. Likewise temporary arrangement for growing forest seedlings for planting in particular area can also be done in temporary nursery.

Permanent nursery: This type of the nursery is placed permanently so as to produce plants continuously. These nurseries have all the permanent features. The permanent nursery has permanent mother plants. The work goes on continuously all the year round in this nursery. These can be large or small depending on the objective and the number of seedlings raised annually. Small nurseries contain less than 100,000 seedlings at a time while large nurseries contain more than this number. In all cases permanent nurseries must be well-designed, properly sited and with adequate water supply.

Objectives of nursery: It occupies an important place in artificial regeneration. The following objectives for which nursery is generally made, clearly bring out its importance.

a. Some important species do not seed ever year. Plantations of these species can be raised annually, only by sowing all available seeds in nursery to raise seedlings to be planted out various years.
b. Some species grow very slowly and if the seeds of these species are sown directly in plantation, the seedlings are most likely to be suppressed by weeds and ultimately killed.
c. Success of roadside avenue plantations depends largely on planting tall and sturdy plants which can be only obtained from nursery.
d. Plantations of some species, when raised by direct sowing are not so successful when raised by transplanting their seedlings. In such cases, nursery is an essential part of artificial regeneration to these species.
e. The best method for introduction of exotics, tropical Pines, Poplars Eucalyptus etc. is only by, planting and therefore nursery is very essential for them.

Benefit of Raising Seedlings in Nursery

1. It is very convenient to look after the tender seedlings.
2. It is easy to protect the seedlings from pests and diseases.
3. Valuable and very small seeds can be raised effectively without any wastage.
4. Uniform crop stand in the main field can be maintained by selecting healthy, uniform and vigorous seedlings in the nursery itself.

Selection of Site

Site is the basic requirement of a nursery. Site is a place upon which one can produce seedlings of plants. Qualities of a good site are:
1. Nearness of road
2. Near a habitat
3. Suitable climate Neither shady nor exposed area
4. Sufficient sunlight
5. Good irrigation facilities
6. Good soil condition
7. Good transport facility.

Rooting Media for Raising Hi-Tech Nursery in Vegetable Crops

The cultivation of plants in systems without soil in situ is defined in literature as "soil-less culture" (Gruda, 2009). Many such systems are based on the use of solid rooting media for growing plants. They are usually called growing media or substrates or potting media. With reference to plant propagation, growing media are defined as all those solid materials, other than soil, which alone or in mixtures can guarantee better conditions than agricultural soil (for one or more aspects). Hence, media of different origin take on the role of soil and provide anchorage for the root system, supply water and nutrients for the plant, and guarantee adequate aeration in the root area (Gruda et al., 2006). All media provide plant support, while the nutrients are provided by added fertilizers. Water and air are provided in the pore spaces in the media. The main functions of rooting media are:
1. Supply of nutrients, air, and water
2. Allow maximum root growth
3. Physically support to the plant.

Characteristics of a Good Rooting Media

1. It should be sufficiently porous so that it is well drained and has proper salinity level
2. It should have good water holding capacity and proper aeration
3. Optimum weight – not too heavy to lift, not so light as to blow away easily
4. Medium should be slightly acidic to neutral. Suitable pH between 5.0 and 6.5 is satisfactory in most of cases.
5. It should be pest free (weed, insect and fungal free).

Rooting media plays an important role in hi-tech nurseries for healthy vegetable seedling production. Usually pro-trays and plug-tray nurseries are used for raising seedlings in hi-tech nurseries in which rooting media are used particularly for (Das *et al* 2018):

   a. Raising seedlings of transplanted vegetables such as capsicum, cauliflower, cabbage, broccoli, Brussels sprouts, tomato, brinjal and chill.
   b. Raising seedlings of directly sown vegetables such as cucumber, bottle gourd, pumpkin, ridge gourds and hyacinth bean etc.,
   c. Suckers of vegetables such as spine gourd and pointed gourd.
   d. Crops viz., ginger and turmeric micro-rhizomes can be sown in the plug trays.

Types of Growing Media

Rooting media used in hi-tech nurseries are highly modified mixtures of organic and inorganic materials. Growing media are primarily divided into organic and inorganic materials. The organic materials include synthetic (like phenolic resin and polyurethane) and natural organic matters (peat, coconut based and composted organic wastes). Inorganic substrates can be classified as natural unmodified sources (sand, tuff and pumice), processed materials (expanded clay, perlite and vermiculite) and mineral wool (rockwool, glasswool). Based on the surface charge activity of materials, these can be distinguished in active (peat, tuff) or inert (rockwool and sand).

The Inorganic Growing Media

Sand: The usual size of sand is from 0.05 to 2.0 mm. Sand increases porosity because of the large particles. It improves aeration and drainage and needs minimum cost incurrence. Quart sand is most useful. However, it has no mineral nutrients. It is relatively inexpensive but heavy. (Miller and Jones, 1995).

Tuff: Tuff is produced from ash and rock fragments ejected during volcanic eruptions. The material is very porous and consists of mostly silicon dioxide and aluminum oxide with small amounts of iron, calcium, magnesium and sodium. It increases aeration and drainage in growing media. Tuffs possess a buffering capacity and may absorb or release nutrients, especially P, during the growth period (Raviv et al., 2002).

Pumice: Pumice is a natural product, a light silicate mineral of volcanic origin. It is used as substrate for vegetables like tomato, cucumber, pepper. Pumice has a low volume weight of 0.4– 0.8 g cm-3 and a TPS of 70–85 percent (Boertje, 1995). Pumice has a neutral pH; it contributes little to plant nutrition, but does not decrease the availability of fertilizer nutrients (Handreck and Black, 2005).

Expanded clay granules: Expanded clay is a granular product with a cellular structure. It is produced by heating dry, heavy clay to 1100 °C: water is released, causing the clay to expand. Expanded clays are light with a low volume weight of 0.28– 0.63 g cm^{-3}; chemically, they are neutral, with a pH of about 7.0 (Raviv *et al* 2002).

Rockwool: It is a fibrous material made from a mixture of basaltic rock and limestone gravel that are converted at high temperature to mineral wool. It has a low volume weight of (approximately 0.07–0.1 g cm-3) and a TPS of 92–97 percent. The main chemical characteristic of rockwool is that it is totally inert, except for some minor effects on pH. It has pH>7 (Jorgensen, 1975; Papadopaulos, 1994). One problem is that rock wool is difficult to dispose after use (Robertson, 1993).

Perlite: Perlite is a natural mineral of volcanic origin which is light weight. The pH is usually neutral to slightly alkaline. Perlite can be used alone or mixed 37 with other substrates for greenhouse plant production. The high porosity helps to control the water-holding capacity and aeration of the substrate.

Vermiculite: Vermiculite is produced by heat treatment of mica. It is porous and light and has a water-holding capacity of three to four times its weight. Chemically it is hydrated magnesium, aluminium, iron, silicate. Similar to perlite, vermiculite is produced by heating the ground and sieved material to 700 to 1000°C. Vermiculite is sterile and light in weight. It is used as a sowing medium, covering germinating seeds, and as a component of potting soil mixtures.

Organic Growing Media

Compost: Compost is the product of organic matter decomposition. Leaves, grass clippings, wood waste, and farm animal manures are some of the common ingredients that are used for compost preparation. Compost contains major and minor nutrients that plants need for good growth. The physical and biochemical properties of compost used as rooting media vary greatly, depending on the materials used, the method adopted and the stage of maturity (Abad et al., 2001).

Sphagnum Moss: Commercial sphagnum moss is the dehydrated remains of acid-bog plants of the genus Sphagnum such as *S. papilliosum*, *S. capillacem* and *S. palustre*. It is generally collected from the tree trunks of the forest species in south Indian hills above 1500 m above MSL during rainy period. It is light in weight, acidic, sterile and has good water-holding capacity.

Peat: Peat is the main component of soil-less media mixes. It consists of the residues from a marsh swamp. It is produced by partial decomposition of plant material under low-oxygen conditions. It consists of at least 30% (dry mass) of dead organic material accumulated on such water-dominated terrestrial surfaces as swamps, fens and bogs (Joosten and Clarke 2002).

Coco peat (Coir pith): The processed coir pith resembles peat and has got many characteristics as that of sphagnum peat, the most common potting media used in horticulture and hence it is commercially known as coco peat. The bricks weigh about 4–5 kg and can expand to 4–5 times of their volume once water is added after loosening them.

Preparing Growing Media for Hi-Tech Nursery

Generally, in hi-tech nursery, rooting media should be soil-less media, light and porous which retains moisture and allows proper drainage and free from weed seeds and any soil borne pathogens or insects. Different types of media combination for plug trays hi-tech nursery (Das et al., 2018):

1. Cocopeat: Sand: FYM: vermicompost (2:1:0.5:0.5) or Cocopeat: Vermiculite: Perlite (3:1:1)
2. Fine soil: Sphagnum Peat Moss: Perlite (2:1:2)
3. Sand: Soil: FYM: Rice Husk Ash (1:1:1:1)
4. Coco peat (70 Kg) and neem cake (1kg) + Azospirillum and Phosphobacteria (each @ 1 kg).
5. Fine Sand for induction of rooting of stem cuttings.

Quality Transplant Production of Vegetables under Protected Condition

Nursery under open field conditions with traditional method is a labour intensive and costly affairs and more over majority of the seedling affected by several biotic and abiotic stresses like, continuous rains, too low and too high temperatures, disease and insect-pest etc., resulting there is wastage of money, labour and time. Controlled conditions include green house, poly house, low tunnel poly house, net house, shade net house etc. where we can raise as well as care the healthy seedlings. Controlled conditions may be created fora small place and seedlings may be raised in plug trays in racks and if it requires additional CO^2, light, humidity may be provided from outside to fulfil the requirements. Water may be given through micro sprinklers. The growth can be stimulated by heating or cooling according to the specific needs of the seed. This technique reduces fluctuations in temperature and moisture that usually occur in open conditions.

Protected Structure

Different types of protected structures are used for quality transplant production. On the basis of cladding material used these are given below.

1. Glass house: Roof and all the four sides of glass house are covered with glass sheets. Greenhouse effect increases temperature inside glass houses. Most of the glass houses are provided with heating systems. During summer, cooling devices are also provided. Temperature, humidity, light and carbon dioxide are also controlled through computerized microprocessor system for providing ideal conditions.

2. Poly-house: Recent advancements in petrochemicals and plastics led to replacement of costly glass houses to less costly poly-houses. Polyhouses are large structures made of aluminium or galvanized iron or locally available wooden materials using ultraviolet stabilized low-density polythene or transparent plastic film as cladding materials for growing plants under controlled or partially controlled environment.

> **a. Low-cost polyhouse:** The cost of establishment of low-cost polyhouse is around`500-1000 per m^2. Low-cost polyhouses are not provided with any climate control device. This is a structure made of 700-gauge polythene sheet supported on bamboo or locally available materials. During winter of mild sub-tropics poly-houses are completely closed at night and as a result temperature inside would be 5-10^{o}C more than outside.
>
> **b. Medium cost polyhouse:** In medium cost polyhouse the covering material used is UV stabilized polyethylene sheets, frame is made up of aluminium rods and the temperature inside polyhouse is controlled by providing "fan and pad cooling system", shade nets and micro sprinklers.
>
> **c. High-cost polyhouse:** The cost of establishment of high-cost polyhouse is around`2000 and above per m^2. It is provided with fibreglass covering along with full climate control devices. Temperature, humidity, light, day length and winds are automatically controlled using computers.

3. Rain shelters: This is naturally ventilated low-cost shelter to protect plants from direct rain. Rain shelters are the most suited protection structures in high rainfall states like Assam and Kerala. It is provided with roof claddings of UV stabilized low density polyethylene film and sides are fully open. Mostly even span structure is used for construction of rain shelters.

4. Tunnels: Tunnel is used for initiating early germination of different summer crops like cucurbits. During rainy season also, a plastic tunnel can be provided to protect mid-season varieties of cucumber raised in nursery against rains (Venkatachalam and Ilamurugu, 2009).

5. Net house: These simple framed structures are of two types, namely shade nets and insect proof nets. Shade nets are perforated plastic materials used to cut the solar radiation so as to protect leaves from wilting/scorching sunlight. These nets are available in three colours i.e., black, green and white and in different shading intensities ranging from 25 to 75%.

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Geospatial and Geostatistical Applications in Precision Agriculture

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Summary
World is on the verge of the digital revolution, so it is the appropriate time to connect agriculture with advanced technologies. Geospatial and geostatistical techniques have a great potential for applications in precision agriculture particularly, owing to ample spectral information sensitive to different soil physico-chemical properties, weather and plant parameters. Continuous spectral information generated using geospatial data helpful in assessment of soil conditions viz., land degradation, mineral identification in soil and rocks, soil organic matter content, soil classification and plant drought and nutrient mapping. Employing the promising capabilities of various models, geospatial tools can help in improving agricultural productivity in a sustainable way. Thus, this review article presented a review of techniques and tools in the context of precision agriculture, future perspectives and critically analyze notions and means to maintain high resource use efficiencies, productivity and higher returns at the field level.

Keywords: Geospatial, geostatistical, precision agriculture, productivity.

Introduction
Global population is going to reach 9.7 billion by 2050 and arable land availability is decrease year wise year and expected to reach 0.15 ha per person (UN, 2022). Since the land availability decreasing over a period of time, there is need to use resources precisely, which leads to the use of precision agriculture for sustainable management. Modern agricultural production relies mainly on monitoring the crop health status, soil condition and effect of fertilizer and pesticide application on the crop yield. Managing all these factors is a major challenge for crop producers. The rapid enhancement in precise monitoring of agricultural crop growth and its health assessment is important for sensible use of farming resources as well as in the management of crop production. Precision agriculture emerges as a transformative approach, offering a suite of technologies capable of enhancing productivity and sustainability. By harnessing the power of geospatial data and geostatistical analysis, precision agriculture enables the meticulous management of agricultural resources. Modern techniques such as Remote Sensing (RS), Geographic Information Systems (GIS), and Global Positioning Systems (GPS) provide critical data and insights, allowing for the optimization of planting, fertilization, irrigation and pest management practices. These technologies facilitate a deeper understanding of the spatial and temporal variability within fields, leading to more informed decision-making and ultimately, more efficient and responsible farming practices.

Precision Agriculture
Agricultural is the backbone of Indian economy, providing livelihood to about 67.0 per cent of the population and contributing approximately 35.0 per cent to the Gross National Product. Precision agriculture (PA) is a management strategy that gathers, analyses and process temporal & spatial and combines it with other information to support management decisions for improving resource use efficiency, productivity, quality, profitability and sustainability of agriculture production. PA emerges as a transformative approach, offering a suite of technologies capable of enhancing productivity and sustainability. By harnessing the power of geospatial data and geostatistical analysis, precision agriculture enables the meticulous management of agricultural resources. PA covers the economic, social and environmental aspects which includes the production functions, efficiencies, net returns, healthy & safe food, conservation rural awareness, minimizing the impact on environment and reducing the carbon footprint level.

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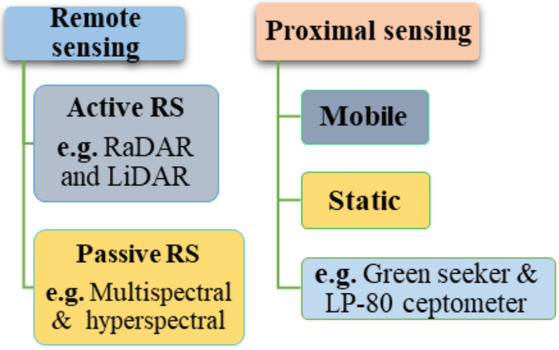
Geospatial Techniques (GT)

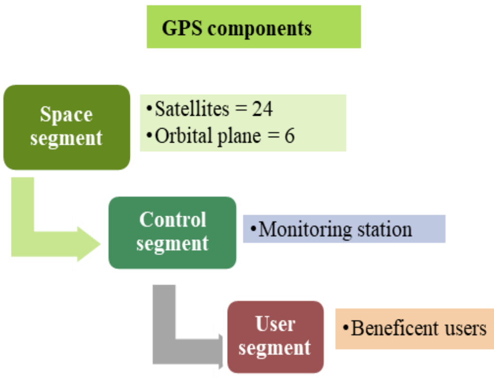
Geospatial is a technique that is used to collect, store & analyzes geospatial data based on a specific geographic location. It forms the basis of delineation, soil survey, characterization and make it possible for decision-makers, those who create policies, planners of land use, and agriculturalists to effectively manage soil resources so that agricultural lands can be used sustainably and to the best of their ability (Papadopoulos et al., 2015). Different geospatial techniques are shown in Fig. 1.

Geostatistical Tools

Geostatistics is a class of statistics used to analyze and predict the values associated with spatial phenomena. Geostatistical tools incorporate the spatial (and in some cases temporal) coordinates of the data (raster and vector) within the analysis and helps in understanding spatial distribution patterns and obtain more accurate maps (Pipalde et al., 2022). There are various geostatistical tools that helps in analysis of geospatial data e.g. Arc GIS, QGIS, SAGA GIS, Geostatistical models.



A)



B)

C)

Figure 1- Different geospatial technologies are Remote sensing, proximal sensing (A), GPS (B) and GIS (C)

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Applications of Geospatial Techniques in Agriculture

1. Sampling and characterization: Geospatial technologies provide up-to-date and real time information about landforms, terraces and vegetation. It is important for better characterization of sampling points and renewing the soil inventory. A study conducted by Upadhyay et al. (2022) in Nainital, Uttarakhand, utilizing GIS-based multi-criteria decision analysis for site selection of apple cultivation, emphasized the role of geospatial tools in identifying suitable cultivation areas, potentially boosting local economies and reducing rural migration.

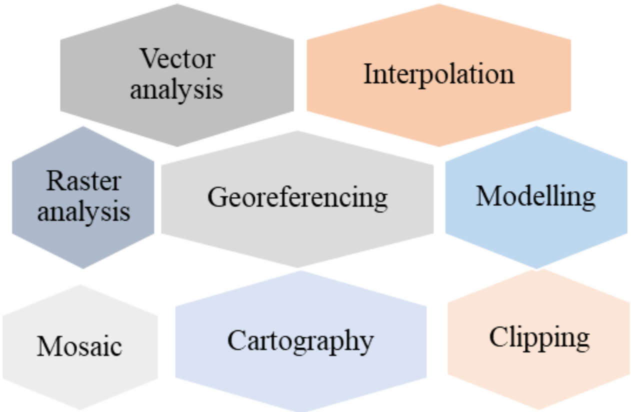
2. Site specific nutrient management: Application of fertilizers in right time and right amount is necessary for improving the production function and resource use efficiency in agriculture. Papadopoulos in 2015 in Kopaida, Greece, showcased the effective use of GIS modelling for site-specific nitrogen fertilization enhancing soil sustainability. Similarly, Kumar et al. (2022) at the Indian Agricultural Research Institute in New Delhi highlighted the optimization of nitrogen management in maize cultivation through Green Seeker technology, leading to significant improvements in grain yield and net returns.

3. Weather forecasting and Yield prediction: GT monitors various variables of weather forecasting with respect to temporal variations that helps the farmers for better decision-making Zhu et al. (2021) in Luochuan County, China, demonstrated the use of remote sensing data for estimating apple flowering frost loss, illustrating the potential of geospatial technologies in mitigating climatic risks to fruit yield. Studies conducted by Heuvelink and Egmond (2010) in Vierhuezen, Netherlands, on NDVI-based mapping for potato varieties, further confirmed the utility of geostatistical models in crop monitoring, management and yield estimation.

4. Irrigation scheduling: The integration of geospatial and geostatistical tools for irrigation scheduling represents a significant leap forward in optimizing water use and enhancing crop productivity. Singh et al. (2016) in Haridwar, Uttarakhand, demonstrated the application of GIS tools in identifying key parameters and indices for effective irrigation scheduling. By generating NDVI and land cover maps, along with thematic maps and databases, crop water requirements and net irrigation water requirements were accurately computed. Another noteworthy study by Sarun et al. (2020) in Thailand employed a ground sensor and unmanned aerial vehicle small cell (GS-UAVSC) model in smart farming applications. This innovative approach allowed for real-time monitoring of soil moisture, enabling precise irrigation scheduling that responds dynamically to the soil's moisture content. The study showcased how the integration of UAV technology with ground sensors could revolutionize irrigation practices by ensuring water is applied efficiently and only when necessary, thereby conserving water resources and improving crop yields.

5. Risk assessment maps: GT helps in prioritization and characterize the area on the basis of various morphometric parameters by spatial prediction and surface modelling patterns. It helps in estimating the spatial distribution of environmental variables and making various maps such as erosion prone maps, fertility degradation maps, insect pest risk assessment maps etc.

Applications of Geostatistical Tools



Conclusion

Geospatial and geostatistical tools help in characterization and mapping of soils and also helps in irrigation scheduling, yield prediction and IPM (Integrated Pest Management). Geospatial data used in conjunction with statistical predictive modeling are more suitable for determining the variability in the climatic pattern and fertility status in soil. These tools empower farmers and researchers to make more sustainable and informed choices, ultimately contributing to food security and environmental sustainability. Pocket friendly technologies must be introduced for farmers only based on obtained images for better and earlier management practices.

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The Success Story: Mineral Mixture - Animal Feed Supplement for High Milk Production

Article ID: 48875

Dr. B. V. Patoliya[1], N. M. Kachhadiya[1], Dr. J. V. Chovatia[1]
[1]Junagadh Agricultural University, Junagadh-362001, (Gujarat) India.

Hi-Tech Nurseries

High Tech Nursery is a combination of poly green house and agrinet house. Vegetative reproduction is used in such nurseries to ensure genetic similarities with the source. These nurseries grow plants in greenhouse, building of glass or a plastic tunnel, designed to protect young plants from harsh weather, while allowing access to light and ventilation. Modern greenhouses allow automated control of temperature, ventilation, light, watering and feeding. Some also have foldback roofs to allow "hardening-off" of plants without the need for manual transfer of plants to the outdoor beds.

<table>
<tr><td>1</td><td>Name</td><td>:</td><td colspan="2">First name: Jaishreeben
Middle name: Hashubhai
Surname: Davra</td><td rowspan="3"></td></tr>
<tr><td>2</td><td>Postal address</td><td>:</td><td colspan="2">At-Karjala Taluka-Savarkundla
Dist-Amreli
Farmer mobile no: 98248 86339</td></tr>
<tr><td>3</td><td>Home town</td><td>:</td><td colspan="2">Village: Karjala
Taluka/Mandal: Savarkundla
District: Amreli
State: Gujarat</td></tr>
<tr><td>4</td><td>Age</td><td>:</td><td colspan="3">42</td></tr>
<tr><td>5</td><td>Education</td><td>:</td><td colspan="3">8</td></tr>
<tr><td>6</td><td>Land holding (acres)</td><td>:</td><td colspan="2">Irrigated: 2.20</td><td>Rainfed: 00</td></tr>
<tr><td rowspan="6">7</td><td rowspan="6">Farming experience</td><td rowspan="6">:</td><td>Crops grown:</td><td>Area (acres)</td><td>Productivity (kg/acre)</td></tr>
<tr><td>Cotton</td><td>1</td><td>950 cotton kg/acre</td></tr>
<tr><td>Maize</td><td>0.50</td><td>5000 kg green fodder</td></tr>
<tr><td>Sugarcane</td><td>0.70</td><td>28348 kg/acre</td></tr>
<tr><td colspan="3">Livestock (no.): 03</td></tr>
<tr><td colspan="3">Farm machinery available: Bullock cart</td></tr>
<tr><td>8</td><td colspan="5">Description of adopted Climate resilient practices: This invention pertains to a process for agglomerating compressible mineral substances in the This invention presents a process aimed at agglomerating compressible mineral substances, which may exist in the form of powder, particles, or fibers. This process occurs in the presence of water within a specified time frame, typically ranging from a few seconds to a few minutes. The duration of this process is adaptable, depending on the specific characteristics of the substances involved and the desired thickness of the resultant products.
Minerals are pivotal for the metabolic functions, growth, milk production, reproduction, and overall well-being of dairy animals. Given that animals lack the ability to synthesize minerals internally, they rely entirely on their diet for these essential nutrients. However, the feeds and fodders commonly provided to dairy animals often fall short in supplying adequate quantities of essential minerals.</td></tr>
</table>

<table>
<tr><td></td><td colspan="5">In response to this shortfall, farm women have devised a method to address the mineral deficiency in dairy animals. They have developed a high-quality mineral mixture specifically tailored to meet the nutritional needs of lactating animals. By integrating this mineral mixture into the diets of their animals, farm women have observed notable enhancements in milk yield and the overall health status of their herds.
This innovation underscores the significance of ensuring that dairy animals receive the requisite nutrients to sustain their physiological functions and optimize their productivity and well-being. It highlights the proactive approach of farm women in addressing nutritional deficiencies and promoting the health and performance of their livestock.</td></tr>
<tr><td>9</td><td colspan="5">Process of Adoption: NDDB has completed mineral mapping for various states/ regions and accordingly area specific mineral mixture formulations have been developed. ASMM has to be fed @ 100-200 g daily, depending upon level of milk production in lactating animals, 50 g daily for growing and non-producing animals and 25 g daily for calves.
Benefits of feeding ASMM:(Area Specific Mineral Mixture)
➢ Improves growth rate of calves. Hence, it leads to early puberty.
➢ Improves reproduction efficiency in male and female animals.
➢ Reduce inter-calving period leading to more productive life of animals.
➢ Improves efficiency of feed utilization.
➢ Improves milk production and SNF content of the milk.
➢ Better immune response; hence better resistance against diseases.</td></tr>
<tr><td rowspan="5">10</td><td rowspan="5">Practical utility of the innovation/ adoption of technology</td><td rowspan="5">:</td><td>Economics of innovation</td><td>Average milk production Farmers Old practice (kg /lactation)</td><td>Average milk production New Innovation (kg /lactation)</td></tr>
<tr><td>Milk yields (kg /lactation)</td><td>1675</td><td>1900</td></tr>
<tr><td>Expenses incurred (Rs. /lactation)</td><td>39550/-</td><td>41580/-</td></tr>
<tr><td>Income incurred (Rs. /lactation)</td><td>66225/-</td><td>75860/-</td></tr>
<tr><td>Net returns (Rs/lactation)</td><td>26675/-</td><td>34280/-</td></tr>
<tr><td>11</td><td>Impact of innovation on other farmers</td><td>:</td><td colspan="3">Yes, more than 10 farmers have adopted this technique for improvement in milk yield and health status of lactating animal.</td></tr>
<tr><td>12</td><td>Any other information pertaining to innovation/ adoption of the technology not covered above</td><td>:</td><td colspan="3">From her farm, yearly she gets 10 tones farm yard manure.</td></tr>
</table>

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The Success Story: Value Addition in Sugarcane by Jaggery Production

Article ID: 48876

Dr. B. V. Patoliya[1], N. M. Kachhadiya[1], Dr. J. V. Chovatia[1]
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Title

Value addition of Sugarcane by Jaggery Production.

Background

Name: **Shri Jayantibhai parshotambhai chandgadhiya**
Address: Village: Karjala, Taluka: Savarkundla, District: Amreli (Gujrat)
Age: 60 years
Education: 3 pass
Landholding: 1.92 ha
Farming Experience: 20 Years
Crops Grown: Sugarcane.

Interventions

Jayantibhai is a progressive farmer of karjala village of Amreli district. From last 5 year, he started sowing sugarcane and from their sugarcane he started Jaggery Production unit and selling their jiggery to different customers in Amreli, Surat and Ahmedabad.

Impact

Horizontal Spread:

Economic gains:

a. Sugarcane Production:

i. Initially, the farmer gained 100 tonnes of sugarcane per hectare.
ii. The cost of cultivating sugarcane was Rs 2.2 lakh per hectare.
iii. The net income from sugarcane production was Rs 1.8 lakh per hectare.

b. Jaggery Production:

i. After starting jaggery production, the farmer produced 28.50 tonnes of jaggery, which translates to 11.87 tonnes per hectare.
ii. The jaggery was sold at Rs 1100 for a 20kg pack (or Rs 55 per kg).
iii. After accounting for all costs, including jaggery production, the farmer earned a net return of Rs 7.80 lakh (or Rs 3.0 lakh per hectare).

c. Total Land Area: The entire land area involved in this scenario is 15 vigha.

To summarize:

a. Initially, the farmer cultivated sugarcane and earned a net income of Rs 1.8 lakh per hectare.
b. Later, the farmer started jaggery production and earned a net return of Rs 3.0 lakh per hectare after deducting all costs, including jaggery production.
c. The total profit from both sugarcane and jaggery production on 15 vigha of land was Rs 7.80 lakh.

This transition from solely sugarcane production to both sugarcane and jaggery production resulted in a significant increase in net returns for the farmer.

Employment Generation

Give employment to 7-8 person in jaggery production unit.

	
JAU Scientist at farmer's field	**Value added product**

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Aquaponics: An approach to Sustainable Agriculture

Article ID: 48877

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[2]Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur, West Bengal, India, 721302.

Introduction

As the world faces issues like population growth, diminishing arable land, water scarcity, and environmental degradation, new and advanced solutions for food production need to be developed which can minimize the stress on the environment (Shekhar et., 2020; 2021; Khose et al., 2022). Among various systems, aquaponics systems are increasingly recognized as an important solution to address these challenges faced in traditional agriculture and can be a sustainable and resource-efficient alternative. Aquaponics involves the integration of fish farming with plant cultivation (Figure 1). Aquaponics is a blended word between 'hydroponics' and 'aquaculture'. Growing plants in a nutrient solution or soilless medium is known as hydroponics (USDA, 2024), whereas aquaculture is the science of rearing fish (FAO, 2024[a]). Thus, by merging aquaculture and hydroponics, aquaponics harnesses the efficient use of resources, particularly water and nutrients, while the controlled environment of aquaponics enables year-round production, ensuring a consistent food supply even in unfavourable climates. The objective of aquaponics is to mutually benefit both fish and plants. Within this self-contained system, fish are bred in tanks, generating nutrient-rich waste such as ammonia. Subsequently, this water, abundant in nutrients, is supplied to hydroponic plant beds, supplying nutrients to the plants. As the plants assimilate these nutrients, they efficiently cleanse and clarify the water, which is then returned to the fish tanks, thereby completing the cycle (Channa et al., 2024; Lennard and Goddek, 2019; Thorarinsdottir, 2015). This closed-loop system mimics natural ecosystems, where waste from one organism becomes nourishment for another, creating a sustainable cycle of nutrient exchange.

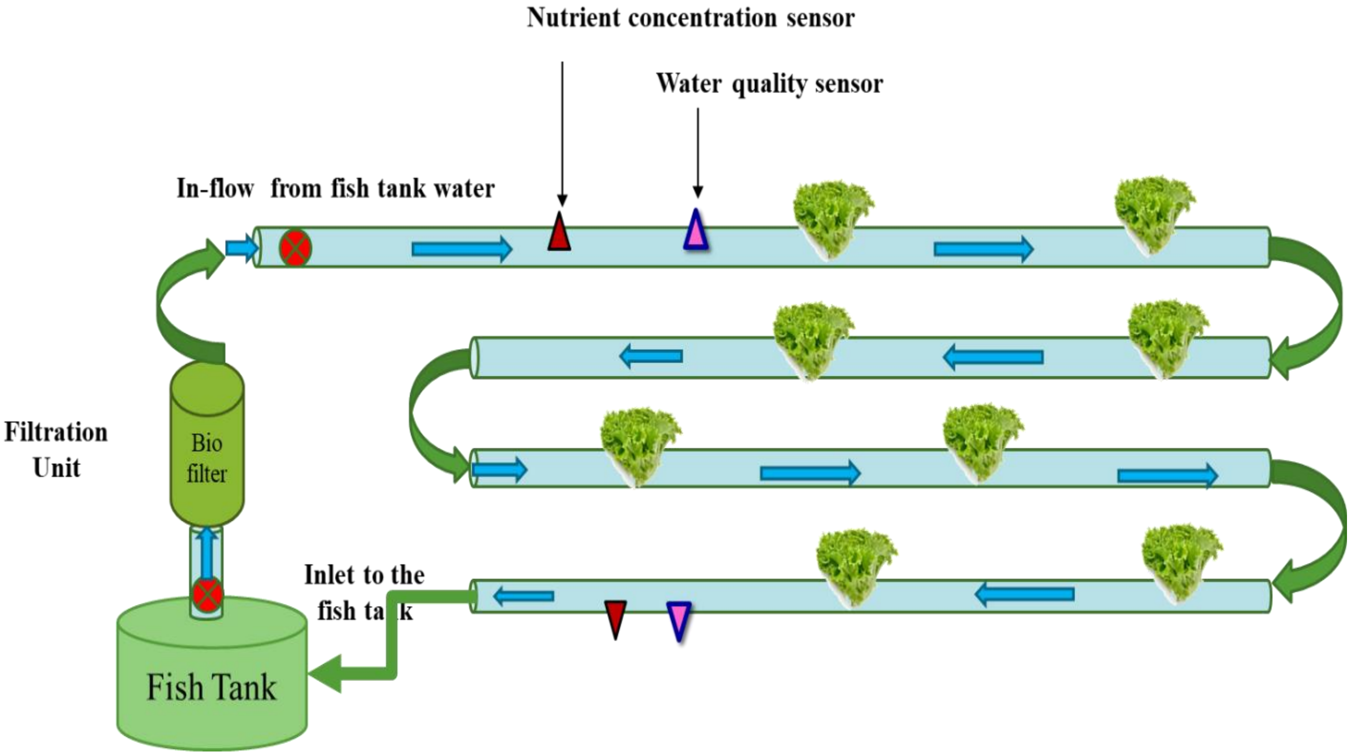

Figure 1 Schematics of aquaponics system

Benefits of Aquaponics

Aquaponics presents a compelling case for both environmental sustainability and economic opportunities.

1. Water Conservation: Aquaponics conserves water because of its closed-loop system, which continuously recirculates water between the plant beds and the fish tank, reducing the need for freshwater inputs. Further optimising water use are methods like covering tanks and beds to lower evaporation, choosing drought-tolerant plants, and collecting rainwater. Aquaponics systems use up to 90.0% less water compared to traditional soil-based agriculture (Calone and Orsini, 2022). Abdel-Rahim et al. (2019) observed that the aquaponics system outperformed the conventional fish nursery system in terms of both technical and financial water use efficiency by 7.1 and 16 times higher, respectively. Love et al. (2015) observed roughly 1.0% water loss per day in an aquaponics system experiment. Suhl et al. (2016) observed that compared to aquaponics, hydroponic systems used 4.22% more water for tomato crops. Thus, aquaponics minimizes water usage and reduces strain on local water resources by recycling water between fish tanks and hydroponic beds.

2. Nutrient Recycling: Nutrient cycling in aquaponics begins with fish waste, primarily in the form of ammonia, which is excreted into the water. Then bacteria convert ammonia into nitrites and nitrates, vital plant nutrients. Plants absorb them through their roots along with other essential elements purifying the water and removing excess nitrogen and other compounds. This filtered water is then returned to the fish tank, replenished with oxygen and cleansed of harmful substances, completing the nutrient cycle. A small portion of nutrients also comes from un-consumed fish feed and water supplied (Eck et al., 2019). The total fertiliser input into the aquaponics system decreased by 25.2% compared to the amount supplied to plants cultivated in a basic hydroponic system (Suhl et al., 2016). This eliminates the need for synthetic fertilizers and reduces nutrient runoff, which can pollute waterways and harm ecosystems (Eck et al., 2019). Al-Hafedh et al. (2008) recommended a fish feed to hydroponic surface ratio of 56.0 g fish feed/m^2 for lettuce to control nutrient build-up in the aquaponics system.

3. Climate Resilience: Aquaponics provide a controlled indoor environment that protects crops from extreme temperatures, pests, and diseases. This resilience to environmental fluctuations ensures more consistent and reliable harvests that contribute to food security in vulnerable areas. Aquaponics generates a comparatively lower level of greenhouse gas emissions to produce an equivalent quantity of goods (FAO, 2024[b]). Alkhalidi et al. (2020) conducted a study in Jordan using a pre-existing aquaponics facility to assess the cooling and heating patterns to create an optimal environment for the growth of plants and fish. They found that a ventilation rate of 50.0% with green colour shading resulted in a significant temperature reduction of nearly 10.0°C.

4. Diversification of Income: Aquaponics allows farmers to diversify their income streams by cultivating fish and vegetables. This diversification can reduce dependence on single crops or livestock, providing stability and resilience against market fluctuations. Silva and Passel (2020) examined a low-income aquaponics operation sans profit and reported that aquaponics systems can reduce food insecurity in semi-arid areas and generate cash even with 40.0% production. Similarly, the crop yield from aquaponics systems was observed to be twice of conventional cropping systems (Sharma et al., 2018).

5. Employment Generation: Aquaponics farming requires skilled labour for system maintenance, fish care, and crop management. By creating new jobs in rural areas, particularly for youth and marginalized communities, aquaponics can contribute to local economic development and poverty alleviation. Training programs and vocational education initiatives can further enhance job opportunities and empower residents. Love et al. (2015) conducted an online survey of 257 respondents who employed a total of 538 full-time workers, 242 part-time workers, and 1720 volunteers for running the aquaponics system indicating the employment opportunities in an aquaponics system.

6. Market Access: The high-quality, fresh produce grown in aquaponics systems is in demand among health-conscious consumers and urban markets (Pollard et al., 2017). Farmers can capitalize on this market demand by establishing direct sales channels, such as farmers' markets, community-supported agriculture programs, or online platforms. By connecting producers with consumers, aquaponics opens up new market opportunities and enhances farmers' profitability. Data released by Future Market Insights Inc. (FMI, 2024) indicates that the aquaponics market size will be 2.2 times within ten years (2023-2033).

Overall, aquaponics offers a sustainable and economically viable solution for agriculture in hilly regions. By combining environmental stewardship with economic empowerment, aquaponics farming has the potential to transform livelihoods, strengthen the local economy, and foster resilience in the face of environmental challenges.

Setting Up Aquaponics

Setting up an aquaponics system involves several key steps to ensure its successful operation. A general guide to setting up an aquaponics system is provided below (Go green aquaponics blog, 2024):

1. Planning and Design: For planning the aquaponics system layout and design, factors such as available space, desired scale, and environmental conditions are considered. Then the components of the desired aquaponics system are determined, which include fish tanks, hydroponic beds, filtration systems, and supporting infrastructure.

2. Selecting Fish and Plants: For choosing suitable fish and plant species for the aquaponics system, factors such as water temperature, pH requirements, growth rates, and compatibility between fish and plants are to be investigated. Indigenous species and varieties adapted to local conditions may be preferred for sustainability and resilience.

3. Building the Infrastructure: This involves constructing the physical infrastructure of the designed aquaponics system. Which includes building fish tanks, hydroponic beds, piping, and plumbing connections and ensuring the system is structurally sound, leak-proof, and properly insulated.

4. Installing Filtration Systems: The installation of filtration systems is important to maintain water quality and remove solid waste from the system. Some of the common filtration components include mechanical filters (e.g., settling tanks, swirl filters), biological filters (e.g., biofilters), and chemical filters (e.g., activated carbon).

5. Cycling the System: Before introducing fish and plants, into the aquaponics system it is necessary to conduct a system cycling; which is the process of establishing a bacterial colony in new aquaponics systems that convert fish waste into plant nutrients. This process known as the nitrogen cycle, typically takes several weeks and involves monitoring parameters such as ammonia, nitrite, and nitrate levels in the water.

6. Adding Fish and Plants: After the system is cycled, fish and plants are introduced gradually into the aquaponics system. A small number of fish is to be introduced initially to avoid overloading the system, and water quality is monitored closely during the initial stocking period. Then the seedlings or starter plants are introduced into the hydroponic beds, ensuring proper spacing and nutrient availability.

7. Monitoring and Maintenance: Water quality parameters such as pH, ammonia, nitrite, nitrate, dissolved oxygen, and temperature are to be monitored regularly. Along with routine maintenance tasks such as feeding fish, pruning plants, and cleaning filtration components. Any issues that arise are addressed promptly to maintain system stability and optimize performance.

8. Harvesting: As the aquaponics system matures, harvesting of fish and plants for consumption or commercial purposes is done along with continuous monitoring and maintenance of the system to ensure long-term success.

By following these steps and paying attention to detail throughout the setup process, a thriving aquaponics system can be established, that provides sustainable food production, and environmental benefits for years to come.

Conclusion

The aquaponics emerges as a transformative solution in addressing pressing challenges faced by traditional agriculture. By seamlessly integrating aquaculture with hydroponics, aquaponics offers a sustainable and resource-efficient alternative that holds immense promise for mitigating environmental stressors while fostering economic opportunities. Its closed-loop system not only conserves water but also recycles nutrients, reducing reliance on synthetic fertilizers and mitigating nutrient runoff that can harm ecosystems. Moreover, the controlled indoor environment of aquaponics ensures climate resilience, providing consistent yields even in adverse conditions. Beyond environmental sustainability, aquaponics fosters economic empowerment. Its ability to diversify income streams and create job opportunities, particularly in rural and marginalized communities, contributes to local economic development and poverty alleviation. Additionally, the high-quality produce grown in aquaponics systems meets the demand of health-conscious consumers, opening up new market opportunities for farmers. Setting up such systems requires meticulous planning and maintenance, but the long-term benefits in sustainable food production and environmental stewardship are significant.

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Moringa - The Nutrient Wonder

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Introduction

Moringa is called as a Miracle tree since all the parts *viz*., fruits, flowers, leaves, seeds and bark of the plant are being used. Native to South Asia, it is grown in India, Ethiopia, Philippines, Sudan. It is also grown in places like East, West and South Africa, Tropical Asia, Latin America, Caribbean, Florida and the Pacific Islands (FAO) (Jegadesan *et al* (2020)). The high nutritive value and its varied use as food and medicine is well known, with leaves also used as forage, trunk used for manufacturing gums, flower nectar as honey and powdered seeds for water purification (Fuglie, 1999). It is drought tolerant and almost all parts of the tree are being used. Malnutrition is one of the existing problems worldwide and moringa undoubtedly is the store house of nutrients which could be used to overcome this problem. Moringa contains wide range of phytochemicals and the leaves are inexpensive and abundantly available. In previous years the moringa leaves were underutilized and now-a-days awareness has been created on the nutritional importance and medicinal value of this miracle tree.

Nutritive and Medicinal Value

Use of Moringa leaves and pods: The leaves and green fresh pods are used as vegetables which are rich in carotene and ascorbic acid (vitamin C) with a good profile of amino acids (Makkar and Becker, 1996). Carbohydrates, proteins, calcium, vitamins (A, B and C), magnesium, potassium, iron, zinc, B. Complexes have been found in abundance (Asante *et al*., 2014). The leaves are considered to offer great potential for those who are nutritionally at risk and may be regarded as a protein and calcium supplement (Rajangam *et al*., 2001). The leaves have anti-inflammatory properties and reduces blood sugar levels (Yadav, S. 2023).

The nutritive value of drumstick leaves when compared to other food is impressive, as can be gauged by the fact that it has 7 times the Vitamin C in oranges, 10 times the vitamin A in carrots, 17 times the calcium in milk, 9 times the protein in yoghurt, 15 times the potassium in bananas and 25 times the iron in spinach. The leaves are rich in natural antioxidants, which help in improving the shelf-life of fatty foods due to the presence of different varieties of compounds like ascorbic acid, flavonoids, phenolics and carotenoids (Siddhuraju and Becker, 2003). Thus, the leaves could be used to improve the nutritional properties of food as well as to overcome malnutrition that is common in developing countries. *Moringa oleifera* was also reported to boost immune systems (Jayavardhanan *et al.,* 1994; Fuglier, 1999). It also possesses anti-cancer properties due to the presence of anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate. The presence of flavonoids gives it anti-inflammatory property. The antibiotic pterygospermin is responsible for antimicrobial properties. Moringa pods are rich in Vitamin C. Considered anthelmintic, the pods are used in the treatment of liver and spleen diseases and joint pain, strengthen bones, cures kidney stones and enhances skin beauty

Use of moringa oil: Moringa oil also possess antitumor, antipyretic, antiepileptic, anti-inflammatory, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol lowering, antioxidant, antibacterial and antifungal activities, and are being employed for the treatment of different ailments in the indigenous system of medicine. Moringa oil is used in the preparation of cosmetic products. It has nourishing and emollient properties, making it an excellent massage oil due to the presence of palmitoleic, oleic and linoleic acids, vitamins A and C and unsaturated fatty acid. This moringa oil is in demand because it is so stable and resistant to rancidity and it has long been valued for its enfleurage property by the perfume industry. It is useful in the manufacture of perfume and hairdressings.

The high level of vegetarian diet in Indian population may not provide adequate protein and other minerals. Inexpensive and adequately available food based on Moringa products will bridge the gap by the development of novel value-added products which has high consumer acceptance, Jagadeesan *et al* (2020).

Nutrient Content in Seeds, Fresh Leaves, Dry Leaves and Pods

Nutrients	Fresh Leaf	Dry Leaf	Leaf Powder	Seed	Pods
Protein (g)	6.7	29.4	27.1	29.4-33.3	2.5
fat (g)	1.7	5.2	2.3	34.7-40.6	0.1
Carbohydrates (g.)	12.5	41.5	38.2	16.5-19.8	3.7
Vitamin 'C' (mg.)	220	15.8	17.3	4.5-5.0	120
Vitamin 'E' (mg.)	448	10.8	113	751-755	-
Magnesium (mg)	42	448	368	635-670	24
Phosphorus (mg)	70	252	204	75	110
Potassium (mg)	259	1236	1324	-	259
Iron (mg)	0.85	25.6	28.2	-	5.3

(Source: Lakshmipriya *et al.*, 2016)

Moringa leaves are used to control blood pressure and helps to get rid of obesity, for tooth decay, useful for blood purification and to control cholesterol and diabetes. It also improves eyesight and reduces headache.

Use of Moringa Flowers

Moringa flowers are traditionally used as a tonic (diuretic). Flowers are considered anthelmintic. Used to cure inflammation, muscular diseases, tumours and enlargement of spleen. In India, juice squeezed from the flowers is given to ease sore throats and colds.

Use of root and stem bark: The root is considered useful against internal fever and is sometimes administered to relieve cold symptoms. The juice from the roots is applied externally as a rubefacient (skin tonic), boundary irritant. The roots are used in India and Indo-China to treat cases of scurvy. In India, the bark of the stem and root is taken as an appetizer and a digestive. The bark of the root is used in the country to stop the enlargement of the spleen and the formation of tuberculous nodes of the neck, to destroy tumors and to heal ulcers (Yang et al., 2006). The root bark has medicinal values and is used for dyspepsia, eye diseases and heart complaints. The tap root of Moringa is used as a spice. The gum is used in calicoprinting. The gum and roots also have antibacterial, antifungal and anti-inflammatory properties.

The bark from the Moringa tree has the ability to heal a variety of diseases. Moringa bark has been used in Ayurvedic medicine since ancient times (Yadav, S. 2023) which is effective in cancer and menstruation, beneficial in sciatica and to heal boils and ringworm

Use of seeds: The seeds are used against fever, the flowers, leaves and roots as a treatment for various tumors viz., stomach tumors. A paste of ground seeds is applied on warts. In India it is applied externally to relieve pain and swelling in case of arthritis or rheumatism and to treat skin diseases. The oil is used to cure hysteria and is applied as a treatment for prostate and bladder problems. It is also used in perfume and hair oil.

Use of gum obtained from stem: Applying gum mixed with sesame oil provides relief for headache. It is also applied in the ears for relief from earache. In Java, the ball is given for intestinal complaints. In India the gum is used for dental caries. In India and Senegal, the gum is believed to be of used in the treatment of fever, dysentery and asthma. In India the gum is used to treat rheumatism. (Yadav, S.,2023).

Conclusion

Though consumption of *Moringa* leaves, fruit and flowers are common in India, the use of such traditional food items has gone down which could be for many reasons including replacement of diet with new and different food including fast food, not valuing the traditional food items, not too much culinary experimentation to make dishes from *moringa* that could be attractive and which retains or even increase the nutritional value and also maybe the time spent to process the leaves for consumption. It is clearly evident that the abundantly available and highly nutritious but largely underutilized *Moringa oleifera,* can be used in various food formulations to enhance the nutritional value and wider acceptance and consumption (Jagadeesan *et al*., 2020). Moringa products can surely address the gaps in the nutritional needs of the growing population and is definitely a store house of nutrients to overcome malnutrition both in urban and rural population especially among women and children.

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Aflatoxin Contamination in Red Chillies: Challenges and Potential Solutions

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Chilli (*Capsicum annuum* Linn.) is an important spice and vegetable crop that belongs to the solanaceae family and genus Capsicum. The native of chilli is considered to be Mexico with Guatemala as the secondary centre of origin. Introduced to India by the Portuguese in 17th century. Chilies come in over 400 different varieties and are known by common names such as chillies, chile, chilli peppers, bell peppers, red peppers, pod peppers, cayenne peppers, paprika, pimento, and capsicum in various parts of the world. Among the spices, dried chilli accounts for the bulk of intake. The dye 'capsanthin' is responsible for the red colour of chilies. The alkaloid 'capsaicin' contained in the pericarp and placenta of chilies gives them their biting pungency. Chillies, besides imparting pungency and red colour to the dishes, are a rich source of vitamin A, C and vitamin E and assist in digestion and is also a source of proteins, minerals, oleoresin and red pigment. Chillies are widely used as spices, condiments, culinary supplements, medicine, vegetable and ornamental plants too. It forms an important ingredient in day-to-day curries, pickles, chutneys and oleoresin.

Chilli pepper originates in South America, it is now widely grown on all continents. Currently, Asian and African production of dried chillies is significantly larger than production in South America. India is the largest producer with 1.72 million tonnes and contributes 41% of world chilli production, followed by China, Ethiopia, Thailand, Pakistan and Bangladesh (FAO, 2020). The production of Chilli in India is dominated by Andhra Pradesh which contributes nearly 37.35% to the total production. Telangana is the second largest producer contributing 23.11% to the total production followed by Madhya Pradesh (15.83%), Karnataka (9.85%), Orissa (3.70%) and others about 12% during 2021-22. In Karnataka, Dharwad, Ballari, Gadag, Raichur and Haveri are the major chilli producing districts with a production share of 28.00, 57.29, 2.36, 6.91 and 0.18%, respectively. India is not only the largest producer but also the largest consumer and exporter of chilli in the world. Indian chillies have been dominating the international chilli market for its important commercial qualities of colour and pungency levels.

Chilli with higher colour value and less pungency are preferred in Europe and the West. It is estimated by Food and Agriculture Organization (FAO) that 25% of agricultural crops are contaminated with mycotoxins that are unfit for human or animal use. Chillies that are grown in warm regions are easily prone to aflatoxin (AF) contamination (Iqbal et al., 2010). Also, there is a fact that among all the spices, chillies are easily susceptible to fungal spoilage. Many surveys from different countries like Belgium, Japan, United Kingdom, Spain, Portugal, Japan, Australia, Turkey, India, Canada, Hungary, China, Pakistan, Russia, Egypt and Singapore indicated the presence of aflatoxin in chilli peppers. Based on the regulation set by European Commission, the maximum permissible levels of AFB_1 and total AFs (B_1, B_2, G_1, G_2) in Capsicum species are 5 and 10 µg/kg, respectively (European Commission, 2006; Commission Regulation EC No.1881/2006; CIRCULAR NO: 05/2022-23). The presence of high concentration of aflatoxins in chillies represents a threat to consumer's health (liver cancer) and thereby restricting its commercial potential to be able to withstand international market demands.

India is the major producer and exporter of chillies but the presence of AF was not deterrent only for export potential but for domestic processing industries as well (www.imotforum.com). Several physical and chemical methods have been proposed to reduce AF in contaminated commodities. Physical methods mainly use segregation, thermal process, and radiation to lower the AFs concentration. A segregation process can be simply completed by sorting, absorbing, or washing out the AFs from foods. Sorting could be significant but incomplete since the presence of fungi growing can be only recognized when severe contamination occurred (Karlovsky et al., 2016). The recovery of absorbent and solvent used for absorbing or washing would be an issue (Piva et al., 1995). A thermal process has been considered inefficient, and it would change the properties of the product. Although roasting (200°C, 25 min) was able to reduce 90% of AFs in contaminated peanuts, the low L value of 39.3 indicated that the peanuts were nearly scorched and presented a dark color (Martins et al., 2017). Radiation methods usually refer to the ionizing or partially ionizing treatments by electromagnetic spectrum with short wavelengths, such as gamma irradiation or UV irradiation. With a sufficient dosage of gamma irradiation, a notable detoxification rate and almost no quality change were reported (Ghanem et al., 2008). However, the cost of gamma irradiation equipment and consumer hesitation about irradiated foods is a concern. Biological detoxification processes such fermentation largely change the form of the foods.

Chemical methods for detoxification are of interest due to their profound efficiency and affordable cost. Alkaline treatment can hydrolyze the lactone ring inside AFs molecules, but the process is reversible in acidic conditions, which might maintain the toxicity of AFs (Price and Jorgensen, 1985). Ozonation can significantly reduce AFs levels, but the whole process may take several hours to complete (Porto et al., 2019). Besides, ozone is toxic and explosive. Ammoniation can open the lactone ring similar to alkaline treatment, and its detoxification ability has been confirmed by the U.S. Department of Agriculture (USDA). However, significant losses of lysine and methionine were reported after ammoniation. Reactive agents such as sodium hypochlorite or sodium bisulfite can undergo chlorination or sulfonation at the C8 or C9 positions, activating AFs molecules to be decomposed (Samarajeewa et al., 1990). Although these chemical methods can effectively detoxify AFs, the safety of the degraded compounds and the removal of residual chemicals after treatments largely limit their application.

Ultraviolet light (UV) provides a high intensity of light. It has been used in the food industry for several purposes like surface sterilization, fluid disinfestation, air treatment, waste treatment, and insect trapping. This technology works with a wavelength range of 190–280 nm and results in germicidal and antimicrobial activities used to decontaminate water, fruits, and root vegetables (Cutler and Zimmerman, 2011). Consequently, the antimicrobial effect of UV light is through the generation of pyrimidine dimers, which distorts DNA helix and interferes with cell replication of exposed microorganisms (Lado and Yousef, 2002). Microscopic evidence has demonstrated that AFs are mainly distributed on or near the surface of contaminated foods, and thus a treatment applied near the surface would be sufficient for detoxification. UV is an ideal treatment due to its ability to detoxify AFs, affordable cost, and less quality impact. UV can degrade aflatoxin B_1 into more than 200 times less toxic compound, aflatoxin B_2, justifying the use of this method in practice (Shen, 2022). Most of the aflatoxin detoxification approaches in foods studied so far are either used in liquid substrates/cultures or limited to groundnut and corn products. There are limited reports on the development of AFB_1 detoxification strategies in red chilies.

Conclusion

Chilli peppers are an integral component of global cuisines, their susceptibility to aflatoxin contamination poses a significant challenge to both domestic consumption and international trade. With India being a major producer and exporter of chillies, the presence of aflatoxins not only threatens export potential but also undermines the safety of domestic processing industries. Various physical and chemical methods have been proposed for aflatoxin detoxification, but each comes with its own limitations, including incomplete removal, alteration of product properties, and potential safety concerns. The application of ultraviolet (UV) light emerges as a promising solution due to its ability to effectively degrade aflatoxins while maintaining food quality and safety. However, further research and development are necessary to optimize UV treatment protocols for chilli peppers and to ensure its practical feasibility within the food industry.

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Quinoa: A Super Food and Climate Resilient Crop

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Native to South America, the quinoa (Chenopodium quinoa) family Amaranthaceae is a short-lived (100–130 days) annual species that can reach heights of 2 m. It has a good resistance to drought, salinity, and cold and can be cultivated on marginal soils up to 3800 meters in elevation. Since quinoa seeds are not derived from grasses like wheat and rice, they are likewise classified as pseudocereals, much like amaranth seeds. In terms of their low cost of production, genetic variety, adaptation to unfavorable soil and climate conditions, and nutritional value, quiona grains are inherently exceptional. Due to these qualities, quinoa is regarded as one of the key crops that may help maintain food sovereignty and security (Zurita-Silva *et al.*, 2014). In their raw state, quinoa grains have 13% water, 64% carbs, 14% protein, and 6% fat (Gordillo Bastidas *et al.,* 2016). These grains are more nutritious than many traditional cereals because they contain a high amount of protein, vitamins, minerals, and important amino acids, particularly lysine. In addition, the plant is well-known for its nutraceutical qualities and is regarded as a superb illustration of a "functional food" that can reduce the chance of developing a number of illnesses (Vega-Gálvez *et al.*, 2010). Quinoa may offer diversity to health-conscious people's nutritious food preparations because it's a simple grain to cook. The "International Year of Quinoa" was proclaimed by the UN General Assembly in 2013.

Quinoa's Adaptability to Various Climatic Situations

Cultivated from sea level to 4000 meters above sea level, Quinoa exhibits a great deal of variety and plasticity in its adaptation to various environmental situations. It can withstand a variety of unfavorable weather conditions that might impact crops, including cold, dryness, and salinity of the soil. The duration of its growing season is 90–240 days.

It grows as a result of 200–280 mm of precipitation annually. The ideal temperature range for quinoa cultivation is between 18 and 20 degrees Celsius, while it can withstand temperature extremes between 39 and -8 degrees Celsius. Although quinoa favors neutral soils, it is typically grown on alkaline soils up to a pH of 9.0. It is more flexible in adapting to changes in soil pH, altitude, and photoperiod. Quinoa seems to be a quantitative short-day species where in the length of the vegetative period depends not only on the day length and latitude of the origin but also on altitude of the origin (Rishi and Galwey, 1984).

Because of distinct ecotypes from different agro-environments have differentiated into diverse forms, quinoa can withstand varying degrees of drought. In response to water scarcity, plants exhibit a variety of adaptive strategies, ranging from morphological to physiological modifications that act as avoidance mechanisms to resistance and tolerance mechanisms.

In order to adapt to the stress of drought, plants alter vital physiological functions such photosynthesis, respiration, water relations, antioxidant production, and hormone metabolism. Drought-related alterations in leaf and root growth, sometimes with significant ontogenetic variation, are observed in whole plants. These physiological and morphological responses to drought demonstrate intraspecific heterogeneity associated with ecotype differentiation.

The crop's resistance to insect pests, capacity to thrive in arid, alkaline soils, and resilience to drought and ground frost are further benefits. Quinoa seeds are protected from animal exploitation by a coating of saponin, a soapy, bitter compound.

Additionally, the chemical serves as a natural pest deterrent. Quinoa thus presents a unique opportunity, as it is a major source of genes with biotechnological applications and a viable crop to examine in light of current and future climate change issues.

Quinoa as a Super Food

Quinoa also called as "Superfood" because, this term is often used to refer to natural foods that are nutrient dense, in other words, foods that offer maximum nutritional benefits for minimal calories. In addition to their nutritional value, these foods are often associated with the prevention of a disease, or believed to offer numerous health benefits such as enhancing the immune system, improving heart health, preventing cancer, reducing inflammation, lowering cholesterol, etc. Quinoa is actually a seed that is classified as a whole grain hence the term "pseudo-grain" used to describe it. It is indigenous to the Andean region of South America, specifically Peru, Bolivia, Ecuador, and Chile, where it has been cultivated for several generations, and only became popular in North America in recent years due to its health benefits. Quinoa is a good source of plant protein and fiber, and is low in fat. Quinoa is a complete protein, meaning that it contains all nine essential amino acids that our bodies cannot make on their own. Its unusually high protein content compared to other plants makes it a healthy alternative to a carb- and meat-centered diet, and consequently, very popular among vegetarians and vegans. Quinoa is also gluten-free, and a source of manganese, calcium, phosphorus, magnesium, folate, thiamin (Vitamin B1), and anti-inflammatory phytonutrients which can prevent disease. In comparison to most cereals, quinoa seeds have a higher nutritional value (Matiacevich et al., 2006) with protein content of quinoa seeds varies from 8 to 22 per cent which is higher than that in common cereals such as rice, wheat and barley. In quinoa most of the protein is located in the embryo which contains higher amount of lysine, methionine and cysteine and act as a good complement for legumes. The lipid content of quinoa ranges from 5.2 to 9.7 per cent which is approximately two times higher than that of maize and wheat (Alvarez-Jubete *et al.,* 2010) and the fat content ranges from 2-10 per cent. Inspite of high amount of lipids, quinoa lipids are stable against oxidation because of the α-tocopherol (Vitamin-E 0.59 - 2.6 mg/100g) which is naturally occurring in it. The starch content of quinoa ranges from 58.1 to 64.2 per cent with a granular diameter of 2 µm and is smaller than the size of starch of common grains (Repo-Carrasco et al., 2003). The amylose content ranging from 3.5 - 22 per cent found in quinoa starch. Quinoa is a good source of minerals which is about two times of the mineral content in cereals. However, Ca, Mg, Fe, and Zn are found in fairly high amount in quinoa (Repo-Carrasco *et al*., 2003). Gluten free diets are generally deficient in Ca, Mg and Fe and the use of quinoa can be promoted as an aid to reduce the deficiency as it is found to be rich in these elements. Quinoa grains are stable towards oxidation owing to the presence of vitamin E and vitamin C which acts as potential antioxidants.

Quinoa seeds

Quinoa Plant

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Global Positioning System in Agriculture

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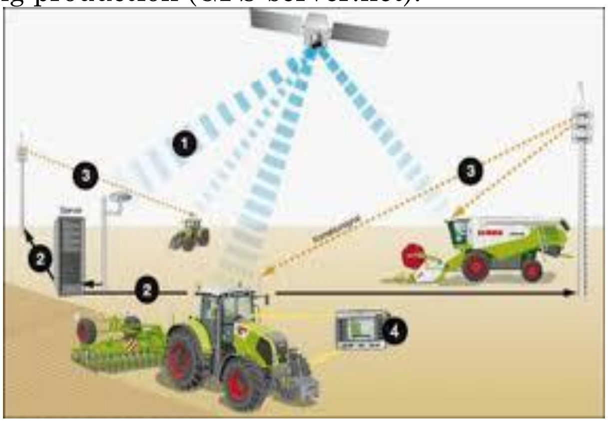
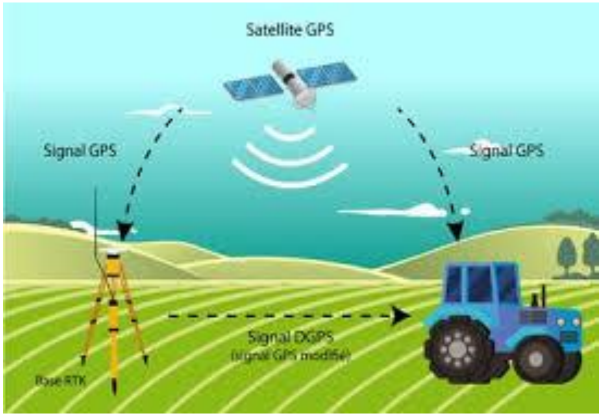
Introduction

GPS (Global Positioning System) technology has become an indispensable tool in modern agriculture, offering a wide range of applications to improve efficiency, productivity, and sustainability. The implementation of precision agriculture or site-specific farming is made possible through the integration of Global Positioning System (GPS) technology. GPS technology, when combined with tracking systems like GPS-server.net, facilitates the gathering of real-time data with precise position information, enabling efficient data manipulation and analysis.

The GPS-server.net service plays a crucial role in precision farming applications such as field planning, yield mapping, and tractor guidance. By leveraging this technology, farmers can access accurate information that empowers them to devise effective soil and plant treatment strategies, ultimately enhancing production (GPS-server.net).





This integration of GPS technology into agricultural practices underscores its significance in optimizing farming operations and maximizing yields. With real-time data collection and precise positioning, farmers can make informed decisions that contribute to improved efficiency and productivity in the agricultural sector. GPS auto-guidance systems revolutionized the way farmers operate machinery. The first GPS auto-guidance system was used on a salt harvester in 1996. By the early 2000s precision farming began to pick up speed

The U.S. Department of Defense developed the system, which originally used 24 satellites, for use by the United States military, and became fully operational in 1995. Civilian use was allowed from the 1980s.

How Sensors are Used in Agriculture?

Sensors play a crucial role in modern agriculture by providing real-time data on various environmental and crop-related parameters. Here are several ways sensors are used in agriculture:

1. Soil Moisture Sensors: Soil moisture sensors measure the water content in the soil, helping farmers optimizes irrigation practices and prevent over-watering or under-watering of crops. These sensors provide data that enables precise irrigation scheduling, leading to water conservation and improved crop yields.

2. Weather Sensors: Weather sensors measure environmental factors such as temperature, humidity, wind speed, and rainfall. This data is essential for monitoring microclimatic conditions within fields and making informed decisions regarding planting, harvesting, and pest management.

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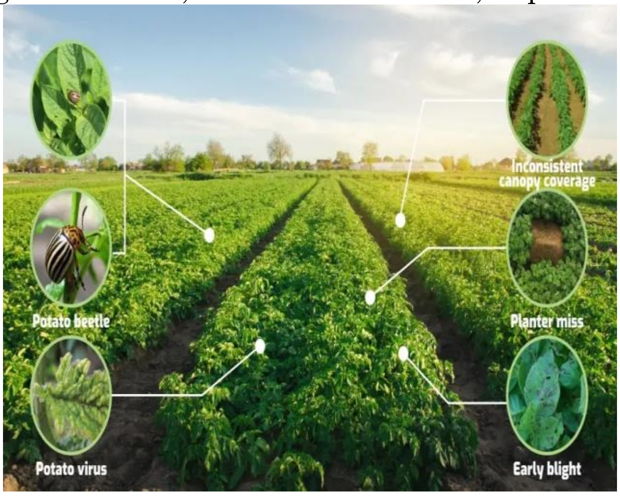
3. Crop Health Sensors: Sensors can detect various indicators of crop health, including chlorophyll content, leaf temperature, and plant stress levels. By monitoring these parameters, farmers can identify early signs of disease, nutrient deficiencies, or pest infestations and take timely corrective actions.



4. Nutrient Sensors: Nutrient sensors measure soil nutrient levels such as nitrogen, phosphorus, and potassium, providing insights into soil fertility and nutrient availability for plant uptake. This information helps farmers optimize fertilizer application rates and reduce nutrient runoff, promoting sustainable soil management practices.

5. Crop Growth Sensors: Sensors can monitor crop growth parameters such as biomass accumulation, canopy cover, and plant height. By tracking crop development in real-time, farmers can assess crop performance, predict yield potential, and adjust management practices accordingly.

6. Pest Detection Sensors: Sensors equipped with imaging or spectroscopic technology can detect pest presence and identify pest species in crops. Early detection of pests allows for timely intervention strategies, reducing crop damage and minimizing the need for chemical pesticides.

By leveraging the data generated by these sensors, farmers can implement precision agriculture techniques, optimize resource use, and make informed decisions to improve overall farm efficiency and productivity.

Uses of GPS in Agriculture

Precision Farming: GPS technology, when combined with geographic information systems (GIS), allows farmers to create precise maps of their fields. By analyzing data on soil composition, moisture levels, and topography, farmers can create customized management plans for each section of their fields.

This precision farming approach optimizes resource utilization, reduces input costs, and maximizes yields.

Field Mapping and Soil Sampling: GPS technology is extensively used in field mapping and soil sampling in agriculture, offering precise and efficient methods for understanding field variability and managing soil resources effectively.

a. Field Mapping:

i. Boundary Mapping: GPS allows farmers to accurately delineate field boundaries, creating digital maps that define the spatial extent of their fields.

ii. Topographic Mapping: GPS combined with elevation data can create topographic maps of fields, identifying high and low areas that affect water flow and drainage patterns.

iii. Yield Mapping: GPS-integrated yield monitors on harvesting equipment record crop yield data as it's harvested, creating yield maps that show spatial variations in yield across fields.

iv. Aerial Mapping: GPS-enabled drones or UAVs equipped with cameras can capture aerial imagery for creating high-resolution maps of fields, providing detailed information on crop health, canopy cover, and pest infestations.

b. Soil Sampling:

i. Grid Sampling: GPS technology enables farmers to establish grid-based sampling points across fields with precise coordinates. This systematic approach ensures representative sampling and helps identify spatial variability in soil properties.

ii. Zone Sampling: GPS-guided zone sampling divides fields into management zones based on factors such as soil type, topography, and historical yield data. Soil samples are collected from each zone to tailor management practices accordingly.

iii. Depth Sampling: GPS assists in determining the exact location for soil sample collection at specific depths within the soil profile. This allows farmers to assess variations in soil properties and nutrient distribution at different depths.

iv. Geo-referenced Sampling: GPS coordinates are assigned to each soil sample collected, providing accurate spatial data that can be integrated into GIS platforms for analysis and interpretation.

v. Precision Sampling: GPS-guided sampling helps optimize sample collection efforts by targeting areas of interest within fields, such as areas with suspected nutrient deficiencies or compaction issues.

By utilizing GPS technology in field mapping and soil sampling, farmers can obtain accurate spatial information about their fields and soil conditions. This data allows for precise management decisions, including variable rate application of fertilizers and amendments, targeted irrigation, and site-specific crop management practices. Ultimately, GPS-driven field mapping and soil sampling contribute to improved productivity, resource efficiency, and sustainability in agriculture.

Yield Monitoring: GPS technology integrated with harvesters and yield monitors allow farmers to precisely measure crop yields across different areas of their fields. By analyzing yield maps, farmers can identify spatial patterns and factors influencing yield variability, such as soil type, drainage, and pest pressure. This data informs decision-making for future planting, input allocation, and crop rotation strategies.

GPS technology plays a pivotal role in yield monitoring in agriculture, offering precise positioning and data collection capabilities that enable farmers to accurately measure and analyze crop yields across their fields.

Yield Data Collection: GPS-integrated yield monitoring systems are installed on harvesting equipment, such as combines or grain carts. These systems measure and record crop yield data in real-time as the crop is harvested. GPS receivers onboard the equipment provides accurate location data, allowing each yield measurement to be geo-referenced to a specific location within the field.

Spatial Mapping: GPS-enabled yield monitors generate spatial yield maps that visually depict the variability in crop yields across different areas of the field. These maps provide valuable insights into factors influencing yield variability, such as soil type, drainage, fertility, and management practices. By overlaying yield maps with other spatial data, such as soil maps or aerial imagery, farmers can identify patterns and trends that help optimize crop management decisions.

Data Analysis and Interpretation: GPS-derived yield data is analyzed to assess overall crop performance, identify high-yielding and low-yielding areas within fields, and evaluate the effectiveness of agronomic practices. Statistical analysis techniques, such as spatial interpolation and regression analysis, are used to quantify yield variability and understand the underlying factors contributing to yield differences.

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Use of Green Technology in Agriculture

Article ID: 48882

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Introduction

Agriculture is the process by which humans grow process and acquire plants. However, the rapid restructuring of the agricultural landscape, a decrease in soil fertility, loss of biodiversity (leading to alterations of biogeochemical cycles), pest attacks and plant disease have raised concerns about uninterrupted agricultural production. The significant rise in global human population and climate change has caused a threat to food security and the sustainable supply of food resources.

What is Green Technology?

Green technology is also known as green tech; green technology encompasses environmentally friendly technologies. We execute them in a way that does not damage environmental stability and conserves natural resources, also referred to as 'clean' technology. They rely on the safe utilization of renewable resources to minimize greenhouse gases.

How do we Work Towards Improving Agricultural Practices?

Agriculture is foremost for the viability of food security. As we apply green technology-based agricultural practices, we can provide guidance for a sustainable path of economic development. Technologies such as conservative tillage, integrated pest management, enhanced nutrient management, and precision agriculture have proven efficient to get ahead in improving agricultural practices.

Objectives of Green Technology for Sustainable Development

The objectives of green technology for sustainable development are aligned with promoting environmentally friendly and socially responsible practices while fostering economic growth and prosperity. These objectives aim to achieve a balance between meeting current needs and ensuring the well-being of future generations. Some key objectives of green technology for sustainable development include:

1. Environmental Protection: The primary objective is to protect and preserve the natural environment, including air, water, land, and ecosystems, by reducing pollution, conserving resources, and mitigating climate change.

2. Resource Efficiency: Green technology aims to optimize the use of natural resources, such as energy, water, and materials, to minimize waste and increase resource sustainability.

3. Renewable Energy Transition: Promoting the widespread adoption of renewable energy sources, like solar, wind, and hydro, to replace fossil fuels and reduce greenhouse gas emissions.

4. Energy and Waste Management: Implementing energy-efficient technologies and waste management strategies to reduce energy consumption and minimize waste generation.

5. Sustainable Agriculture and Food Security: Advancing sustainable agricultural practices that promote soil health, biodiversity conservation, and food security for present and future generations.

6. Green Building and Infrastructure: Developing sustainable buildings and infrastructure that are energy-efficient, environmentally friendly, and contribute to the overall well-being of occupants

7. Circular Economy: Encouraging a circular economy model, where resources are reused, recycled, and repurposed, reducing waste and extending the life cycle of products.

Renewable Energy

Renewable energy in agriculture refers to the utilization of sustainable and environmentally friendly energy sources to meet the energy needs of agricultural operations and processes. By integrating renewable energy technologies into farming practices, agricultural producers can reduce reliance on fossil fuels; lower operating costs, and mitigate environmental impact associated with energy consumption. Here are some common applications of renewable energy in agriculture:

1. Solar technologies are very versatile for agricultural usage. It works by converting solar light radiation into electrical energy. Farmers can use the electricity generated from the sun for running farm machinery, lighting, and water pumping.

2. Solar thermal technologies are another green technology that is becoming more favored. It works by converting solar heat radiation into heat energy.

3. Wind turbines are a popular choice for farmers because they don't use up much land. Farmers can use them for pumping water for irrigation.

4. Biomass is derived from biological organisms such as plants, animal waste, and corn. This material is then converted into energy by burning. The heat is used directly for heating buildings, drying crops, and dairy operations.

Zero Tillage

Zero tillage, also known as no-till farming or direct drilling, is an agricultural practice that involves planting crops into untilled soil without prior ploughing, cultivation, or seedbed preparation. In zero tillage systems, farmers avoid disturbing the soil structure and leaving crop residues on the soil surface, allowing for minimal soil disturbance and maximum soil conservation.

Biotechnology

The application of biological techniques, genetic engineering, and molecular biology to improve crop production enhances agricultural sustainability, and address challenges related to food security, environmental conservation and economic development.

Vertical Farming

Vertical farming is the method of growing crops in vertically stacked layers instead of traditional horizontal farming. Vertical farming can be a sustainable urban farming method, providing environmental, economic, and social benefits. Farmers achieve an increased yield. There is reduction in water and fertilizer wastage. This new technology can cut water consumption by as much as 95%.

The crops are in a controlled climate, there is fewer requirements for pesticides and fertilizers as pests and diseases are minimal. However, the massive benefit is that vertical farms can be located anywhere, especially in urban populated areas to meet food demands locally.

Irrigation Monitoring

Irrigation monitoring refers to the process of tracking and assessing various parameters related to irrigation practices in agricultural fields to optimize water use efficiency, improve crop yield, and conserve water resources. Monitoring irrigation systems involve collecting data on factors such as soil moisture level, weather condition, crop water requirements, irrigation scheduling, and water distribution to ensure that crop receive the right amount of water at the right time and at the right place.

Drones

Drone is also known as unmanned aerial vehicles (UAVs) or unmanned aerial system (UAS), have revolutionized agriculture by providing farmers with valuable data and insight to optimize crop management practices, increase productivity, and reduce costs.

Drones are equipped with various sensors, cameras, and imaging system that enable them to capture high-revolution aerial imagery, multispectral data, and real-time information about crop health, soil conditions, and field variability.

Conclusion

These green technologies are leading the way in changing how the agricultural sector works. There will be a series of new green technologies sometimes mixed in to return to some more 'traditional' techniques. Research is in progress for new technologies, and people are working hard to make our Earth a more sustainable place. Agriculture will always be essential for humanity, so it is in our best interests to find the most successful way to keep it green and sustainable.

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Aflatoxin Contamination in Red Chillies: Challenges and Potential Solutions

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Chilli (*Capsicum annuum* Linn.) is an important spice and vegetable crop that belongs to the solanaceae family and genus Capsicum. The native of chilli is considered to be Mexico with Guatemala as the secondary centre of origin. Introduced to India by the Portuguese in 17^{th} century. Chilies come in over 400 different varieties and are known by common names such as chillies, chile, chilli peppers, bell peppers, red peppers, pod peppers, cayenne peppers, paprika, pimento, and capsicum in various parts of the world. Among the spices, dried chilli accounts for the bulk of intake. The dye 'capsanthin' is responsible for the red colour of chilies. The alkaloid 'capsaicin' contained in the pericarp and placenta of chilies gives them their biting pungency. Chillies, besides imparting pungency and red colour to the dishes, are a rich source of vitamin A, C and vitamin E and assist in digestion and is also a source of proteins, minerals, oleoresin and red pigment. Chillies are widely used as spices, condiments, culinary supplements, medicine, vegetable and ornamental plants too. It forms an important ingredient in day-to-day curries, pickles, chutneys and oleoresin.

Chilli pepper originates in South America, it is now widely grown on all continents. Currently, Asian and African production of dried chillies is significantly larger than production in South America. India is the largest producer with 1.72 million tonnes and contributes 41% of world chilli production, followed by China, Ethiopia, Thailand, Pakistan and Bangladesh (FAO, 2020). The production of Chilli in India is dominated by Andhra Pradesh which contributes nearly 37.35% to the total production. Telangana is the second largest producer contributing 23.11% to the total production followed by Madhya Pradesh (15.83%), Karnataka (9.85%), Orissa (3.70%) and others about 12% during 2021-22. In Karnataka, Dharwad, Ballari, Gadag, Raichur and Haveri are the major chilli producing districts with a production share of 28.00, 57.29, 2.36, 6.91 and 0.18%, respectively. India is not only the largest producer but also the largest consumer and exporter of chilli in the world. Indian chillies have been dominating the international chilli market for its important commercial qualities of colour and pungency levels.

Chilli with higher colour value and less pungency are preferred in Europe and the West. It is estimated by Food and Agriculture Organization (FAO) that 25% of agricultural crops are contaminated with mycotoxins that are unfit for human or animal use. Chillies that are grown in warm regions are easily prone to aflatoxin (AF) contamination (Iqbal et al., 2010). Also, there is a fact that among all the spices, chillies are easily susceptible to fungal spoilage. Many surveys from different countries like Belgium, Japan, United Kingdom, Spain, Portugal, Japan, Australia, Turkey, India, Canada, Hungary, China, Pakistan, Russia, Egypt and Singapore indicated the presence of aflatoxin in chilli peppers. Based on the regulation set by European Commission, the maximum permissible levels of AFB_1 and total AFs (B_1, B_2, G_1, G_2) in Capsicum species are 5 and 10 µg/kg, respectively (European Commission, 2006; Commission Regulation EC No.1881/2006; CIRCULAR NO: 05/2022-23). The presence of high concentration of aflatoxins in chillies represents a threat to consumer's health (liver cancer) and thereby restricting its commercial potential to be able to withstand international market demands.

India is the major producer and exporter of chillies but the presence of AF was not deterrent only for export potential but for domestic processing industries as well (www.imotforum.com). Several physical and chemical methods have been proposed to reduce AF in contaminated commodities. Physical methods mainly use segregation, thermal process, and radiation to lower the AFs concentration. A segregation process can be simply completed by sorting, absorbing, or washing out the AFs from foods. Sorting could be significant but incomplete since the presence of fungi growing can be only recognized when severe contamination occurred (Karlovsky et al., 2016). The recovery of absorbent and solvent used for absorbing or washing would be an issue (Piva et al., 1995). A thermal process has been considered inefficient, and it would change the properties of the product. Although roasting (200°C, 25 min) was able to reduce 90% of AFs in contaminated peanuts, the low L value of 39.3 indicated that the peanuts were nearly scorched and presented a dark color (Martins et al., 2017). Radiation methods usually refer to the ionizing or partially ionizing treatments by electromagnetic spectrum with short wavelengths, such as gamma irradiation or UV irradiation. With a sufficient dosage of gamma irradiation, a notable detoxification rate and almost no quality change were reported (Ghanem et al., 2008). However, the cost of gamma irradiation equipment and consumer hesitation about irradiated foods is a concern. Biological detoxification processes such fermentation largely change the form of the foods.

Chemical methods for detoxification are of interest due to their profound efficiency and affordable cost. Alkaline treatment can hydrolyze the lactone ring inside AFs molecules, but the process is reversible in acidic conditions, which might maintain the toxicity of AFs (Price and Jorgensen, 1985). Ozonation can significantly reduce AFs levels, but the whole process may take several hours to complete (Porto et al., 2019). Besides, ozone is toxic and explosive. Ammoniation can open the lactone ring similar to alkaline treatment, and its detoxification ability has been confirmed by the U.S. Department of Agriculture (USDA). However, significant losses of lysine and methionine were reported after ammoniation. Reactive agents such as sodium hypochlorite or sodium bisulfite can undergo chlorination or sulfonation at the C8 or C9 positions, activating AFs molecules to be decomposed (Samarajeewa et al., 1990). Although these chemical methods can effectively detoxify AFs, the safety of the degraded compounds and the removal of residual chemicals after treatments largely limit their application.

Ultraviolet light (UV) provides a high intensity of light. It has been used in the food industry for several purposes like surface sterilization, fluid disinfestation, air treatment, waste treatment, and insect trapping. This technology works with a wavelength range of 190–280 nm and results in germicidal and antimicrobial activities used to decontaminate water, fruits, and root vegetables (Cutler and Zimmerman, 2011). Consequently, the antimicrobial effect of UV light is through the generation of pyrimidine dimers, which distorts DNA helix and interferes with cell replication of exposed microorganisms (Lado and Yousef, 2002). Microscopic evidence has demonstrated that AFs are mainly distributed on or near the surface of contaminated foods, and thus a treatment applied near the surface would be sufficient for detoxification. UV is an ideal treatment due to its ability to detoxify AFs, affordable cost, and less quality impact. UV can degrade aflatoxin B_1 into more than 200 times less toxic compound, aflatoxin B_2, justifying the use of this method in practice (Shen, 2022). Most of the aflatoxin detoxification approaches in foods studied so far are either used in liquid substrates/cultures or limited to groundnut and corn products. There are limited reports on the development of AFB_1 detoxification strategies in red chilies.

Conclusion

Chilli peppers are an integral component of global cuisines, their susceptibility to aflatoxin contamination poses a significant challenge to both domestic consumption and international trade. With India being a major producer and exporter of chillies, the presence of aflatoxins not only threatens export potential but also undermines the safety of domestic processing industries. Various physical and chemical methods have been proposed for aflatoxin detoxification, but each comes with its own limitations, including incomplete removal, alteration of product properties, and potential safety concerns. The application of ultraviolet (UV) light emerges as a promising solution due to its ability to effectively degrade aflatoxins while maintaining food quality and safety. However, further research and development are necessary to optimize UV treatment protocols for chilli peppers and to ensure its practical feasibility within the food industry.

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A Review: Sustainable Production of Arid Fruit Crops Through Nutrient Management

Article ID: 48884

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Introduction

During the last decade, climate change has had a direct impact on several plant-related aspects, such as physiological processes, disease–pest frequency, yield, and the qualitative composition of fruit. The fruit production industry needs to determine new strategies and establish new cultivation methods that could enhance crop production, preserve fruit quality, meet the world's demand for food, and safeguard biodiversity.

Arid fruit crops (AFCs) play an important role in the economic and nutritional security of the inhabitants of arid regions. People inhibiting in dry land areas are known to suffer from a number of nutritional disorders owing to lower intake of protective foods like fruits & vegetables. Growth of fruit industry in such areas shall definitely increase their intake and helps in improving health hazards. The health giving properties of fruits have been recognized long before the discovery of vitamin and minerals in daily human diet and termed as a "**Protective food**". Fruits like ber (*Ziziphus mauritiana*), aonla (*Emblica officinalis*), pomegranate (*Punica granatum*), custard apple (*Annona squamosa*) fig (*Ficus carica*), guava (*Psidium guajava*), tamarind (*Tamarindus indica*) and mulberry (*Morus sp*.) *etc*. are important arid fruit crops.

Sustainable Fruit Production

It encompasses responsible and environmentally conscious practices aimed at ensuring the long-term viability of fruit farming. Some aspects of sustainable fruit production include minimal soil disruption, cover cropping, profitability and social responsibility and nutrient management. From these, nutritional management in arid fruit crops is one the most important aspect for obtaining high yield per unit area. It is necessary that the fruit growers should have appropriate knowledge about fruit tree nutritional management. Nutritional requirement of a plant varies with soil, crop species and its characteristics, environmental factors (i.e. temperature, rainfall, humidity, light *etc.*) and age of plants. These factors are closely related with plant metabolism, growth and development.

Nutrient Management

Nutrient refers to all those compounds required by plant as a source of development material and energy without which, it will not be able to complete its life cycle. While management involves the amount, source, placement and timely application of plant nutrients through the chemical fertilizers, organic manures and bio-fertilizers.

From an environmental point of view, the biggest single issue for Agriculture is the impact of fertilization. It takes a lot of fossil fuel to produce the nitrogen fertilizer and to move all the other major fertilizer components to where they are used. Nitrogen and phosphorus fertilizers can contaminate ground or surface waters. The best way to avoid all of these problems is to only deliver fertilizer to crops at the rate and timing that they can extract it from the soil and use it. For many specialty crops this is actually a practical possibility. Fertilizers can be delivered through the irrigation water (drip, sprinkler *etc.*) and growers can choose how much to deliver when based on testing of the growing crops themselves. This is already a common practice for many specialty crops.

Custard apple (*Annona squamosa*): Kumar *et al.* (2009) observed increase infruit yield (5.21 kg/plant) and TSS (21.39 ˚B) with the application of 400-250-400 g/plant NPK, while maximum average fruit weight (255.0 g) and pulp weight (101.8 g) were found in control of custard apple fruit cv. Balanagar.

Pomegranate (*Punica granatum*): Sheikh and Manjula (2009) reported the maximum fruit yield (76.04 kg/plant), fruit weight (335.25 g), fruit diameter (8.05 cm), juice (49.97 %), TSS (17.02 ^{0}B), titrable acidity (0.60 %), ascorbic acid (15.26 mg/100ml) and total sugar (11.70 %) in the plants applied with P (200 g/plant), N (400 g/plant) and K (200 g/plant) in pomegranate fruit cv. Ganesh.

Aonla (*Emblica officinalis*): Tripathi and Shukla (2011) recorded that the foliar application of calcium nitrate at 1.5% increased the weight of fruit, volume of fruit, pulp weight, TSS, total sugar and ascorbic acid and decreased stone weight and Titratable acidity in aonla cv. Banarasi.

Guava (*Psidium guajava*): Sharma *et al*. (2013) revealed that the maximum fruit length, fruit diameter, fruit weight and pulp weight with the application of Azotobactor 200 g/tree + 25 % N/tree through FYM + 75 % N/tree through inorganic fertilizer in guava cv. Sardar.

Ber (*Ziziphus mauritiana*): Mahendra *et al.* (2009)[a]observed the highest fruit yield (36.60 kg/tree), fruit weight (19.12 g), TSS (14.00 ˚Brix), total sugars (9.90 %) and the lowest acidity (0.17 %) with treatment of FYM+100%NPK+Azotobacter+PSB in ber fruit cv. Banarasi karaka.

Mahendra *et al*. (2009)[b] observed the maximum plant height (5.70 m), plant spread (2.62 m), fruit set (57.55%) and fruit retention (42.80 %) with the application of FYM+100%NPK+Azotobacter+PSB in ber fruit cv. Banarasi karaka.

Future Need

Need to study the identification of nutrient constraints and management under arid fruit cropping systems for different soils. Need to study the combined application of organic with inorganic fertilizers to reduce cost and increase the yield in arid zone fruit crops. Improvement through awareness in growers for in area under cultivation, production and productivity of arid fruit crops with nutrient management for better supply of these fruits in whole country.

Conclusion

Arid fruit crops are rich sources of energy and nutrients particularly micronutrients (like iron and calcium) and vitamins (like vitamin B, C, folic acid, and carotenoids) which play important role in malnutrition alleviation and obesity management in arid and semi-arid regions of India. So, sustainable production of different arid fruit crops can be increase through proper nutrient management.Integrated nutrient management is the best approach for improving yield and quality of aonla and ber. Application of INM as well as foliar spray of micronutrient improve fruit retention and yield parameters in guava.

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Mitigating Wild Animal Issues in Agriculture: Strategies for Coexistence

Article ID: 48885

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Introduction

Agriculture plays a vital role in sustaining human life, providing food, and supporting economies worldwide. However, the coexistence of agriculture and wildlife often poses challenges, as wild animals may cause damage to crop, leading to economic losses for farmers. Balancing the needs of agriculture with wildlife conservation is crucial for maintaining biodiversity and ensuring sustainable food production. This article explores the problems associated with wild animals in agriculture and proposes solutions to foster harmonious coexistence.

Challenges to Agriculture

While agriculture is essential for food production, the interaction between wild animals and agricultural activities can lead to various problems. Some of the key issues include:

1. Crop Damage: Wild animals, including deer, rabbits, rodents, and birds, are known to damage crops by feeding on them or trampling through fields. This can result in significant yield losses for farmers, impacting both their livelihoods and the global food supply.

2. Predation on Livestock: In regions where agriculture and wildlife habitats overlap, predators such as wolves, coyotes, and big cats may pose a threat to livestock. This creates a challenge for farmers who must protect their animals while respecting the conservation needs of these wild species.

3. Disease Transmission: Wild animals can serve as carriers of diseases that affect crops or livestock. For example, certain insects and birds can transmit plant pathogens, leading to the spread of diseases among crops. This poses a threat to agricultural productivity and food safety.

4. Biodiversity Impact: Intensive agriculture practices, including the use of pesticides and habitat destruction, can negatively impact the natural habitats of wild animals. This can contribute to a decline in biodiversity, disrupting ecosystems and potentially causing long-term ecological imbalances.

5. Habitat Fragmentation: Expansion of agriculture often results in habitat loss and fragmentation, isolating wildlife populations. This can disrupt ecological balance and biodiversity, potentially leading to population declines or even local extinctions.

6. Crop-Eating Insects: Insects, both wild and domesticated, can have a significant impact on crop yields. While some insects are beneficial for pollination, others can be destructive pests that damage crops and reduce agricultural productivity.

7. Human-Wildlife Conflict: As agriculture expands into natural habitats, conflicts between humans and wildlife may increase. Animals may venture into farmland in search of food, leading to confrontations, property damage, and safety concerns for both farmers and the public.

8. Pollution and Habitat Destruction: Agricultural practices can result in habitat destruction and pollution, affecting the quality of water, air, and soil. This can have indirect consequences on the health and survival of wild animal populations.

Addressing these challenges requires a balance between agricultural productivity and conservation efforts. Sustainable farming practices, habitat preservation, and responsible wildlife management can contribute to mitigating the conflicts between wild animals and modern agriculture.

Additionally, the development of innovative technologies and alternative farming methods may offer solutions to reduce the negative impact of wild animals on agricultural activities.

Solutions for Coexistence

1. Habitat Management: Implementing habitat management practices, such as creating wildlife corridors and buffer zones, can help mitigate the impact of agriculture on natural habitats. These measures provide spaces for wild animals to thrive while minimizing conflicts with agricultural activities.

2. Livestock Guardian Animals: Using guardian animals, such as dogs can help protect livestock from predators. These animals act as a deterrent, reducing attacks and allowing for coexistence between farming and local wildlife.

3. Fencing and Deterrents: Installing sturdy fences around crop fields can deter larger animals like deer and rabbits. Additionally, employing non-lethal deterrents such as noise devices, motion-activated lights, and scent repellents can help keep wildlife away from cultivated areas.

4. Integrated Pest Management (IPM): Adopting Integrated Pest Management practices involves using a combination of biological, cultural, and chemical methods to control pest populations. This approach minimizes the reliance on chemical pesticides, promoting a more balanced ecosystem that includes natural predators and beneficial insects.

5. Research and Technology: Investing in research and technology to develop innovative solutions, such as smart fencing, automated scare devices, and remote monitoring systems, can enhance the effectiveness of wildlife management in agriculture.

6. Natural Repellents: Some farmers may prefer to using natural resources instead of mechanical and chemical protective practices. The way to minimize crop damage from wild animals is Beehive fencing, fish or garlic natural emulsion, smoke, castor oil etc.

Here are Some Common Types of Fencing Used to Protect Against Wild Animals

Protecting crops and livestock from wild animals often requires the installation of effective fencing. Several types of fencing can be employed based on the specific needs of the agricultural setting and the types of wildlife present.

1. Traditional Fencing:

a. Chain Link Fencing: Sturdy and durable, chain link fencing is effective in keeping out larger animals like deer. It allows for visibility and can be combined with other deterrents.

b. Woven Wire Fencing: This type of fencing is versatile and comes in various mesh sizes. It can be effective against different-sized animals, including rabbits and smaller pests.

2. Bamboo Fencing:

Bamboo Panels: Bamboo fencing can be an eco-friendly option for deterring smaller animals. It is aesthetically pleasing and provides a natural look to the surroundings.

3. Wooden Fencing:

Split Rail Fencing: While not suitable for keeping out smaller pests, split rail fencing can be effective for marking boundaries and deterring larger animals.

4. Rope and Twine Fencing:

Polywire and Polyrope: These are lightweight options that are effective for temporary fencing or rotational grazing. They often have some conductivity, creating a psychological barrier.

5. Electric Fencing:

Electric Netting: Suitable for both temporary and permanent use, electric netting is often used for poultry and small animal enclosures. It delivers a mild shock to deter animals.

6. Polypropylene Fencing:

Poly Deer Fencing: Lightweight and invisible, poly deer fencing is designed to keep out deer and other wildlife. It is durable and weather resistant.

7. High-Tensile Wire Fencing:

Smooth Wire Fencing: High-tensile smooth wire is used for creating strong and effective barriers. It is often used in combination with other fencing materials for added strength.

8. Game Fencing:

Heavy-Duty Wildlife Fencing: Used in areas with a high concentration of large wildlife, such as elk or bison, heavy-duty game fencing is tall and robust to prevent animals from jumping or breaking through.

9. Wildlife Deterrent Fencing:

Tilted Fencing: This design involves angling the fence outward, creating an overhang that discourages climbing or jumping by animals.

Coyote Rollers: Rotating cylinders placed on top of the fence prevent animals like coyotes from gaining traction and climbing over.

10. Combination Fencing:

Multi-Layered Fencing: Combining several types of fencing materials, such as electric wire with traditional fencing, can provide a more effective barrier against a range of wildlife.

When selecting a fencing type, it is essential to consider the specific wildlife threats in the area, the size of the animals, and the desired level of permanence for the fence. Additionally, regular maintenance is crucial to ensure the ongoing effectiveness of the fencing in protecting agricultural assets from wild animals.

Conclusion

1. The coexistence of agriculture and wild animals is essential for maintaining ecological balance and ensuring sustainable food production. By implementing proactive measures like habitat management, fencing, and integrated pest management, farmers can mitigate the challenges posed by wildlife.

2. Collaborative efforts between farmers, researchers, and policymakers are crucial to finding innovative solutions that promote harmony between agriculture and the natural world. Through responsible and sustainable practices, we can strike a balance that benefits both agricultural productivity and wildlife conservation.

3. The government should implement various scheme and subsidize on fencing for reducing wild animal attack. The forest department should conduct afforestation programme on massive scale in nearby forest area of villages to reduce attack of wild animals in farming.

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Maturity Indices in Vegetable Crops

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Abstract

The determination of optimal harvest time is crucial for fruit and vegetable growers to ensure the production of high-quality crops and maximize market value. Maturity indices serve as essential tools for assessing the readiness of vegetables for harvest. The physiological and biochemical changes that occur during the ripening process of vegetable crops. These changes include respiration and ethylene production, colour changes, texture changes, acid content, aroma development and seed development. Understanding these changes is essential for developing effective maturity indices. These indices provide measurable indicators of crop maturity, allowing growers to make informed decisions regarding the optimal harvest time. The specific maturity indices used for various vegetable crops.

Introduction

Maturity indices are important indicators used in agriculture, particularly in vegetable crop production, to determine the optimal time for harvesting. These indices help farmers and growers make informed decisions about when to harvest their crops to ensure maximum yield, quality, and marketability. Here are some common maturity indices used in vegetable crops.

Determination of Maturity Indices

Physical Appearance:

a. Size: Monitoring the size of vegetables such as tomatoes, cucumbers, and eggplants can indicate maturity. Typically, fully mature vegetables reach their maximum size.

b. Color: Changes in color can indicate maturity. For example, tomatoes change from green to red as they ripen, while bell peppers change from green to their respective colors (red, yellow, orange, etc.).

c. Texture: Texture changes can indicate maturity. For instance, cucumbers become firm and crisp when mature.

d. Shape: Some vegetables, like squash and zucchini, develop a characteristic shape when mature.

Physiological Indices:

a. Seed Development: Monitoring the development of seeds within the vegetable can indicate maturity. Mature vegetables often have fully developed seeds.

b. Stem and Leaf Characteristics: Changes in stem and leaf characteristics, such as drying or yellowing, can indicate maturity.

c. Flower Development: In some vegetables, the development of flowers or the cessation of flowering can indicate maturity.

Chemical Indices:

a. Sugar Content: Monitoring sugar content, often measured as Brix levels, can indicate maturity. Fully mature fruits tend to have higher sugar content.

b. Starch to Sugar Ratio: In some vegetables, starch content decreases and sugar content increases as they mature.

c. Acidity Levels: Changes in acidity levels can indicate maturity in certain vegetables, such as citrus fruits.

Taste and Flavor

1. Taste Test: Actual taste testing can be a reliable indicator of maturity in some cases. For example, sweetness in fruits like melons and strawberries can indicate maturity.

2. Aroma: Aroma development can indicate maturity, particularly in herbs and aromatic vegetables.

Harvest Interval

Monitoring the time interval from planting to harvest can be an indirect indicator of maturity. Each vegetable crop has an approximate harvest window that indicates maturity.

Market Standards

In commercial agriculture, there are often established market standards for maturity, including size, color, and other characteristics. Adhering to these standards ensures market acceptance and quality.

It's important for farmers to consider multiple indices and factors when determining maturity, as different vegetables may have unique indicators of readiness for harvest. Additionally, factors such as weather conditions, soil health, and cultivar differences can influence maturity indices. Regular monitoring and experience are key in accurately assessing maturity in vegetable crops.

Maturation is the stage of development leading to the attainment of the consumer for a particular purpose.

1. Physiological maturity - when a plant or plant part will continue ontogeny even if detached.

2. Horticultural maturity - when a plant or plant part possesses the pre requisites for utilization by.

Maturity Indices for Important Vegetables

Tomato: The stage of maturity for harvest depends upon the purpose for which they are used and the distance covered to reach the market. The maturity standards of tomato are grouped as follows:

a. Immature: Before seeds have fully developed and jelly like substance surrounding the seeds has formed. Fruits are not suitable for consumption. Fruits harvested are tough and leathery and develop poor colour when ripened artificially.

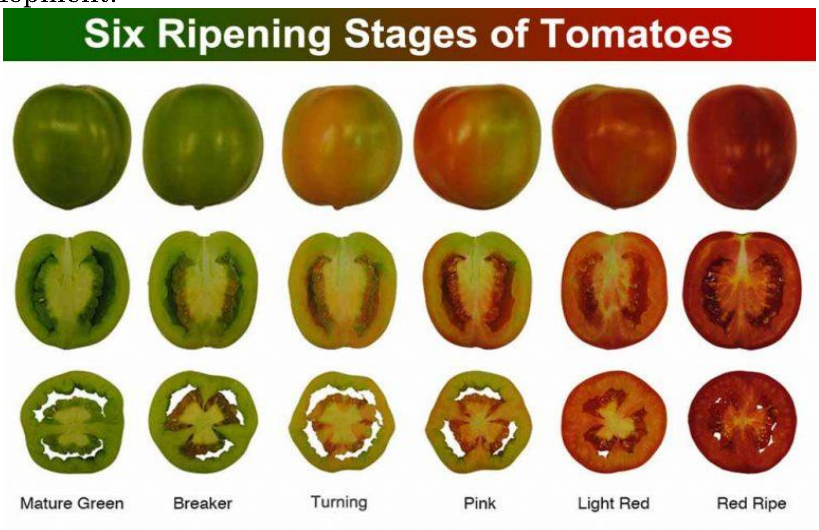
b. Mature Green: Fully grown fruit, light green colour at blossom end changed to yellowish green. Seeds are surrounded by jelly like substance, filling the seed cavity. This kind of fruit is artificially ripened and suitable for long distance market. The longest shelf life of fruits was obtained by harvesting tomato fruits at this stage.

c. Turning: 1 th of the surface at blossom end shows pink colour (Breaker Stage). Green house tomatoes are harvested at this stage.

d. Pink: 4 th surface shows pink colour.

e. Hard ripe: Nearly all the areas are red or pink with firm flesh.

f. Over ripe: Fully coloured and soft. This is suitable for processing, as it possesses good quality and colour development.



Okra: Okra pods are immature fruits and are harvested when they are very rapidly growing. Immature green, tender fruits should be picked 3rd to 5th day from the time of first pod formation or 3 to 7 days after flowering. Okra should be harvested when the fruit is bright green, the pod is fleshy and seeds are small. After that, the pod becomes pithy and tough, and then the green colour and mucilage decrease. Development of crude fiber is used to determine the optimum stage of maturity.

Brinjal: Tender fruit with desirable size having soft seeds (over mature, if fruit is dull in colour and seedy). Pick brinjal when their colour is bright and glossy. Once they lose their shine they are too old. Pick the fruit like capsicum. Days of maturity 70-80.

Chilli: Fruits are picked according to their type and purpose when they are grown:

- **a. Green fruits**: Fruits are harvested when they are still green but fully grown. It needs 5-6 pickings for harvesting the whole crop.
- **b. Pickles**: Either green or ripe fruits are collected.
- **c. Drying:** Red fully ripe fruits are picked at an interval of 1-2 weeks and harvesting continues for a period of about 3 months. The ripe chillies are dried under sun for 8-15 days, while commercially it is dried at about 54oC in 2-3 days. Days of maturity 60-90.

Capsicum:

- **a. Green pepper varieties** - Fully mature green fruits should be harvested before ripening
- **b. Red and yellow varieties** - Fully mature fruits should be harvested at the onset of colour change.

Pepper fruits at the time of harvest should be firm and crisp not tender and immature.

Cucurbits: Harvest cucumber, bottle gourd, bitter gourd, snake gourd, ridge gourd and sponge gourd when they are still young, tender and have soft seeds inside. They should be harvested before fruit colour changes from green to yellow. Do not store cucumbers with apples or tomatoes. Cucumbers will spoil after about one week. Harvest before the seeds inside swell.

Water melon: Water melon is harvested at fully ripe stage. Maturity signs are withering of tendril, change in belly color or ground spot to yellow and the thumping test produce dull sound on maturity and metallic sound in unripe fruits. Metallic sound from thumping for shipping and dull hollow sound when thumping is for immediate use/local market.

Musk melon: Full slip stage-easily separated from vine with slight twist living clean cavity (immediate use). Half slip stage (shipping)

Gherkins: The crop is ready for harvest between 30 and 35 day after planting. The price of the produce is fixed only by the grade of the fruit.

Onion: Bulbs are considered mature when the neck tissues begin to soften and tops are about to abscise and decolourise.

Moringa: Fruits of sufficient length and girth are harvested before they develop fibre.

Sweet potato: When the leaves turn yellow and begin to shed, tubers can be harvested. The tubers can also be cut and judged. In immature tuber, cut surface shows dark greenish colour while the colour will be milky white in fully mature tubers.

French beans: Tender and fleshy pods can be harvested before the formation of fibre for vegetable purpose. Seed size, percent seed, dry matter content, distribution of seeds are the reliable maturity indices when the crop is harvested for seed purpose.

Peas: The maturity of the pods is indicated by the change of pod colour from dark green to light green with well-filled grains/seeds.

Conclusion

The maturity indices play a vital role in determining the optimal harvest time for vegetable crops. Their application helps growers ensure the production of high -quality produce, enhance post-harvest management and meet consumer demands. Understanding the physiological and biochemical changes during ripening, exploring different maturity indices and addressing challenges in maturity assessment are key areas for future research and advancements in the field.

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STR Dryer: An Innovative Mechanical Crop Drying Techniques

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Summary
Grain drying is a crucial unit process that minimises loss and extends storage time for the purpose of marketing and seed use after harvest. High moisture encourages the growth of mould and insects that are harmful for grain. A STR dryer is an innovative technique for drying of crops in short duration. In this dryer temperature and moisture distributions is quite uniform. Duration of drying of crop in this dryer is about 4–6 h depending upon the type of crop, available moisture, air velocity and source of energy used. This dryer is considered to be a one of the alternative effective drying technologies.

Introduction
The process of drying involves passing hot air through a thin layer of the substance in order to remove moisture and reach equilibrium moisture content (EMC). The temperature, velocity, relative humidity, variety, and maturity of the drying air all affect the amount of moisture is removed from agricultural products. Hence, various isolated and combined methods are involved in moisture removal from a grain (Couto, 2002). Depending on the harvest technique, variety, and region, cereal crops are harvested in a moisture range of 16 to 20% (w.b). During harvesting season, microorganisms, insects, and other pests can damage paddy due to its high respiration rate. Insects and moulds that are harmful to grain grow in environments with high moisture content. When crop is stored at a moisture level that is too high, it becomes vulnerable to fungal infections and chemical reactions, which can cause damage following dehusking (Mehdizadeh *et. al.,* 2012). In order to avoid insect infestation and rice grain and seed quality degradation, it is imperative that the crop be dried.

In Bihar, sun drying is the traditional method of drying. When crop is sun dried, farmers leave it out in the open, in their yard or on a concrete surface for a long duration of time. It is a laborious procedure that is dependent on the weather as well. Rain and other abrupt changes in the weather might hinder the sun-drying process. They cause damage to grain and lower its quality and market value. They can cause delayed drying, rewetted grains, and quality degradation. For Bihar, to get better drying results, alternative drying techniques including mechanical drying must be adopted.

STR Dryer
An economical hot air circulation dryer was developed in the department of Agricultural Engineering of Bihar Agricultural University, Sabour. The dryer is developed for rapid and efficient drying of crops.

Construction and Working of Dryer
The STR dryer consists of two cylinders (inner, outer), blower, hot air pipe, stove, net and thermometer. Stainless steel (SS) wire mesh is used for the inner and outer bins (8mm mesh). These cylinders are made in a way that allows grains to be positioned correctly within their annular spaces. The outside bin can be modified to dry 350 to 500 kg every batch, depending on the availability of grain, while the inner bin remains constant. The outer bin should be configured to accommodate 450 kg of paddy at its best. Fuel can also be made from agricultural leftovers like straw, rice husk briquettes, wood, and occasionally coal. The dryer has a fan mounted on top that is readily available locally to draw hot air in and force it uniformly into the perforated cylinders. A one horsepower electrical motor operates the blower. The hot air that a hob produces is sent via a hot air pipe. A temperature monitor device has been installed to continuously check the grain's temperature since high temperatures or quick drying lower seed germination rates and milling yields because cracks will form. The drying performance of the dryer is

appreciable by reducing the grain moisture to 10 % during drying. The average time required for drying of grains is about 4-6 hrs with average drying efficiency.

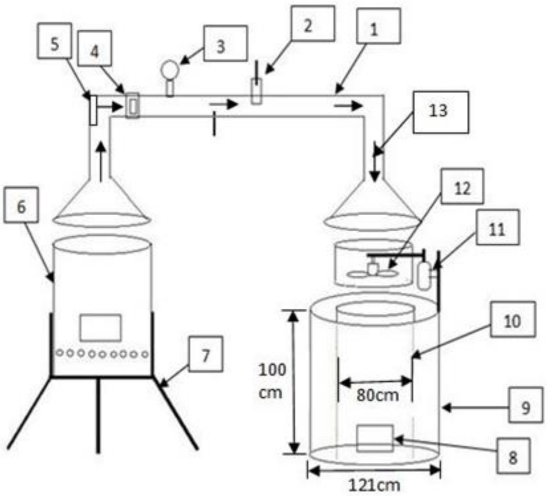

Fig. 1: Schematic and photographic view of STR dryer 1. Hollow pipe; 2. Digital temperature sensor ; 3. Pressure gauge ; 4. Digital anemometer ; 5. Gate valve ; 6. Stove ; 7. Tripod stand ; 8. Discharge gate ; 9. Outer cylindrical bin ; 10. Perforated inner cylindrical bin; 11. Motor 12. Fan and 13. Hot air.

Importance and Future Scope

The STR dryer is suitable for small and marginal farmers for drying of maize, paddy, wheat etc. This type of dryer will help the famers to save grain losses during harvesting. It will allow to early harvest the crops before scattering losses and can be dried in the mechanical dryer. The los cost dryer has high drying efficiency with minimum drying time. It has provision to control hot air flow rate resulting in maintaining the temperature inside the drying chamber. The source of heat generation in stove can be done through easily available materials like agriculture residues, rice husk, coal etc. The following are the other importance of STR dryer:

1. Quick method of drying of grains.
2. Perfect drying is possible even under unfavourable weather condition.
3. To lower labour intensity, enhance working conditions, boost worker productivity, and offer practical ways to realise modernization, intensification, and industrialization of agriculture.
4. To enhance grain processing, storage, and quality.
5. It may prevent the contamination that results from food drying naturally, when the grain is naturally dried, care must be taken to keep it clean and avoid farmers from soaking into contaminants like silt.
6. Seed loss is minimized.
7. Low cost of construction.
8. Easy to operate.
9. Can be installed in thresh yard or storage hall.
10. Suitable for drying of maize, paddy, wheat etc.
11. Minimize the postharvest losses.

The dryer has wider future scope in production of food grains. Its drying can be improved though introduction of automation. The source of heat generation can be replaced through better source. The dryer can be used for drying of other small grain with minor modification and adjustment of rate of hot air supplied. A special attention is needed i.e. mixing of grains from centre to outer portion inside the cylindrical bin.

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Effects of Ethylene on Quality of Fresh Fruit and Vegetable

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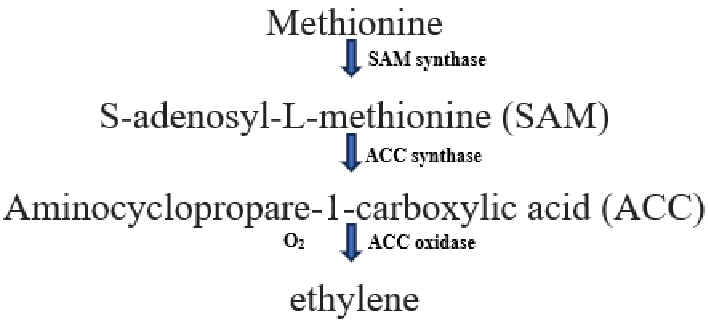
Introduction

It is a gaseous plant hormone that stimulates ripening of fruit, suppression of development, abscission of leaves, aging, and numerous other plant processes. This colorless gas is produced by plants naturally and serves as a regulator of plant growth. When present in extremely small amounts, this gaseous plant hormone regulates harvested horticulture crops. Fruits, vegetables, and ornamental plants all react differently and in various ways to endogenously delivered ethylene, which can be beneficial. Several forms of stress, such as mechanical wounding and cutting, promote the formation of ethylene. When fruits and vegetables are sliced or chopped for processing as fresh goods, ethylene production is consequently enhanced. The level of quality attained during harvest typically limits the quality of fresh fruits and vegetables that are given to consumers, and postharvest management can usually only preserve rather than raise quality. The final quality and growth of fresh fruits and vegetables are influenced by both genetic and environmental variables. Fruit post-harvest management during harvesting, shipping, and storage affects the quality of both fresh and processed fruit. This handling must be carefully supervised to maintain the highest fruit quality upon harvest.

Ethylene Synthesis



Effects of Ethylene on Quality of Fruits and Vegetables

Stresses like cold and wounding encourage the production of ethylene, which can improve the ripening of fruits. Ethylene and certain phenolic chemicals that have been linked to a decrease in some diseases improve phenylopanoid metabolism. There are many legitimate reactions to both endogenously produced and exogenously administered ethylene that speed up the ripening of fruit.

It should be possible to genetically build transgenic plants with anti-sense constructions to reverse particular developmental changes by locating, analyzing, and isolating the inducers for these genes.

Beneficial Effects of Ethylene in Fruits and Vegetables

The use of ethylene to cultivate plants in fields and orchards, as well as plants in greenhouses and harvested goods, is associated with its advantageous effects. Fruit and vegetables may have been ripened by ethylene gasses, which also have a liquid form effect on bulb sprouting, seed germination, a reduction in apical dominance, the start of roots, the stimulation of latex and other secretions, the enhancement of color development, and the support of cultural control over insect pests.

1. Effects of ethylene on fruits and vegetables appearance:

a. The consumer prefers to associate fresh fruits' appearance with their quality. For example, ethylene speeds up chlorophyll breakdown in banana fruits, leading them to appear yellow or orange. A similar process happens in tomatoes, where C_2H_4 increases chlorophyll loss and the emergence of red color.

b. The destructive ripening is caused by temperature.

i. Soft, ripe pulp with a greenish-yellow skin color, a weak neck, split peel, and brown flecks on a greenish-yellow peel are indications of high temperature disorders (cooked fruit).

ii. Low temperatures and Insufficient ethylene might lead to uneven ripening. Ethylene produced during the ripening process regulates a number of physiological processes, including the biosynthesis of sugar, peel discoloration, and firmness loss.

The climacteric period in fruits that are fruitful begins with an increase in respiration rate and metabolic activity, which indicates the beginning of ethylene production. As the fruit reaches the fully ripe stage, ethylene production increases and falls in tandem with variations in respiratory climacteric. Critical metabolic and physical changes, such as an increase in acids, a decrease in tannins and hemicelluloses, a quick conversion of starch to sugars, a ripening process that begins, and softening of the pulp and skin tissues, are all indicators of the starting point of ripening.

2. Effects of ethylene on fruits and vegetables texture: Ethylene has positive benefits on tissue softening, but its unintended softening also has a definite texture-altering effect. Even for storage in a controlled environment, quality can be improved by removing C_2H_4. For example, melons (*Cucumis melo*) kept in controlled environments with 10% CO_2 and 10% O_2 showed less deterioration and were firmer when a C_2H_4 absorbent was added to the storage space.

3. Ethylene enhances taste and flavor of fruit by stimulating repining: It is believed that ethylene production, which surges dramatically in ripening climacteric fruit, orchestrates a variety of ripening processes. By promoting fruit ripening, C_2H_4 generally improves flavor and taste. But in tomatoes that were selected when they were mature-green and ripened with C_2H_4, the overall volatile development never reached the levels achieved by fruit that was ripened on the plant.

Future Prospects

Eliminating ethylene from the environment around fruit can extend its shelf life. Because of the higher quality and longer shelf life of tropical fruits, postharvest technology has the potential to enable developing nations to earn more essential foreign exchange through the creation of controlled or modified atmospheres. In order to provide high-quality products and make a profit, it is therefore necessary to look for alternative control or management techniques for the future, such as the employment of postharvest technologies to create regulated or modified atmospheres.

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Vertical Farming: Problems and Possible Approaches

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Introduction

Prime agricultural land can be scarce and costly. With global population expansion, there is an increasing demand for more food and more space on which to grow it. However, some entrepreneurs and farmers are looking up, rather than out, for more space to grow food. One solution to our desire for extra space may be found in abandoned warehouses in our towns, new buildings constructed on environmentally degraded land, or even used cargo containers from ocean voyages. This method, known as vertical farming, includes growing crops in controlled indoor conditions with exact light, nutrients, and temperature. Vertical farming involves growing plants in layers that can reach several floors tall. Although small, home vertical gardening (including window farms) has existed for decades, commercial-scale vertical farms have only been seriously examined in the United States for the past few years.

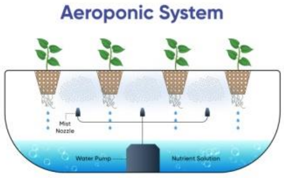
Despite the fact that this term is not new, it is not widely recognized worldwide, and in India, where urban areas rely heavily on rural areas for food, they face major issues such as non-availability and price fluctuations of commonly used vegetables and fruits. With 50% of the Indian population expected to live in cities by 2050, when climate change and mental illness caused by overcrowding, pollution, and other factors would be at their peak and reliance on conventional farming would be impossible, vertical urban indoor farming or Roof Top Garden (RTG) farming would be a lucrative option.

Types of Vertical Farms

Vertical farms come in different shapes and sizes, from simple two-level or wall-mounted systems to large warehouses several stories tall. But all vertical farms use one of three soil-free systems for providing nutrients to plants—hydroponics, aeroponics, or aquaponics. The following information describes these three growing systems:

1. Hydroponics: The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. The plant roots are submerged in the nutrient solution, which is frequently monitored and circulated to ensure that the correct chemical composition is maintained.

2. Aeroponics: The National Aeronautical and Space Administration (NASA) is responsible for developing this innovative indoor growing technique. In the 1990s, NASA was interested in finding efficient ways to grow plants in space and coined the term "aeroponics," defined as "growing plants in an air/mist environment with no soil and very little water." Plants grown in these aeroponic systems have also been shown to uptake more minerals and vitamins, making the plants healthier and potentially more nutritious.



3. Aquaponics: An aquaponic system takes the hydroponic system one step further, combining plants and fish in the same ecosystem. Fish are grown in indoor ponds, producing nutrient-rich waste that is used as a feed source for the plants in the vertical farm. The plants, in turn, filter and purify the wastewater, which is recycled to the fish ponds.

Pros and Cons of Vertical Farms

Some of the advantages of vertical farming are as follows:

1. Continuous Crop Production
2. Elimination of Herbicides and Pesticides
3. Protection from Weather-Related Variations in Crop Production
4. Water Conservation and Recycling
5. Climate Friendly.

In spite of these perceived advantages of vertical farms, some agricultural experts are skeptical that the costs and benefits will pencil out. Some think that expensive urban real estate in many cities may rule out vertical farms (although using abandoned warehouses or environmentally contaminated sites may help the economics). And the high electricity usage to run lighting and heating/ cooling in a vertical farm impacts the economics. Below is a summary of the perceived disadvantages of vertical farming:

a. Land and Building Costs
b. Energy Use
c. Limited Number of Crop Species
d. Pollination Needs.

Problems and Possible Alternative Approaches in Vertical Farming and Urban Agriculture in India

Urban agriculture has a long way to go before it can be used effectively in India and elsewhere, as vertical farming is not yet a reality on a major scale. The two primary issues have been financial and technological feasibility. Vertical farming, also known as indoor farming, requires modern building materials and renewable energy systems such as light shelves, light pipes, and fiber optics that deliver natural light deep into buildings to provide energy for photosynthesis, as well as skilled workers to operate it, so the rate of return does not appear to be profitable to investors. Conventional farming, on the other hand, does not require either of these; but, in the future, Z-farming (Zero-Acreage) and vertical farming may become viable options for investors. This is because, in the event of climate change, relying on the outside environment for conventional farming would be unfeasible. Additionally, with global warming reaching its peak and the urban heat island effect increasing in cities, urban farming in the form of roof top gardening (RTG) could be a profitable option for the future. There are several sorts of agriculture and farming systems in urban settings nowadays. Some of them can be used for the use of vertical farming which is a future goal of India.

Agriculture land is becoming increasingly scarce, and its cost is rising. This notion is not new in India; it has been used in rural areas for decades, with landlords giving farmers a piece of land to cultivate in exchange for roughly half of the grains produced. We do not see urban farming in practice in India due to a lack of open spaces in cities as well as a lack of understanding and thought among people in India. For example, because India is a developing country, there is a lot of construction work going on in building construction that takes about 2- 4 years on average (taking group housing as an example), so if vacant lands where construction has not yet begun farming are used during that time, it can also contribute to the food supply. Also, builders constructing flats provide green open spaces in their communities, but only with beautified flora. Thus, providing incentives, creating awareness, and encouraging people to engage in urban gardening is critical and necessary for future cities.

Vertical Farming: A Possible Replacement to Conventional Farming in Future

The number of miles that food travels in cities from its source of production may expand dramatically in the future if cities' reliance on rural conventional farming for food and nutrition security continues as it does today. In this situation, future cities would have to produce their own food, and with rising land prices, conventional land farming would be impossible. However, vertical farming or roof top farming (also known as Zero-Acreage Farming because they do not use land) would be a viable approach and solution for city nutrition.

Conclusion

Vertical farms in urban settings are a relatively recent occurrence, although interest in this method is increasing. Several variants of vertical farms are being tested around the world, and new technologies and technology are anticipated to improve these farms' energy efficiency and profit margins in the future. In the foreseeable future, most vertical farms will concentrate on high-return, short-rotation crops like salad greens, with local restaurants frequently purchasing all of the production. In addition, vertical farming has opened up new possibilities for architecture and urban design. Urban designers have emphasized the significance of making cities greener, healthier, and safer. Vertical farming, by merging food production and architecture, aids in the creation of multifunctional buildings. There are few benefits to count, so there is a need for institutional support as well as interest in people to participate in it. This is possible by spreading awareness of the benefits associated with it, strengthening policies like incentivizing farming to make it appealing to urban dwellers, financial and technological support by the government to developers of urban farmers, or moving forward to a concept of "sharing backyard" so that different communities can be reached. Once all of these steps are completed, urban agriculture in India can serve as an urban regeneration tool for current and future cities, providing social (creating and enhancing social interaction), economic (enhancing job opportunities in cities), and environmental benefits.

The Agricultural Revolution: How AI is Transforming Food Production?

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Introduction

In the age-old battle against hunger and food scarcity, humanity has always sought innovative solutions. Today, as our population grows and climate change threatens traditional farming practices, technology has emerged as a critical ally. Artificial Intelligence (AI), once confined to science fiction, is now revolutionizing agriculture and food production. From precision farming to predictive analytics, AI is reshaping how we grow, harvest, and distribute food around the world.

Precision Farming

Precision farming is a game-changer in modern agriculture, allowing farmers to optimize crop yields while minimizing resources. AI-powered systems collect and analyze data from various sources such as satellites, drones, and sensors to provide insights into soil health, weather patterns, crop growth, and pest infestations. By leveraging this data, farmers can make informed decisions, such as when to plant, irrigate, fertilize, or apply pesticides, resulting in increased efficiency and reduced environmental impact. For example, in Brazil, AI-driven precision agriculture has helped soybean farmers increase yields by up to 15% while reducing pesticide use by 25%.

Crop Monitoring and Management

One of the most significant challenges in agriculture is monitoring vast expanses of land efficiently. AI-enabled drones equipped with cameras and sensors can survey fields with unprecedented detail, detecting issues like nutrient deficiencies, water stress, or pest outbreaks. These drones can also precisely apply treatments, such as targeted pesticide spraying or irrigation, reducing waste and ensuring healthier crops. Additionally, AI-powered software can analyze images captured by satellites to monitor crop health on a larger scale, providing valuable insights to farmers and policymakers alike.

Predictive Analytics

Predicting future agricultural trends and challenges is crucial for sustainable food production. AI algorithms can analyze historical data, weather patterns, market trends, and even social media to forecast things like crop yields, demand, and pricing. This information helps farmers make strategic decisions about which crops to plant, where to allocate resources, and when to harvest. For instance, IBM's Watson Decision Platform for Agriculture uses AI to provide personalized recommendations to farmers, helping them optimize their operations and increase profitability.

Smart Irrigation and Water Management

Water scarcity is a pressing issue in agriculture, exacerbated by climate change and population growth. AI-powered irrigation systems use sensors to monitor soil moisture levels in real-time, allowing for precise watering based on plant needs. These systems can also factor in weather forecasts to adjust irrigation schedules accordingly, reducing water waste and improving crop health. In California's Central Valley, AI-driven irrigation systems have helped farmers cut water usage by up to 30%, contributing to both environmental conservation and cost savings.

Supply Chain Optimization

AI is not only revolutionizing farming practices but also transforming the entire food supply chain. AI algorithms can analyze data from various sources, including sensors, RFID tags, and blockchain technology, to track products from farm to fork. This real-time visibility enables better inventory management, quality control, and logistics optimization, reducing food waste and ensuring fresher, safer products for consumers. Companies like Walmart and Nestlé are already using AI to streamline their supply chains, improving efficiency and sustainability.

In an era where technology has infiltrated almost every aspect of our lives, it's no surprise that agriculture and food production are also undergoing a technological revolution. At the forefront of this revolution is artificial intelligence (AI), a powerful tool that is reshaping farming practices, enhancing crop yields, and ensuring food security for a growing global population.

Precision Agriculture: Cultivating Efficiency

Gone are the days of one-size-fits-all farming methods. With AI, farmers can now implement precision agriculture techniques that tailor farming practices to specific conditions within each field. This means using sensors, drones, and satellite imagery to collect vast amounts of data on soil composition, moisture levels, temperature, and crop health. AI algorithms then analyze this data to provide insights into optimizing planting schedules, irrigation, and fertilizer use.

For example, AI-powered drones equipped with multispectral cameras can scan crops to detect areas of stress or disease. By identifying these issues early on, farmers can take targeted action, such as applying pesticides only where needed, thus reducing environmental impact and increasing crop yields.

Predictive Analytics: Anticipating Challenges

AI doesn't just analyze current conditions; it can also predict future outcomes. By crunching historical data alongside real-time information, AI algorithms can forecast things like crop yields, pest outbreaks, and optimal harvest times.

This predictive capability allows farmers to make proactive decisions to mitigate risks and maximize productivity. For instance, AI-powered models can predict weather patterns and suggest optimal planting times to avoid extreme weather events or capitalize on periods of favorable conditions.

Autonomous Machinery: Farming Without Farmers

The image of a farmer toiling in the fields from dawn till dusk may soon be a thing of the past, thanks to AI-driven autonomous machinery. From self-driving tractors to robotic harvesters, these machines are revolutionizing the way crops are planted, tended, and harvested.

Autonomous machinery not only reduces the need for manual labor but also operates with incredible precision. For example, AI-powered tractors can navigate fields with centimeter-level accuracy, planting seeds at optimal depths and spacing. This precision not only improves crop yields but also reduces resource wastage.

Supply Chain Optimization: From Farm to Fork

AI isn't just transforming what happens on the farm; it's also revolutionizing the way food moves from field to table. By analyzing data from every stage of the supply chain, AI algorithms can optimize logistics, reduce waste, and ensure food safety.

For example, AI can track perishable goods in real-time, monitoring temperature and humidity levels to prevent spoilage during transportation. Additionally, AI-powered predictive analytics can anticipate fluctuations in demand, allowing for better inventory management and distribution planning.

Challenges and Considerations

While the potential benefits of AI in agriculture are vast, there are also challenges to overcome. One major concern is the digital divide, as access to AI technology may be limited in rural areas with poor internet connectivity or inadequate infrastructure. Additionally, there are ethical considerations surrounding data privacy and ownership, as well as concerns about job displacement as automation increases.

Artificial intelligence is not just a buzzword; it's a game-changer for agriculture and food production. By harnessing the power of AI, farmers can increase efficiency, reduce environmental impact, and ensure food security for a growing global population. While there are challenges to overcome, the benefits of AI in agriculture are undeniable. As we continue to innovate and refine these technologies, the future of farming looks brighter than ever.

The integration of AI into agriculture and food production represents a paradigm shift in how we approach feeding the world sustainably. By harnessing the power of data and algorithms, farmers can optimize their operations, increase yields, and reduce environmental impact. Moreover, AI-driven innovations are not limited to large agribusinesses but are increasingly accessible to smallholder farmers worldwide, leveling the playing field and empowering communities. As we continue to embrace AI technologies, we move closer to a future where hunger is no longer a global challenge, but a solvable problem.

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Navigating Environmental Crossroads: Addressing Disposed Paper Cups and Declining Bee Populations

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Abstract
Human activities pose a grave threat to honey bees, crucial pollinators for numerous plant species, including many essential food crops. Discarded tea cups outside shops contain sugary residues that lure honey bees, trapping them and contributing to their decline. This situation leads to Colony Collapse Disorder (CCD), where worker bees vanish from hives, leaving behind the queen and brood. Without these workers, colonies struggle to survive, risking the collapse of entire bee populations and posing significant threats to ecosystems and global food security. Mitigation efforts involve raising awareness about the impact of waste on bees, advocating for proper disposal practices, and creating environments conducive to bee survival.

Keywords: Paper Cups, Sugar Residues, Colony Collapse Disorder, Bees Decline.

Introduction
Insects play a significant role in practically every ecosystem since they are a major group that is closely related to many ecological processes in forest and agro-ecosystem formation. One of their main responsibilities is pollination. India relies heavily on honey bees, namely *Apis mellifera, A. florae, A. cerana* and *A. dorsata* for agricultural pollination. Despite the fact that honey bees are indispensable to human kind, studies have shown that in the last 25 years, more than 40% of the bee population in India has disappeared. The decline in bee numbers worldwide in recent years has alarmed scientists, environmentalists, and the general public. Because bees are vital pollinators for ecosystems and agriculture, the global decline in bee populations is worrying. Although well-known causes of this reduction include habitat loss, pesticide use climate change and microwave towers, a lesser-known offender has surfaced: paper cups. Disposed paper cups outside juice and coffee shops could be behind the India's Colony Collapse Disorder (CCD) disappearing honey bee population that pollinate 80% of all crops.

The Plight of Disposed Paper Cups
Particularly in the context of the takeout coffee culture, disposable paper cups have become a commonplace fixture in our everyday lives. Despite being practical, their extensive use has resulted in an astounding quantity of trash. The majority of paper cups have a thin plastic lining inside to keep them waterproof; this makes the cups non-recyclable and contributes to the issue of single-use plastics.

Bees and Paper Cups
Coffee shops and juice centres in urban, semi-urban, rural and biodiversity protected areas are increasingly using disposable paper cups instead of glass or plastic ones due to changes in lifestyle patterns and growing environmental consciousness. The honey bees are drawn to the discarded cups by the sweet residue. The high residual sugar in the cups attracts bees as an alternate food source, and they ignore visiting flowers. Honey bees are known to modify their foraging strategies frequently due to their short-term memory, which enables them to quickly adjust to changing food source profitability. When visiting these "cup flowers," a sizable number of honey bees never went back to the colonies. To them, these cups serve as "death traps."

A survey of the waste cups produced by five different coffee shops was conducted by Chandrasekaran *et al.*, (2011). These shops provide between 160–7000 cups a day on average, with a daily average of roughly 1225 cups. In their competition to gather sugar, the bees fell into the cups holding the leftover coffee, tea,

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or milk and became unable to fly which leads to the death of bees. 25,211 dead bees were observed for 30 days. The depth of the waste bin with cups, the amount of leftover drinks, the location of the sampled establishments, and the length of the visit all affect the average death rate. The cups containing 3-6 ml of beverage residues found at a depth of 20–40 cm in waste bins had the highest death rate (23%) between 10:00 and 14:00 hours. The bees trapped at the bottom (60 cm) of the bin at most successfully escaped to the middle zone only. After that, the cups are delivered to the recycling yard, where 680 bees are physically killed every day to prevent stinging.

In a similar vein, Sandhilyan (2014) discovered that disposable cups also attract the dammar or stingless bee, *Melipona irridipennis* (Meliponidae), one of the major pollinators. It was discovered that roughly 48 bees had perished in a single cup within ten minutes of observation. Additionally, throughout the same day (8 hours of observation), over 800 bees were disposed of in a single dustbin in front of a tea shop.

A similar perspective was observed by the present author Mukilan (2024) at Namakkal. Bees are attracted towards the sweet residues left in the tea cups, Majority of bees are unable to fly and after one hour of observation there are more than 100 bees are died in dustbin.

Conclusion

The tendency toward increased urbanization and the consequent rise in beverage shops may make bee mortality in and around urban and semi-urban habitats worse. Millions of disposable cups are used every day worldwide. This could lead to a collapse of bee colonies in the future and a decrease in agricultural productivity worldwide. Even though there have been reports of bee collapse in many different places in the past, emerging countries like India lack scientific proof or even awareness of this issue. These observations could be a contributing factor to the decline in Indian bee numbers.

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Fig 1. Honey bees coming into contact with paper cups containing sugary residue

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Training and Pruning in Fruit Crops

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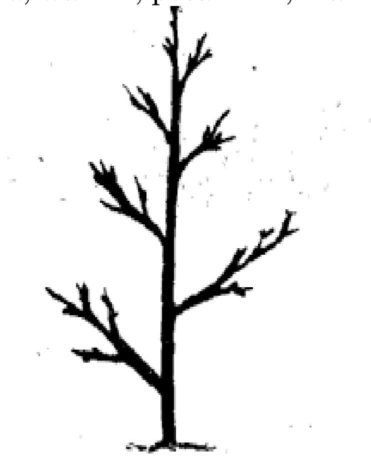
Training

Training is a new practice in which tree growth is directed into desired shapes and forms. The main purpose of training is shaping of young fruit plants.

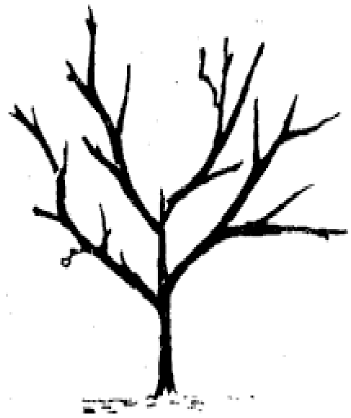
Methods of training systems:
1. Central leader system
2. Open//vase leader system
3. Modified central leader system.

Central leader system: In this system the central axis of plant is allowed to grow unhindered permitting branches all around. This system is also known as closed centre system or palmette system and common in use in mango and sapota, walnut, pecan nut, mahua and apple etc.



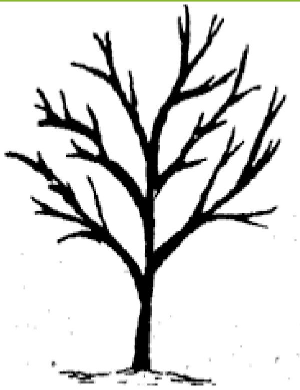
Central leader system

Open centre system (Vase shaped): In this system the main stem is allowed to grow to a certain height and the leader is cut to encourage lateral scaffold from near the ground giving a vase shaped plant. This is common in peaches and Japanese plum, fig and nectarine etc.



Open/vase system

Modified leader system: This system is in between open centre and central leader system wherein central axis is allowed to grow unhindered up to 4—5 years and then the central stem is headed back and laterals are permitted. It is common in apple, pear, cherry, plum, guava and almost all the fruits can be trained by this method.



Modified central leader

Other Systems of Training

Training systems	Best examples
Bower system/pandal/arbour/pergola	Grapes
Telephone/6-can system	Grapes
Kniffin/4-cane system/espalier system	Grapes
Cordons system	Peach
Single stem system	Citrus, Annona and Fig
Multiple stem system	Pomegranate
Two arm kniffin system	Passionfruit
Bareja system	Betel vine
T-Bar or pergola system	Kiwi
Head system	Grapes

Pruning

Pruning is the removal of a portion of a tree to correct or maintain tree structure. The main purpose of pruning is/are:

1. To increase productivity
2. For consistent productivity
3. Early flowering and fruiting
4. To facilitate various cultural operations
5. Enhance the production and quality of fruits
6. Regulation of shape and growth of trees

Pruning is done in two ways:

a. Thinning out: The removal of undesirable shoots or branches without leaving any stub is known as thinning out. It encourage the tree growth e.g. Mango, quince, olive and loquat.

b. Heading back: The removal of terminal portion of the shoots, branches or limb leaving its basal portion is known as heading back. It reduces the tree size by topping and hedging.

Intensity of Pruning

Light pruning	Guava, Litchi and Kinnow mandarin
Slightly severe pruning	Apple
Heavy/severe pruning	Ber, Peach, Mulberry and Phalsa

Other Important Techniques of Pruning

1. Root pruning: The removal of roots 40 cm away from the plants. It helps to inducing dwarfness and fruitfulness in mandarin.

2. Top working: It is a practice in which two successive either by budding or grafting operations are performed on a same plant. Example- Apple and Mango etc.

3. Ringing: The removal of complete ring of bark from a branch or a trunk. It increases fruit bud differentiation in Mango, Grapes and Apple.

4. Leaf pruning: The removal of old and senescence leaves in Date palm in the month of June is known as leaf pruning.
5. Dehorning: The removal of overcrowding and intermingling of branches is known as dehorning. It induces flowering in Mango.
6. Girdling: The removal of 2-3 cm white strip of barks around the stem. It helps for increasing the berry size in Grapes.
7. Thinning: The removal of part of flower bud/small fruits from a heavy crop is known as thinning. It helps for increasing the fruit size and improves the quality of Grapes, Peach and Plum.
8. Bending: In this, bends the branches or shoots. It helps to increases the lateral branches and fruit production. Example- Guava cv. Allahabad Safeda in Deccan region of MH.
9. Notching: The partial ringing of a branches above a dormant lateral bud is known as notching. It helps to increasing the fruiting branches in Poona fig in MH at the height of 0.5 cm in the month of July.
10. Nicking: The partial ringing of a branches below a dormant bud is known as notching. It helps to increasing the flowering shoots in Apple and Poona fig.
11. Smudging: The practice of smoking the trees with the help of potassium nitrate @ 1 percent. It helps to induce the off season flowering in mango in Philippines.
12. Skirting: The removal of low hanging branches of tree is known as skirting. Ex. - Mango.
13. Tip pruning: Mango
14. Containment pruning: It is commonly used in HDP of temperate fruit crops.

The critical time of pruning in some specific crops is under below:

Crops	Time of pruning
Mango	November and December but TNAU recommended August and September
Guava	Concurrent pruning-May, September and December
Grapes	Forward pruning- October Backward-March to April
Peaches	Mid December to January End
Ber	North India- May to June Rajasthan- April to May South India-February to March Bangalore-April
Fig	December
Phalsa	December to January

NOTE: Banana, Papaya, Jamun, pineapple and Aonla do not requires regular prune/trainee.

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Plant Growth Regulators in Fruit Plants

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Plant Growth Regulators

Plant hormones are not nutrients but chemicals that in small amount to promote and influences the growth, development and differentiation of cells and tissues.

It is divided into two parts: Growth promotors/regulators and Growth inhibitors/retardants:

Growth promotors: Those chemical substances which promote the growth and development of the plants are known as promotors/regulators. It regulates the growth of the plants. **Example-** IAA, NAA, Ethylene and Cytokinin etc.

Growth inhibitors: Those chemical substances which inhibit/checks the growth and development of the plants are known as inhibitors/retardants. It checks the growth of the plants. **Example-** Paclobutrazol, Ancymidal, Daminozide, Cyclocel (CCC), Maleic Hydrazide (MH) and ABA etc.

Classes of PGRs

1. Auxin (Precursor- Tryptophan):

Natural Auxin	IAA (Indole-3-Acetic Acid) was coined by F.W. Went in 1927. Zinc is essential for bio-synthesis of IAA.
Synthetic Auxin	IBA (Indole-3-Butyric Acid)- Rooting Hormone NAA (1-Naphthalene Acetic Acid) - Used for the vegetative propagation of plants from stem and leaf cuttings. 2, 4-D (2, 4- Dichlorophenoxy Acetic Acid)- at below 20 ppm it is used as a plant hormone but more than 20 ppm it is used as weedicide. 2, 4-D is a stable auxin group growth regulator that aids callus production from explants.

Site of Auxin: Shoots and root tips, young expanding leaves and seeds.

Role of Auxin:

a. Polar translocation (Apex to downward movement). Ex- IAA
b. Promotes the apical dominance
c. Shoot and root development
d. Avena curvature test and oat coleoptile test are the best example of auxin.
e. Low auxin promotes root growth while high auxin enhances shoot growth.

2. Gibberellins (**Precursor- Terpenoids**) - It was discovered by E. Kurosawa in 1927.

Site of GA production- Young leaves

Role of GA:

a. Stimulate the cell elongation
b. Tolerance to chilling
c. Promotes the seed production
d. Induction of flowering in long day plants
e. Breaking the dormancy of seeds, tubers and shoots
f. Prevention of genetic and physiological dwarfism
g. Anti-gibberellins are Paclobutrazol and Ancymidal etc.

3. Cytokinin- (Precursor-5'-AMP (Isopentyl group):

Natural	Zeatin
Synthesis	Kinetin and Benzyl Acetate (Highly used for Plant Tissue Culture)

Site of cytokinin production- Root tips

Role of cytokinin in plants:

a. Cell division
b. Delaying senescence (Richmond Lang Effect)
c. Induces the flowering in short day plants.
d. Differentiation of cells
e. Low auxin: cytokinin ratio promotes shoot growth while high auxin: cytokinin ratio promotes root growth.
f. Skoog and Miller coined the auxin-cytokinin hypothesis of plant morphogenesis.

4. Abscisic acid (ABA) (**Precursor- Sesquiterpenoid pathway/Mevalonic acid**) - It is naturally occurring plant hormone and consider as stress hormone.

Site- All organs//terminal buds

Role:

a. Bud dormancy
b. Stimulates the closure of stomata
c. Disease resistance
d. Protection cells from dehydration.

5. Ethylene (C_2H_4) (**Precursor- Methionine while immediate precursor is ACC**) - It is consider as gaseous hormone and ripening hormone.

Role:

a. Stimulates shoot, root growth and differentiation of plants (Triple response effect)
b. Enhances the latex flow (Rubber)
c. Stimulates leaf and fruit abscission (Phytogerontological hormone)
d. Induction flowering in pineapple.
e. Initiation of fruit ripening (Citrus, Banana, Mango and Tomato)
f. Stimulates flower and leaf senescence.

PGRs Used in Fruit Plants

Fruit plants	PGRs	Effects//Results	Remarks
Mango	NAA @ 200 ppm	Reduce the floral malformation	At the time of FBD (Oct-Nov)
	NAA @ 50 ppm	Reduction of fruit drops	At pea stage
	2,4-D @ 10-20 ppm	Pre-harvest fruit drop	-
	PBZ @ 5 g//tree	To overcome the problem of alternate bearing	1st in Oct-Nov followed by Feb (Deblossoming)
Citrus	2,4-D @ 10-20 ppm	Pre-harvest fruit drop	Mandarin and mandarin hybrids
Grapes	GA @ 10-40 ppm	Enlargement of panicle growth	-
	GA @ 30-40 ppm +CPPU @ 2 ppm	Berry elongation	Bajra grain berry size stage
	GA @ 50 ppm	Berry thinning	50 % bloom stage/Calyptra stage
Banana	2,4-D @ 25 ppm	Removal of seediness	Poovan variety
	Ethrel @ 500 ppm	Accelerate the ripening	-
Guava	NAA @ 800 ppm+Deblossoming	Maximum yield in winter season	-
Pineapple	Ethephon @ 100 ppm	Uniform flowering	All months
	Ethephon @ 25 ppm+Urea @ 2 %+Ca/Na carbonate @ 0.04 %	Uniform flowering	March-May
Apple	NAA+Sevin	Heavy Thinning	-
	NAA @ 10 ppm	Prevent the pre-harvest fruit	-

		drop	

NOTE: Ethylene absorbers- Potassium Permanganate and Activated Charcoal
Auxin inhibitors- 1-MCP and CPA

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Maximizing Crop Yield and Water Conservation: The Evolution and Efficacy of Micro Irrigation

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Introduction

Water shortage and the requirement for effective water management strategies have grown to be major global concerns, particularly in agriculture, where water is essential to crop productivity (Pereira et al., 2002). Conventional irrigation techniques frequently result in increased energy usage, ineffective nutrition delivery, and water waste. As a result, micro irrigation has become a viable way to maximize crop productivity, reduce resource use, and optimize water use. This article explores the idea, development, elements, advantages, difficulties, and potential applications of micro irrigation, emphasizing its importance in contemporary agriculture. The Centrally Sponsored Scheme on Micro Irrigation was introduced in January 2006 by the Department of Agriculture & Cooperation, Ministry of Agriculture (Sivanappan et al., 2016). It was expanded to the National Mission on Micro Irrigation in June 2010 and remained there until.

Fig: Micro Irrigation

Components of Micro Irrigation

1. Emitters and Drippers: These form the foundation of micro irrigation systems, supplying precisely the right amount of water directly to the root zones of the plants (Madramootoo and Morrison, 2013). There are many different kinds of emitters available, such as adjustable drippers, non-compensating drippers, and pressure-compensating drippers, which provide water supply flexibility based on crop requirements and soil conditions.

2. Tubing and Pipes: The distribution network of micro irrigation systems is made up of premium tubing and pipes that move water from the source to the emitters. Usually constructed of sturdy materials like polyethylene, these parts are long-lasting and resistant to chemical and UV deterioration.

3. Filters: Filters are essential for clearing the water supply of pollutants, silt, and debris, avoiding emitter clogging, and guaranteeing continuous system performance. Screen, disc, and sand media filters are common filter types that fulfill particular filtration needs depending on the quality of the water.

4. Pressure Regulators: Pressure regulators optimize emitter performance and guarantee uniform water distribution throughout the field by maintaining constant water pressure inside the irrigation system. Pressure regulators increase system efficiency and crop output by minimizing pressure fluctuations brought on by changes in elevation or pump operation.

5. Valves and Control Systems: In micro irrigation systems, valves and control systems regulate the flow and timing of water delivery, enabling fine control over irrigation volume and timings. Water efficiency and resource utilization are improved by the remote monitoring and modification of irrigation parameters made possible by advanced control technologies including timers, sensors, and automated controllers.

Benefits of Micro Irrigation

1. Water Conservation: By delivering water straight to the plant's root zone, micro irrigation reduces water losses from deep percolation, runoff, and evaporation. Micro irrigation is a sustainable solution for water-scarce locations since it perfectly matches water delivery to crop water requirements, resulting in water savings of up to 50% when compared to conventional irrigation methods.

2. Improved Crop Yield and Quality: Micro irrigation provides a steady supply of water and keeps the soil at the ideal moisture content, which encourages healthy root development, nutrient uptake, and general plant growth. According to studies, crops cultivated using micro irrigation have better fruit quality, higher yields, and more uniformity than crops grown with conventional irrigation, which increases farmer profitability.

3. Energy Efficiency: Micro irrigation systems use less pressure than conventional overhead sprinkler systems, they use less energy to pump and distribute water. Using energy-efficient pumps in conjunction with accurate water distribution results in long-term savings on energy consumption and reduced operating expenses.

4. Enhanced Nutrient Management: Minimizing nutrient loss and runoff, micro irrigation enables targeted administration of fertilizers and soil amendments straight to the root zone. By enhancing nutrient efficiency, cutting down on fertilizer waste, and reducing environmental pollution, this focused strategy supports sustainable agricultural practices.

Challenges and Limitations

1. Initial Investment Costs: Smallholder farmers, particularly those in developing nations, may find it prohibitive to make the initial equipment purchase and installation costs, even if micro irrigation has long-term advantages and financial savings. This obstacle can be removed to encourage a wider adoption of micro irrigation systems through the availability of inexpensive financing and government incentives.

2. Maintenance Requirements: Proper maintenance is essential to ensure the efficient operation of micro irrigation systems and prevent issues such as clogging, leaks, and component degradation. Regular inspection, cleaning, and repairs are necessary to optimize system performance and maximize water savings.

3. Salinity and Water Quality: High salinity levels and poor water quality can pose challenges to micro irrigation by causing emitter clogging, reduced water infiltration, and soil degradation. Pre-treatment measures such as filtration, sedimentation, and water quality testing are essential to mitigate these issues and maintain system reliability (Zhu et al., 2018).

Future Prospects and Innovations

1. Smart Irrigation Technologies: Advancements in sensor technology, data analytics, and precision agriculture are driving the development of smart irrigation systems that optimize water use based on real-time weather conditions, soil moisture levels, and crop water demand. Integration with Internet of Things (IoT) platforms enables remote monitoring and control, empowering farmers to make informed decisions and maximize resource efficiency.

2. Drought-Resistant Crops: The development of drought-resistant crop varieties through genetic engineering and breeding programs holds promise for enhancing the resilience of agricultural systems to water scarcity. Combined with micro irrigation techniques, these innovations can help sustain crop production in arid and semi-arid regions facing increasing water stress due to climate change.

3. Hybrid Irrigation Systems: Hybrid irrigation systems that combine micro irrigation with other water-saving techniques such as rainwater harvesting, soil moisture sensors, and mulching offer a multifaceted approach to water management. By leveraging complementary strategies, these integrated systems optimize water utilization across diverse cropping systems and climatic conditions (Sadler et al., 2007).

Conclusion

The practice of micro irrigation is an innovation in agricultural water management that provides a long-term solution to the problems of food security and water scarcity. Farmers may optimize crop productivity while minimizing environmental impact by using micro irrigation, which combines precise water delivery, effective nutrient management, and energy conservation. Micro irrigation is positioned to play a pivotal role in determining the future of agriculture and guaranteeing the resilience and sustainability of global food systems for future generations, as technology advances and adoption rates rise.

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Carbon Sequestration to Mitigate Climate Change

Article ID: 48895

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Introduction

The term "carbon sequestration" is used to describe both natural and deliberate processes by which CO_2 is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils, and sediments), and geologic formations. The world is grappling with the urgent need to combat climate change, which poses an existential threat to ecosystems, economies, and human societies. Among the various strategies for mitigating climate change, carbon sequestration stands out as a crucial and effective tool. This article delves into the concept of carbon sequestration, its mechanisms, and its vital role in addressing the global climate crisis.

Understanding Carbon Sequestration

Carbon sequestration refers to the capture and long-term storage of atmospheric carbon dioxide (CO2) and other greenhouse gases (GHGs) in various natural or artificial reservoirs. The primary goal is to reduce the concentration of GHGs in the atmosphere, thereby mitigating the greenhouse effect and global warming.

This is important, as around 45% of the CO_2 emitted by humans remains in the atmosphere, which is a significant factor behind global warming. Carbon sequestration can prevent further emissions from contributing to the heating of the planet.

Carbon sequestration can happen in two basic forms: biologically or geologically. Also, while it's being encouraged artificially through various biological and geological methods, it also happens naturally in the environment on the biggest scale.

1. Geological Carbon Sequestration: This is where carbon dioxide is held in subsurface rock formations and other geologic structures. Carbon dioxide is released from energy-related sources like power plants or natural gas processing facilities, or from industrial sources like steel or cement production firms. This carbon dioxide is then injected into porous rocks for long-term storage. When carbon is captured and stored in this way, fossil fuels can be used until a substitute energy source is widely adopted.

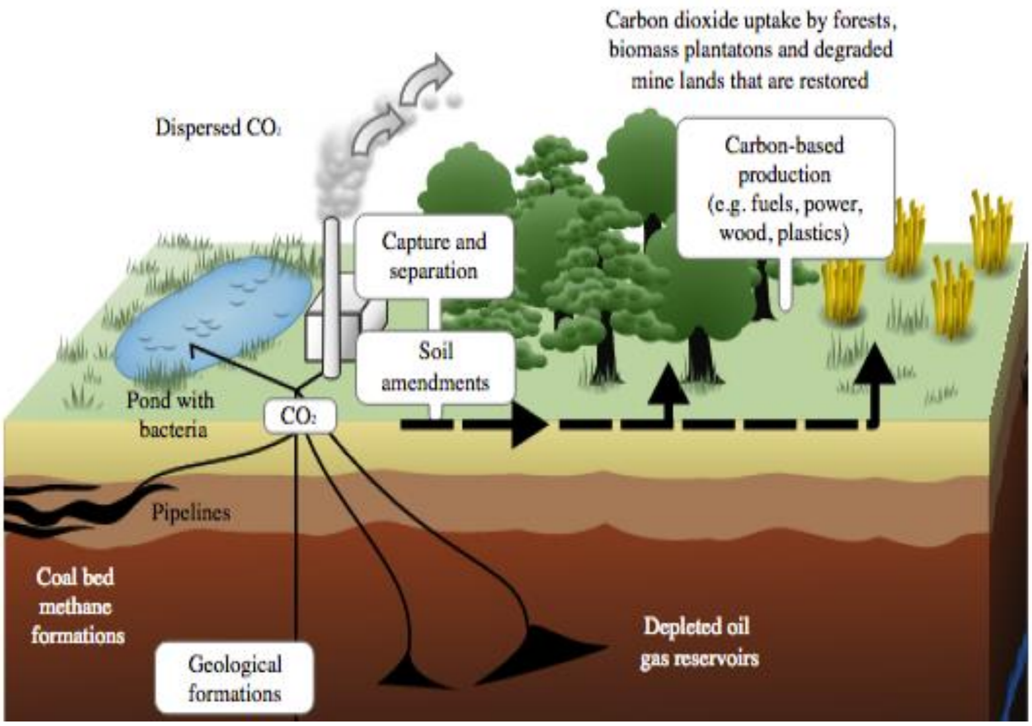
2. Biological Carbon Sequestration: Biologic carbon sequestration refers to storage of atmospheric carbon in vegetation, soils, woody products, and aquatic environments. For example, by encouraging the growth of plants—particularly larger plants like trees—advocates of biologic sequestration hope to help remove CO_2 from the atmosphere.

3. Technological Carbon Sequestration: Scientists are exploring new ways to remove and store carbon from the atmosphere using innovative technologies. Researchers are also starting to look beyond removal of carbon dioxide and are now looking at more ways it can be used as a resource.

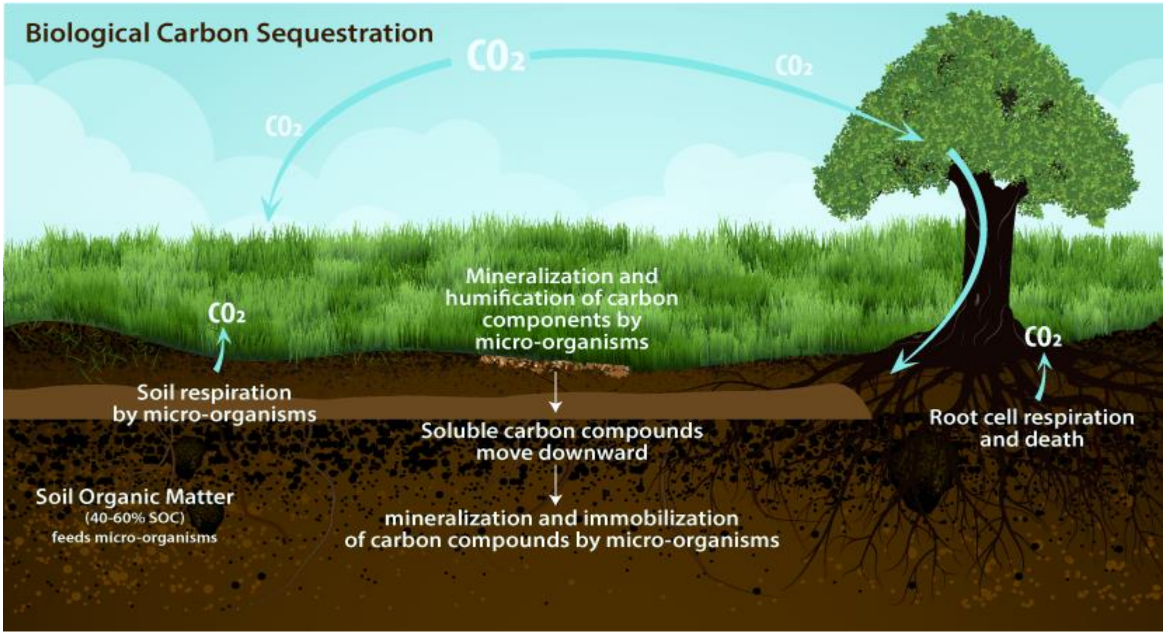
Graphene production: The use of carbon dioxide as a raw material to produce graphene, a technological material. Graphene is used to create screens for smart phones and other tech devices. Graphene production is limited to specific industries but is an example of how carbon dioxide can be used as a resource and a solution in reducing emissions from the atmosphere.

Direct air capture (DAC): A means by which to capture carbon directly from the air using advanced technology plants. However, this process is energy intensive and expensive, ranging from $500-$800 per ton of carbon removed. While the techniques such as direct air capture can be effective, they are still too costly to implement on a mass scale.

Engineered molecules: Scientists are engineering molecules that can change shape by creating new kinds of compounds capable of singling out and capturing carbon dioxide from the air. The engineered molecules act as a filter, only attracting the element it was engineered to seek.



Geological Carbon Sequestration



Biological Carbon Sequestration

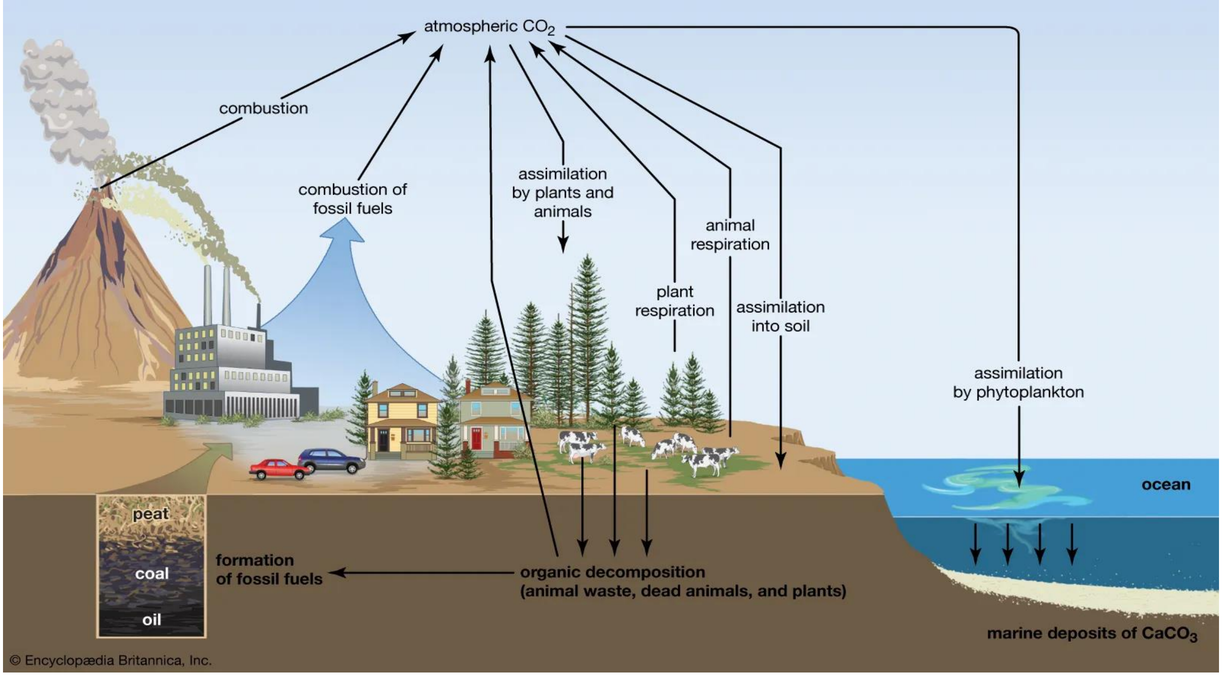
Mechanisms of Carbon Sequestration

1. Forests and Vegetation: Forests, grasslands, and other ecosystems play a pivotal role in carbon sequestration. Trees and plants absorb CO2 from the atmosphere during photosynthesis, converting it into biomass. As forests grow and mature, they store vast amounts of carbon in their trunks, branches, leaves, and roots.

2. Soil Carbon: Soil is a significant carbon reservoir. Certain agricultural and land management practices, such as no-till farming and reforestation, can increase soil carbon content by preventing the decomposition of organic matter.

3. Oceanic Carbon: Oceans act as a significant carbon sink by absorbing CO2 from the atmosphere. However, this process can lead to ocean acidification, impacting marine ecosystems.

4. Carbon Capture and Storage (CCS): CCS technologies capture CO2 emissions from industrial sources like power plants and store it underground, preventing it from entering the atmosphere.



Importance of Carbon Sequestration

1. Climate Mitigation: Carbon sequestration directly mitigates climate change by reducing the concentration of GHGs in the atmosphere, slowing down the global temperature rise.

2. Ecosystem Health: Natural carbon sequestration processes, such as afforestation and reforestation, promote ecosystem health, biodiversity, and habitat preservation.

3. Agricultural Resilience: Practices that increase soil carbon improve soil fertility, water retention, and resilience to extreme weather events, benefiting agriculture.

4. Economic Opportunities: Carbon sequestration initiatives can create jobs and economic opportunities in sectors like forestry, renewable energy, and carbon trading.

Carbon Sequestration Strategies

1. Reforestation and Afforestation: Planting trees and restoring forests on deforested or degraded lands is a straightforward and effective way to sequester carbon. These actions enhance biodiversity, improve local air and water quality, and provide additional ecosystem services.

2. Sustainable Agricultural Practices: Implementing sustainable agricultural practices like no-till farming, cover cropping, and crop rotation can increase soil carbon content while also improving soil health and crop yields.

3. Wetland Restoration: Wetlands are highly efficient carbon sinks. Restoring and conserving wetlands not only sequesters carbon but also provides valuable habitat for wildlife and helps control flooding.

4. Ocean-based Solutions: Protecting and restoring marine ecosystems like mangroves and seagrass beds can sequester significant amounts of carbon. Additionally, oceanic carbon capture and storage (OCCS) technologies are being developed to capture and store CO2 from the atmosphere.

Conclusion

Carbon sequestration is an essential strategy for mitigating climate change, offering a powerful means to reduce greenhouse gas concentrations in the atmosphere. Implementing natural and artificial carbon sequestration methods can help slow global warming, enhance ecosystem health, and create economic opportunities. As we face the climate crisis, it is imperative that governments, businesses, and individuals prioritize and invest in carbon sequestration efforts to protect our planet and secure a sustainable future for generations to come.

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SHG's: A Boon for Rural Poor

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Poverty and unemployment are among the major problems of developing countries, to which India is no exception. In India, according to the Human Development Report (2007), 28.6 percent of the population was living below the national poverty line and 80.4 per cent of the population was living on (less than) the original UN Development Goal of two dollars a day (PPP), while the Employment and Unemployment Sur-vey Report (2009-2010) estimated the overall unemployment rate at 9.4 per cent. The figures for rural areas are generally worse than those for urban areas. The of ficial rural unemploymentrate, for example, is put at 10.1 per cent as op-posed to the urban rate of 7.3 per cent, while poverty rates are over 50 per cent higher in rural areas than in urban (GIPC 2010; Alkire and Maria2010).In this context, the phenomenon of develop-ment oriented Self Help Groups (SHGs) in the Indian context is an interesting issue to investigate. Various experts on developmental issues (poverty, inequality, hunger) have ar gued that employment opportunities and enhanced income from both farming and non-farming activities are essential for rural economic development and the reduction of rural poverty (Narayanasamy et al.2003; Kay 2009). Rural communities that are well organized have better chances to develop such opportunities, for example by means of self-organization and the generation of community based income generating activities (Gurumoorthy 2000; Barbara and Mahanta 2001).The employment of SHG programs has emerged as a popular strategy for the facilitation of micro-enterprise development by government, non-government organizations and educational institutes in rural areas in India. These initiatives are not simply the expressions of a neo-liberal politics that favours entrepreneurship and mar -kets as the key for development, they are also the expressions of rural people's needs and interest in their own participation and empowerment (Narayanasamy et al. 2003). Self-help as a strategy for social development emphasises self-reliance, human agency and action (Sabhlok2006). According to social action theory, people take action towards their goals as groups within the context of their social environment. They have their own, locally defined motives and be-liefs, their own interpretations of the meaning of a situation, and they control their own actions (Weber 1991).

Self-help group (SHG) has emerged as popular method of working with people. The concept of SHG in India was introduced during 1985. As all of us know, the originator of the concept of self help group was Nobel Prize winner, the great, economist, prof. Mohammad yonus. As explained by Jha (2000) SHG is a small economically homogenous affinity group of the rural poor voluntarily coming together to save small amounts regularly which are deposited in a common fund to meet emergency needs of members and to provide collateral free loans decided by group. The country has witnessed a rapid growth of SHGs in the last decades. The promotion of SHGs in India began more formally in 1992 with the launch of SHG elaborated SHGs in another words. According to NABARD SHG is a small, economically homogeneous and affinity group of rural poor who is voluntarily ready to contribute to common fund to be lent to its member as per group decision ,which works for group solidarity, self group awareness, social and economic empowerment in the way of democrating functioning(1995). Self help groups are generally very effective in improving the level of knowledge, skills and awareness through informal education and peer learning exchange. Discussion in the meeting and training programs.

Objectives

The Self Help Groups Project has both Economic/Development and Social objectives.

Economic/Development:

a. To promote saving and teach financial management skills.
b. To improve access to saving and credit services.
c. To improve living standards.
d. To reduce vulnerability to poverty in times of crisis (sickness, death etc)

e. To further economic self-reliance.

Social:

a. To encourage community coherence.
b. To provide a forum for the sharing of ideas and knowledge.
c. To provide support for members in difficulty.
d. To aid the community in identifying and resolving their own problems.

Characteristic Features of Self-Help Groups

The benefits of SHGs over the formal financial institutions are due to following characteristics features of SHGS: Flexible and simple system of working and management of pooled resources in a democratic way. Loans are given mainly on trust with minimum papers and without any security. The rate of interest on loan given by SHGs is higher than that of banks but lower than that of money lenders. Defaulters are rare because of intimate knowledge of the end use of credit and prompt loan recovery due to peer pressure. Reduction in dependence on financial institutions. Development of self confidence, self reliance, self- esteem, social and economic empowerment, among poorest section of society.

Major Roles Performed by SHGs

Access to saving and credit: the primary role expected of SHGs is improving the access to saving and credit for the rural poor. Studies available indicate that as a result of the participation in SHGs, members have been able to accumulate significant savings. Own savings can be handy and useful in many ways. Many SHGs members even consider development of saving habit as major impact of their participation in SHGs.

SHGs are utilizing the savings mobilized to lend small loans internally among their members for fulfilling emergency consumption needs as well as social credit needs. SHGs are borrowing from banks and SHGs federations to meet bigger credit needs of members for production purposes.

The members of the SHGs have been able to reduce their dependence on money lender very significantly. Through credit obtained from SHGs, the members made its use both to protect their families from various vulnerabilities as well as build their economic base to escape from poverty. The members are utilizing SHG loan for various purposes like, consumption housing, marriage, education, health and other social and productive needs. Members are also using SHG loans for regular economic activities like agriculture, animal husbandry and petty business.

SHGs as a Means of Micro Financing

Basically, SHGs are being promoted as part of micro finance interventions aimed at helping poor to easily obtain the financial services like saving, credit and insurance. Micro finance is a tool in poverty alleviation and development of the nation. Micro finance as a alternative source of credit for the rural poor, has received wide attention in recent years. It is programs that provide credit for self employment of other financial and business services including saving and technical assistance to very poor persons. Various micro finance institutions are functioning in India. Leading national financial institutes like the small industries development bank of India, the national bank for agriculture and rural development and rastriya mahila kosh have a played a significant role in making micro credit a real movement. Most of these organizations tend to operate within a limited geographical range. Very few organizations like SEWA have been successful in replicating their experiences in other part of the country and act as a resources organization. Many organizations are involved with SHGs for credit and other purposes. Shells as row materials. They also prepare household products like, pickle, papad.

Women's Empowerment

Another role as SHGs is seen in the terms of their potential to empower the women members, socially and economically. The access to savings and credit helps women members to look after her family's financial needs for consumption and production purposes. The ability to meet such needs of the family would enhance the standing of the woman in the family leading to better gender relations. The continued participation in SHG is further likely to enhance the awareness, skills and other abilities of women resulting in developing individual self-esteem and in getting due social recognition. SHGs help the women to establish their creditworthiness.

Activities Carried Out Under SHG

SHG encourage the members to start and run micro enterprises. Their activities include making paper cups and paper plates out of biomes, tailoring, screen printing, mat machine, making sculptures and other ornamental articles, making greeting cards and spoon using locally available coconut. Shells as row materials. They also prepare household products like, pickle, papad, vermicelli, jam, jelly, murabba, phenyl, perfumes, etc.

Conclusion

Self help group is a small and informal association poor having preferably similar socio economic background and who have come together to realize some common goals based on the principles of self help and collective responsibility. The major roles played by SHGs are in improving access to saving and credit, as a means of micro financing and in empowerment of women. Development organizations and policy makers have included access to credit for poor people's as a major aspect of poverty alleviation programs through SHGs.

Micro finance is one of the excellent schemes for SHGs members. It has evolved as a policy and program to cater to the needs of deprived groups, specially women and poor. There is no doubt that the economic status of is one benchmark of development. SHGs are the real path finder's in the development of rural women.

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National Mission for Edible Oils - Oil Palm (NMEO-OP): Boosting India's Self-Reliance in Edible Oils

Article ID: 48897

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Introduction

India's agricultural landscape is poised for a transformative journey with the advent of the National Mission for Edible Oils - Oil Palm (NMEO-OP). Anchored in scientific rigor and technological innovation, NMEO-OP aims to revolutionize the nation's edible oil production sector, offering sustainable solutions to enhance productivity, mitigate environmental impact, and ensure food security.

The Need for Self-Reliance

The Import Dependency: India imports approximately 9 million metric tons of palm oil annually, constituting a staggering 56% of its total edible oil imports. This heavy reliance on foreign markets not only strains our economy but also exposes us to price fluctuations and supply disruptions.

NMEO-OP's Vision: The NMEO-OP mission is clear: achieve self-reliance in edible oils. By harnessing the potential of oil palm cultivation, India can reduce its dependence on imports and ensure food security.

Key Objectives of NMEO-OP

Expanding Cultivation Area: Currently, only 3.7 lakh hectares of land in India are under oil palm cultivation, out of a potential 28 lakh hectares. NMEO-OP aims to expand the oil palm area to 10 lakh hectares by 2025-26. This additional cultivation area will be distributed across general states and the North Eastern states, with a focus on achieving a targeted fresh fruit bunch (FFB) production of 66 lakh tonnes.

Boosting Crude Palm Oil (CPO) Production: NMEO-OP aims to increase CPO production from a mere 0.27 lakh tonnes (2019-20) to a robust 11.20 lakh tonnes by 2025-26.

Creating Consumer Awareness: Educating consumers about the importance of edible oils and maintaining a consumption level of 19 kg/person/annum until 2025-26 is a critical aspect of the mission.

Strategic Implementation

Seedlings and Nurseries: NMEO-OP focuses on increasing seedling production by establishing seed gardens and oil palm nurseries. Ensuring a steady supply of quality seedlings is essential for meeting the expansion targets.

Enhancing Productivity: The mission emphasizes improving the productivity of fresh fruit bunches (FFBs). Measures include expanding drip irrigation coverage, diversifying from low-yielding cereal crops to oil palm, and promoting inter-cropping during the 4-year gestation period.

Stakeholder Engagement: NMEO-OP operates in a mission mode, actively engaging state departments of agriculture and horticulture, universities, research institutions, cooperatives, and oil palm processors. The collective effort ensures that the benefits of the mission reach the targeted beneficiaries.

Financial Commitment

NMEO-OP has been allocated a substantial outlay of Rs. 11,040 crore over a five-year period. This investment is not just about oil; it's an investment in India's food security and economic resilience.

As Prime Minister Narendra Modi rightly stated, NMEO-OP is a step toward making India Atmanirbhar (self-reliant) in edible oils. It's time to turn the soil into gold, one oil palm at a time.

At the heart of NMEO-OP lies a strategic focus on oil palm cultivation, recognizing its immense potential to alleviate India's dependence on costly edible oil imports. Oil palm (Elaeis guineensis) stands out for its remarkable oil yield per hectare, making it a compelling choice for boosting domestic production. However, achieving sustainable cultivation requires a multifaceted approach rooted in scientific principles.

Scientific Principles

Crop Improvement: One of the key scientific pillars of NMEO-OP is the development and adoption of high-yielding oil palm varieties tailored to India's diverse agro-climatic zones. Through rigorous breeding programs and genetic improvement initiatives, scientists aim to create varieties optimized for yield, disease resistance, and environmental adaptability. These efforts draw upon advances in molecular genetics, marker-assisted selection, and genomic technologies to accelerate the breeding process and enhance crop performance.

Crop Management: Precision agriculture plays a pivotal role in optimizing resource utilization and maximizing productivity within oil palm plantations. Leveraging cutting-edge technologies such as remote sensing, geographic information systems (GIS), and sensor-based monitoring systems, farmers can fine-tune agronomic practices in response to real-time data on soil moisture, nutrient levels, and crop health. This data-driven approach enables targeted interventions, such as precision irrigation and nutrient management, resulting in improved resource efficiency and crop yields.

Sustainability: Sustainability is a guiding principle embedded throughout NMEO-OP's scientific framework. By promoting agroecological practices that minimize environmental impact while maximizing productivity, the mission seeks to ensure the long-term viability of oil palm cultivation. Intercropping oil palm with nitrogen-fixing legumes or shade-providing trees enhances soil fertility, biodiversity, and ecosystem resilience, while reducing the need for synthetic inputs and chemical pesticides.

Capacity building: Furthermore, NMEO-OP emphasizes the importance of capacity building and knowledge transfer to empower farmers with the skills and tools needed to adopt sustainable agricultural practices. Training programs, demonstration plots, and extension services facilitate the dissemination of best practices and enable farmers to leverage scientific insights for informed decision-making.

Socio-economic benefits: Beyond its agricultural implications, NMEO-OP holds significant socio-economic benefits for rural communities. By generating employment opportunities, improving farm incomes, and reducing import dependency, the mission contributes to rural development and economic empowerment. Additionally, by enhancing domestic edible oil production, NMEO-OP strengthens India's food security and resilience to external market fluctuations.

Conclusion

The National Mission for Edible Oils - Oil Palm (NMEO-OP) represents a landmark initiative at the nexus of science, agriculture, and sustainability. By harnessing scientific knowledge, technological innovation, and interdisciplinary collaboration, NMEO-OP charts a course towards a more resilient, productive, and environmentally sustainable agricultural future for India. As the nation strives to unlock its agricultural potential and address pressing challenges of food security and sustainability, NMEO-OP stands as a beacon of hope, offering scientific solutions to fuel the country's agricultural transformation.

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3D Food Printing: An Emerging Alternative to Conventional Food Manufacturing

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Summary

Using a food printer and a computer-added system, three-dimensional (3D) food printing involves building food layer by layer to create a finished food design. 3D food printing has the potential to completely transform the food manufacturing sector because to the growing demand for wholesome, ready-to-eat meals and the ability to tailor food items to meet certain dietary needs. Furthermore, if food makers are given the freedom to precisely measure out portions and designs, food waste may be decreased and eventually an effective and sustainable food production system may result. Nevertheless, this technology is still in its infancy and need more testing and refinement to expand the system before being on sale. The many printing methods, advantages, and possible market situations are all briefly covered in this article.

Keywords: 3D food printing, food industry, sustainable.

Introduction

Automation has penetrated and is being implemented in nearly every industry, including supply chain, manufacturing, transportation, healthcare, education, robotics, aerospace, and defense. This is due to advancements in science and technology. Over the past ten years, the idea of 3D food printing has become more and more popular in the food manufacturing and formulation sectors. The term "3D food printing" refers to the technology of additive manufacturing, in which printers employ computer control to make three-dimensional items.

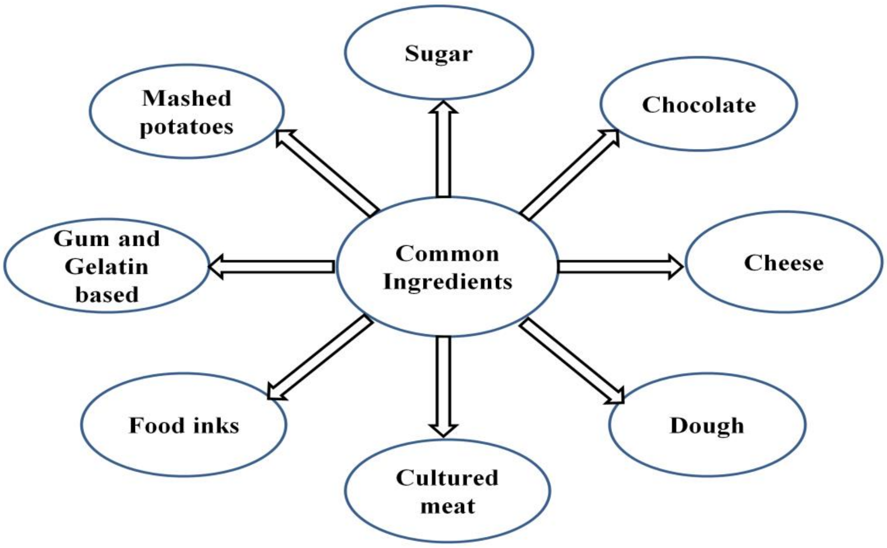

Fig 1: Common ingredients used in 3D Food Printing

In the food sector, 3D printing is used to create food items from food ingredients like dough, chocolate, sugar, and so on (Fig. 1). The meal is assembled into the desired shape layer by layer. While certain foods can be eaten right away after printing, the food that has been created in this way might need to be cooked afterwards. Food makers may create food that is adaptable in terms of its shape, texture, flavor, nutrition, and other attributes thanks to 3D printing. Food scientists and researchers are working to create food that is both inexpensive and produced with efficiency in order to transform the food manufacturing process.

3D Food Printing Technologies

There are certain techniques in which 3D food design can be applied. They are:

1. Extrusion-based Printing: Food ingredients are fed into an extruder, where they are extruded under different pressures and temperatures through the printing nozzle and then deposited, layer by layer, onto the printing bed in this 3D food printing method. For food printing, it is the most used method. Figure 2 displays a standard flow diagram for extrusion-based 3D food printing.

Food materials: Solid-based, paste material

2. Inkjet Printing: Here, thermal or piezoelectric ink is dispensed from the printing head to decorate or fill food surfaces, such as those of cakes or pizzas. Drop-on-demand and continuous jet printing are two possible inkjet modes. The drop is dried in a variety of settings, including air resistance, gravity, and motion momentum.

Food materials: Liquid-based low viscosity materials like pizza sauce, and fruit puree.

3. Binder Jetting: Functions by first applying a powdered component, and then, to fuse the food particles together, misting an edible liquid binder over the powder.

Food materials: Liquid-based and powdered-based (sugars, starch, and flour).

4. Selective Laser Sintering: The materials (powdered) are melted and fused using high-temperature laser beam energy to form layers and construct a 3D sculpture.

Food materials: Non-sticky Powdered materials like fat chocolate and sugar.

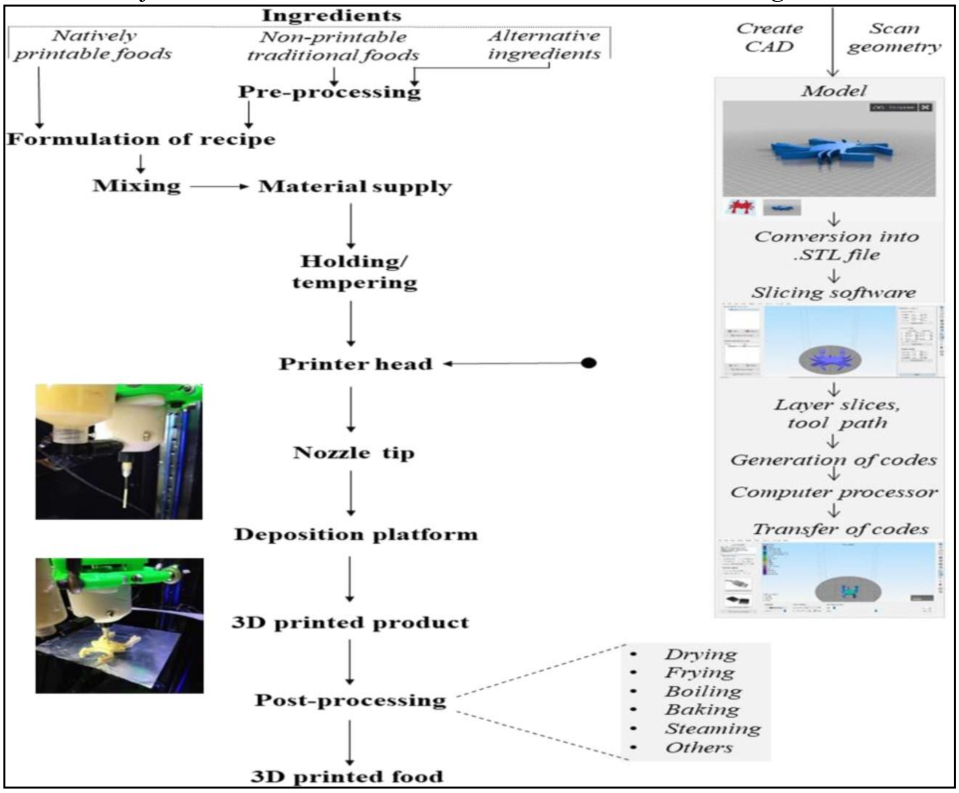

Fig 2: Schematic flow diagram of a typical extrusion-based food 3D printing process (Moses *et al.*, 2019)

Benefits of 3D Food Printing

1. Automation: By employing basic computer commands, the meal is printed automatically, minimizing the need for human intervention.

2. Customizable Foods: By altering the ratio of ingredients or the combinations of different ingredients, customized food products can be made based on the tastes of the consumer.

3. Precise Ingredient Control: Accuracy in dispensing the food materials is high.

4. Creativity: Complex 3D food geometries can be prepared which are difficult to create manually.

5. Personalizing meals: Meals can be made to regulate the variety and quantity of vitamins, nutrients, and calories. This pertains to hospitalized patients who have dietary restrictions.

6. Unconventional food consumption: Unusual, nutrient-dense plants and semi-liquid insects high in protein could be cooked and displayed in a more appealing way.

7. Easy reproducibility: By providing the same raw materials, printing settings, and compatible printing equipment, consistent products can be made easily.

8. Increased sustainability: Ultimately, less waste and more sustainable manufacturing methods arise from using only the measured resources needed to produce a certain meal design.

Market Potential of 3D Food Printing

Demand is being created for the market by leading businesses' increased R&D efforts as well as by their inventive and original culinary products. Additionally, the market is growing because of the rise in consumer desire for individualized, healthful, and tailored food products. The market for 3D food printing is predicted to be worth USD 0.68 billion in 2024 and is projected to grow by USD 2.71 billion in 2029, according to current market analysis (Source: Mordor Intelligence). This market has enormous potential to completely transform the food sector. Table 1 lists a few of the leading manufacturers of 3D-printed food items.

Table 1: Top companies providing 3D-printed foods:

Sl. No.	Company Name	Country	Food Category
1	Redefine meat	Israel	Plant-based meat products
2	Barilla	Italy	Pasta
3	Mycusini	Germany	Chocholate
4	Wiibox	China	Chocolate
5	BeeHex	USA	Customized Astronaut foods, Cookies, cakes, pancakes
6	Digital Food Lab	France	choco, Marzipan, pasta
7	Pancakebot	Norway	Pancake
8	SavorEat	Israel	Plant based-burgers
9	ByFlow	Netherlands	Pastry, pasta, meat
10	Aleph Farm	Israel	Cultivated meat
11	Revo foods	Austria	Plant-based seafood
12	NuFood	UK	Customized and nutritious food items
13	Mmuse	China	Chocolate extrusion
14	Choc Edge	UK	Chocholate
15	Natural Machines	Spain	Pasta, burgers, pizza, chocolate
16	CandyFab	USA	Sweet candies of different sizes
17	WASP	Italy	All sorts of food
18	Biozoons Food Innovations	Germany	Meals for seniors who struggle to process solid foods
19	TNO	Netherlands	Pasta, Plant-based meat
20	MeaTech	Israel	Cultivated meat

Conclusion

By offering personalized, nutrient-rich, individual-specific meals, 3D printing technology has opened up a world of possibilities for the food manufacturing industry. However, 3D-printed foods are still in the early stages of development, and a number of issues related to material formulation, printer optimal process parameters, post-processing considerations, printability quality assessment, and safety must be resolved before releasing the product onto the market and scaling up for mass production.

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Application of Nanotechnology in Agricultural Engineering

Article ID: 48899

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Introduction

The manipulation of matter at the molecular or atomic level, or nanotechnology, has become a disruptive field with enormous ramifications for agricultural engineering. Using the special qualities of materials at the nanoscale, agricultural engineers are investigating novel approaches to solve urgent issues in agriculture, such as effective resource management and sustainable crop production (Elizabeth et al., 2019). Nanotechnology has promising opportunities in agricultural engineering to enhance farming operations, equipment design, and environmental conservation. In order to maximize resource usage, reduce environmental impact, and improve production, engineers can create cutting-edge tools and technologies by incorporating nanomaterials, nanosensors, and nanodevices into agricultural systems. Precision agriculture is one of the main fields where nanotechnology is making major advancements. Real-time, ultra-precision monitoring of environmental parameters, crop health, and soil conditions is made possible by nanoscale sensors and systems (Pramanik et al., 2020). With the use of this abundance of data, agricultural engineers may maximize crop yields and resource efficiency by implementing focused interventions, such as precise fertilization and irrigation plans.

Nanofertilizers

By using nanostructured formulations, nanotechnology provides creative ways to increase fertilizer efficiency. Because of their increased surface area, nutrient particles at the nanoscale are more soluble and available to plants (Chhipa, 2017). By supplying nutrients straight to plant roots, nano-fertilizers can minimize leaching and runoff while boosting the effectiveness of nutrient absorption. Furthermore, fertilizer granules coated with nanocoatings can be shielded from deterioration, guaranteeing a sustained release of nutrients throughout time.

Nanosensors

The application of nanotechnology has made it possible to create extremely sensitive, small-sized sensors that can detect a wide range of factors in real-time and with high precision, including temperature, pH, crop health, and levels of nutrients in the soil. For continuous monitoring of agricultural conditions, these nanosensors can be integrated into wearables, drones, or soil probes. This enables farmers to make data-driven decisions to optimize crop management and resource utilization.

Nanopesticides

Innovative ways to improve crop defense against pests, illnesses, and environmental stressors are provided by nanotechnology. Plant protection films, coatings, and barriers that shield plants from UV rays, diseases, and unfavorable climatic conditions can be created using nanomaterials such nanoparticles and nanocoatings (Chhipa, 2017). To stop microbiological growth and stop crop spoiling, these nanoparticles can also be functionalized with bioactive substances or antibacterial agents.

Environmental Sustainability

Agricultural engineering has a strong emphasis on environmental sustainability, and nanotechnology provides creative ways to lessen the negative environmental effects of agricultural activities. Water quality and ecosystem health can be protected from contaminants, heavy metals, and pathogens in agricultural runoff by using filtering systems based on nanomaterials. Furthermore, the use of nanoremediation technology has the potential to restore damaged land and clean up contaminated soils.

Decision Support System

With the use of imaging technologies and nanosensors, nanotechnology makes it easier to capture vast amounts of data. This data is processed by sophisticated data analytics, AI algorithms, and machine learning to provide predictive models and useful insights for improving crop management techniques. These insights will help farmers plan their irrigation, fertilize their fields, manage pests, and determine when to harvest their crops. This will increase crop yields and optimize resource use.

Agricultural Water Management

By lowering water losses from evaporation, leaks, and inefficient distribution, nanotechnology can increase the effectiveness of irrigation systems. Infrastructure longevity can be improved and water loss from permeation can be reduced by applying nanocoatings to irrigation pipes and water storage tanks. Furthermore, to improve water retention and decrease irrigation frequency, soil amendments containing nanoscale water-absorbing polymers can be added.

Highly sensitive and selective sensors for tracking agriculturally relevant water quality indicators, like pH, dissolved oxygen, nutrient levels, and microbial contamination, can be developed more easily thanks to nanotechnology (López-Valdez et al., 2018). By giving farmers access to real-time data on water quality, nanosensors help them avoid crop damage from low water quality, identify any problems early, and manage irrigation more effectively.

Conclusion

Through the development of novel approaches to improve farming operations' sustainability, efficiency, and productivity, nanotechnology presents great potential to transform agricultural engineering. Agricultural engineers can help create a more resilient and ecologically conscientious agricultural industry that feeds the world's expanding population and protects natural resources for coming generations by embracing the potential of nanotechnology.

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Pulse Beetle: A Threat to Stored Pulses Grain

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Pulses are one of the important groups of worldwide crops which play a major role in the daily diet of people. Pulses contain 20-30% of protein which is almost three times higher than that found in cereals. Pulse crops are commonly subject to long-term storage (Tiwari *et al.*, 2011) and the storage conditions such as time, temperature and moisture content induce physicochemical and biological changes leading to a significant effect on the nutritional composition, germination and longevity (Menkov, 2000). Insect-pests are the most diverse groups of animals on earth which affect the welfare of humans in diverse ways. Stored grain pests infest grains to accomplish their food and shelter requirements for living as a result which cause qualitative and quantitative losses (Srivastava and Subramanian, 2016). The storage insect-pests which attack storage grains are rice weevil, maize weevil, lesser grain borer, granary weevil, Angoumois grain moth, khapra beetle, Indian meal moth, red flour beetle and pulse beetles. Among all the stored grain insect-pests, pulse beetle, *Callosobruchus spp.* are the major threat in pulse storage. *Callosobruchus chinensis*, *C. maculatus* and *C. analis* [Order: Coleoptera & Family: Bruchidae] are the three commonly known pulse beetle species in stored pulses.

Constrain Due to Pulse Beetle

These are very prolific, quick in breeding and increasing their population within short period of time. On an average this pest cause 5–10 & 20–30% pulse crop losses in the temperate and the tropical countries, respectively during storage. Storage losses due to insect pest infestations have been a problem of major concern among smallholder farmers who use traditional storage structures (Mendesil *et al.*, 2007). It is also a problem at the time of transportation which can damage the grains by direct feeding or indirectly by deterioration and contamination of grain by their fecal matter, exuviae or secondary infestation. Direct feeding damage resulted as reductions in grain weight, nutritional value, germination and market value. Whereas deterioration and contamination from the presence of insects resulted in the reduction of grain and market value due to insect parts, odors, molds and heat damage (Tyagi *et al.*, 2019). Farmer storing their produced pulses seed either in bag, locally available container and loose in the room where they are also living, unable to fumigate the produce for the control of this pest. Under such circumstance, unprotected stored pulses seeds suffer heavy losses. Its infestation started either in the field on the maturing pod which is carried to the stores with the harvested crops or it originates in the storage sites itself. If appropriate management is not adopted, then it can damage 100% of stored pulses within few months of storage. This pest is attacked to different pulses like Black gram, green gram, red gram, chick pea, beans, peas, cowpea and soybean.

Marks of Identification

The eggs of *Callosobruchus chinensis* are smooth, domed structures with oval, flat bases. *C. chinensis* larva is identified by its creamy white and oval and flabby body. The adult beetle measuring 3-4 mm in length, oval, chocolate or radish brown and has long serrated antenne. There is a pair of the hind margin of thorax, a spine on each of the inner and outer edges of the inner and outer edges of the end of hind femur and truncate elytra, not covering the pygidium (Fatima *et al..,* 2016).

Freshly laid eggs of *C. maculatus* were tiny, oval to spindle shaped, whitish, smooth and translucent in appearance. The larva was apodous, stout, creamy colour with a brown colour head and "C" shaped scarabeiform. The pupa of the beetle was light cream in color and as the pupal duration increased the colour changed from light cream to dark brown. The various appendages were held close to the body. *C. maculates* adult emarginated type of eyes, small (3-mm long) orange-brown beetles with a body that tapers towards the head. Their wing covers (elytra) are slightly shorter than their abdomen.

Life Cycle

Eggs were cigar shaped and shiny bright yellow which laid singly to developing pods or stored grains which are glued to grain. A single female lays 34-113 eggs at the rate of 1-37 per day. The egg period is 6-16 days; the larval period is 10-38 days. The pupal stage lasts 4-28 days. The average lifespan of an adult is 5-20 days. The average life span of an adult is 5-20 days,. In summer season it completes its life cycle in 25 to 34 days and in winter season it completes its life cycle in 45 to 50 days. The insect passes through 7-8 overlapping generation in year.

Nature of Damage

Pulse beetles are cosmopolitan insect and primary pest of stored pulses which laying eggs on seed surface during field condition and further growth carried out in storage. The adult and larva feed pulses cotyledon and embryo axis which makes it unable to germinate and such infested seeds are not useful for sowing purpose. The larva is found inside the seed with the mature larva excavating underlying seed tissue, leaving a visible 'window' just below the seed testa, within which it pupates and encloses. The maximum damage was occurred when favourable condition *i.e.* optimum temperature 30^0C and relative humidity 70%. It is also proved that size of seeds doesn't matter, but texture and diameter of seed coat affect the infestation of pulse beetle (Chakraborty *et al.*, 2015; Vyas, 2014; Teotia and Singh 1968; Ahmed *et al.,* 2018). The pulse beetles have a short developmental period and a high degree of reproductive capacity. Therefore, the incidence reaches a high degree within a short period and the damaged seed is unfit for consumption as well as for seed and storage purposes.

Management

1. Hygiene and sanitation: The storage structure should also be neat, clean and reasonably air tight so that control measures may be possible. Threshing floor or yard should be clean, free from any insect infestation, away from the vicinity of village or granaries to avoid horizontal and cross infestation. Pods should be harvested as soon as they mature

2. Proper stacking: Stack properly on the dunnage (wood/ plastic) 0.5 meter away from the walls and floor in the lines keeping 0.5 meter space between two lines and 0.2 meter open space toward the roof. Do not stack more than 10 bags vertically.

3. Disinfestations of storage container, structure and stores: Clean and disinfest bags by dipping in the boiled water and drying under sun, when re- used. Treat the old gunny bags by dipping in cypermethrin 0.01% or fenvarlerate 0.01% or malathion 0.1% for 10 minutes and dry them completely under sun when used for seed purpose only. Pulses seeds should be stored below 12 per cent moisture content escape from the attack of pulse beetle.

4. Use of Solar heat or cold: The use of solar energy has long been practiced as one of the effective methods for minimizing pulse beetle infestation stored pulse seeds. The seeds are sun dried or stored in refrigerated conditions in an air tight beetle-proof containers.

5. Mixing of inert dust and sand: Sand as 40-60 mm top layer on seeds has most effective in reducing the oviposition as well as egg hatching. Inert dusts particularly based upon silica content are gaining importance as storage protectants.

6. Mechanical cleaning: Broken and cracked grains promote attack of pulse beetle. Hence, screening and sieving out such seeds reduce the insect infestation. Regular screening of seeds done away from the stores to avoid any re-infestation

7. Radiation method: Giving full attack of ionizing ultraviolet light (wavelengths of 10e 400 nm, photon energies of 3e124 eV) having ability to kill and prevent pulse beetle infestation on pulses.

8. Chemical method: Fumigants are applied to eliminate infestations already present while protectants are mostly admixed with grain to prevent insect infestation from occurring at the time of the storage period. Before using the store-rooms should be disinfested with approved residual insecticides preferably important for the management of stored pests. Synthetic insecticides are not recommended for food grains used for consumption. Only chemicals registered for direct application to grains should be used and these should be applied according to recommended doses. Methyl bromide and phosphine are the most commonly used chemicals for fumigation. Phosphine fumigation is one of the commonly used insect pest control measures.

Conclusion

Pulse beetle, *Callosobruchus spp.* are the most common and widespread insect pests during storage in pulses. The pulse pods should be harvested as it became mature which should be sun dried or stored in refrigerated conditions in an air tight beetle-proof containers. These measures are eco friendly, environmentally safe and cost effective too. At the time of storage the further preventive method of damage due to this pest, fumigation is the best method to control insects than treated bags. Integrated pest management method involves various components for efficient management of insect pests in stored grains. It relies on managing insect populations through host plant resistance, physical, biological, botanical, and chemical control techniques.

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Microplastics - The Tiny Menace in the Aquatic Environment - and Means for its Reduction

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Introduction

Microplastic contamination is a significant issue worldwide because of its widespread distribution, poor biodegradability, toxicological properties, and detrimental effects on aquatic and terrestrial wildlife. Microplastics are released into stormwater via dumping, landfilling, transportation, artificial grass, fertilizers, and land-applied biosolids. Microplastics can also enter aquatic habitats by direct dumping or unregulated land-based sources. It is one of the greatest human-induced calamities that we are facing now.

Microplastics are found in everything, from the food on our plates to the water we drink to remote regions with no human habitation for hundreds of kilometers. The entry of microplastics into aquatic systems must be reduced or eliminated to safeguard the environment and public health. This can be done by implementing tactics including consumption reduction, public outreach, modern wastewater treatment and sludge removal techniques, restrictions of macro and microplastic sources, and suitable stormwater management techniques. The Arctic, formerly thought to be one of the most pristine regions on Earth, has been shown to contain microplastics. Researchers believe that when it snowed, the wind carried microplastics into the sky and caused them to settle.

Global plastics manufacturing peaked at 390.7 million metric tonnes in 2020, up from 375 million metric tonnes in 2016. In addition, the ubiquity of world nano-microplastic pollutants is a main difficulty due to exceptionally resistant pollution, which poses a toxic chance to each fish and mammal.

Microplastics

Microplastics are tiny plastic fragments measuring less than five millimeters in diameter. Small amounts were gradually produced due to the dissolution of the bulk polymer. On the other hand, some, like the beauty microbeads used in facial washes, were designed specifically for very lightweight. Various applications include paints, cosmetics, detergents, diapers, and pharmaceuticals. As a result, a flood of tiny particles eventually reaches the environment.

Primary microplastics are produced intentionally, while physicochemical oxidation processes produce secondary microplastics. Weathering and photo-fragmentation are the two main mechanisms of plastic degradation, leading to chain breakage and brittleness. So far, the smallest microparticle in the ocean reported is 1.6 micrometers in diameter[(13)]. However, microplastics are much lower when changes occur, such as external damage. In addition, microplastics can break down into nanoparticles during food processing.

Adverse Effects of Microplastics

Today, we inhale and ingest microplastics through contaminated seafood, tap or drinking water, and common beverages. Microplastics can leach chemicals from water bottles made of plastic, dermatological products, and other plastic containers, which can lead to health issues like endocrine disruption, weight gain, insulin resistance, decreased reproductive health, and cancer. However, not much evidence shows the adverse health effects of microplastics, and further research is required to determine their potential impacts. Marine biologists found plastic in the diets of seabirds during animal studies 40 years ago during their research. The Convention on Biological Diversity in Montreal in 2012 declared the eating or entangling of plastic of seven sea turtle species, 45% of marine mammal species, and 21% of seabird species[(14)]. If we talk about humans, laboratory tests have shown to cause human cell damage, including both allergic and cell death. A study conducted in 2018 also found the presence of microplastic in the feces of eight people in Austria[12]. Another study showed the presence of microplastics in the placentas of unborn babies[11]. Furthermore, the study shows the presence of microplastics in human blood samples and the lungs of some patients. The report by the American Lung Association in 2022 stated Chronic obstructive pulmonary disease (COPD), which results from chronic inflammation, is the 4th leading cause of death in the United States.

Innovative Ways for Microplastic Reduction

Creative techniques for reducing microplastic ranges are essential to deal with the growing problem of microplastic pollution in our environment.

1. Implement a ban on single-use plastic, one of the microplastic sources in our waterways.
2. Some ecologically sensitive areas should be prohibited from using single-use plastic items and similar materials.
3. Using biodegradable polymers in the region instead of traditional plastics is an exciting solution.
4. Another development in nanotechnology is manufacturing nanoparticles that effectively accumulate and remove microplastics from the surroundings. For instance, magnetic nanoparticles are designed to attract and remove microplastics from aquatic environments.
5. To stop microplastics from entering the environment, wastewater remedy facilities must additionally use contemporary filtration technology. Using these progressive strategies can assist in reducing the quantity of microplastic that affects ecosystems and human health.
6. A massive ocean clean-up machine is needed to clean the plastic from the ocean floating on the water's surface and keep it from degrading and further breaking down into microplastics.
7. Using natural fiber for clothing instead of synthetic fiber can reduce the amount of synthetic fiber reaching our ocean, which is non-biodegradable.
8. Avoid products that contain microbeads like toothpaste, facewash, detergent, etc.
9. Avoid the single use of plastic and use cloth or paper bags.
10. By trying to replace the packaging material, we should consider using other bio-degradable and sustainable packaging materials whenever possible. For example, consider banana leaves for food instead of plastic dishes for eating, which is seen in the southern states of India.
11. Educating people is also very important in raising awareness about the harmful effects of microplastics and promoting sustainable materials.
12. Promoting regular beach clean-up is also a good practice to keep our beaches clean and plastic-free, and a ban on plastic near coastal sites can reduce the amount of plastic going to sea.
13. Carrying single-use plastic carry bags in fishing vessels should be penalized.
14. Incentivize fishermen who bring the plastics accumulated or collected during fishing operations.

Current Challenges in Microplastic Reduction

To reduce the microplastics from our water bodies, thereby avoiding the severe threat they cause to the environment and biodiversity, we need different approaches like research and development, recognized public awareness campaigns, and strategies for replacing plastic use in everyday life. Awareness at the school and college levels is required to impart the thinking and responsibility of the next generation towards the environment and the harmful effects of using these materials on our soil and aquatic ecosystems. Reducing primary plastic sources can help reduce secondary microplastic accumulations in our water bodies. To combat the presence of microplastics in the environment, implementation of appropriate waste management and chain of command practices are very important. Collaboration is essential between various organizations and governments to effectively manage microplastics and plastic usage.

Conclusion

Microplastics are small, tiny plastic particles everywhere now, including the water we drink, the air we breathe, and the food we eat. It is spread in all climatic regions, even in the Arctic and Antarctic. It has a variety of sources, and some of them we can eliminate by changing our lifestyle and making small changes in our day-to-day lives. These microplastics are very harmful to humans as they can lead to lung diseases, damage and death of the cells, and many more. Microplastics are also present in the blood, feces, and placentas of unborn babies. It is also harmful to animals and is seen in the diet of marine birds, sea turtles, and other aquatic animals as they eat these plastic bags, which mimic jellyfish. Reducing this is challenging as it is nearly everywhere now, including the deepest point of the ocean, the Marina trench to Mt. Everest, but efforts are required to minimize this and make it happen. Because without trying, we can't fight this evil. Collective efforts are needed from the government to formulate and implement regulations and citizens to make sustainable choices and avoid plastic to combat and eliminate this microplastic menace. As individual decisions can significantly impact people's contribution, it is essential because, without this, it is impossible. Working together can have a considerable effect and positive changes for future generations.

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The Healing Elixir: Stingless Bee Honey's Journey from Hive to Health

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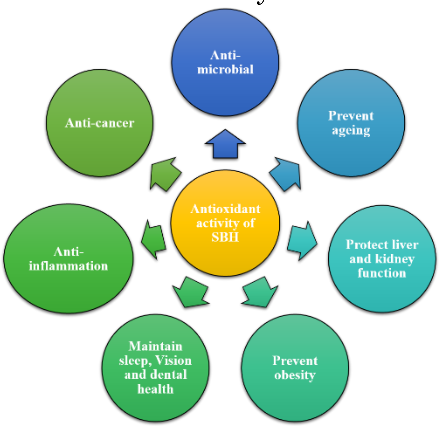
Introduction

Stingless bees or Dammer bees (*Melipona* sp), found globally, are potential commercial pollinators due to their preference for tropical flowering plants. With colonies of hundreds to thousands of workers, they exhibit highly eusocial behaviour. Meliponiculture, the scientific approach to stingless beekeeping, is well-established in tropical regions. Stingless bee honey, known as "pot-honey," is esteemed for its nutritive and medicinal properties. It undergoes a unique fermentation process by *Bacillus* species, producing alcohol and acetic acid. Other fermentations yield bioactive components like antibiotics and antioxidants. Each species boasts distinctive microbiomes and processing dynamics that shape honey's properties. Enzymes and compounds added during fermentation aid in nutrient preservation and digestion.

Biological and Therapeutic Aspects of Stingless Bee Honey (SBH)

Stingless bee honey holds promise for therapeutic applications due to its diverse array of physiological, pharmacological and biological properties. These properties stem from various flavonoids and polyphenols present in the honey, which have been associated with a range of health benefits including anti-inflammatory, anti-diabetic, antimicrobial, antioxidant, anticancer and healing effects.

1. Antioxidant activity of Stingless bee honey: The antioxidant potential of SBH is attributed to its richness in total phenolic and flavonoid content. SBH has been utilized to develop antioxidant-rich honey formulations, which aid in mitigating oxidative reactions and combating free radicals in both food systems and human health. SBH contains both non-enzymatic and antioxidant enzymes.



Antioxidant activity of stingless bee honey in human body

For example, Superoxide dismutase is an antioxidant enzyme that neutralizes free radicals and reactive oxygen species to produce molecules that are less damaging to the body. Ascorbic acid, tocopherol and phenolic compounds, on the other hand, are non-enzymatic substances that neutralize reactive oxygen species by preventing and interrupting the harmful chain reactions that free radicals induce. The polyphenol components gallic acid, chrysin, caffeic acid, Mandelic acid, caffeic acid, chlorogenic acid, rosmarinic acid, vanillin, umbelliferone, syringaldehyde, sinapaldehyde, aromadendrin, isoquercitrin, eriodictyol and carnosol are the substances that supports SBH's strong antioxidant content (Tuksitha *et al.,* 2018).

2. Wound healing activity of Stingless bee honey: Wound healing is a complex biological process that is essential for repairing damaged skin and restoring its integrity. The healing process is divided into several consecutive but overlapping stages, including haemostasis, inflammation, proliferation and remodelling. However, some wounds fail to heal in a timely manner called chronic or delayed acute wounds. They appear due to various reasons including poor oxygenation, infections, age, hormonal imbalance, stress, diabetes and obesity, smoking and unhealthy diet. Honey is one of the natural products that are famous for their wound healing properties. First, SBH is a natural agent and it has an aesthetically pleasing appearance. Second, SBH helps debride wounds, keeping them clean and hygienically unspoiled. Finally, honey stimulates the formation of granulation tissue and reepithelialisation, in addition to encouraging angiogenesis (Jalile *et al.,* 2017).

Component of SBH that can enhance the wound healing rate	**Sugars (Glucose and fructose)**
	Proteins, Vitamins and Minerals
	Peroxide components: glucose oxidase for the production of hydrogen peroxide and D-gluconic acid
	Non peroxide component: Flavonoids and Polyphenols (Protocatechuic acid)
	High acidity
	High Water content

3. Anticancer properties of stingless bee honey: Polyphenols with anticancer effects that can be found in SBH are quercetin, apigenin, chrysin and luteolin. The mechanisms by which these polyphenols prevent cancer include inducing tumor cell apoptosis, modulating cancer signalling pathways and inhibiting cell proliferation. As a result, cancer prevention is more likely to be successful if uncontrolled cell proliferation can be blocked or reduced. Uncontrolled cell proliferation has caused the cancer cells to multiply at a quicker rate. Cell proliferation can be effectively inhibited by polyphenols, which are also well-known for their antioxidant qualities (Hossen *et al*., 2017).

4. Antimicrobial activity of Stingless bee honey: SBH is rich in phenolics and flavonoids, offering strong antimicrobial properties against various pathogens. It effectively fights off both Gram-positive bacteria such *as Bacillus subtilis, B. megaterium, B. brevis* and *Micrococcus luteus,* as well as Gram-negative bacteria like *Escherichia coli* and *Pseudomonas syringae*. Additionally, SBH's unsaturated pyrrolizidine alkaloids (PA) have demonstrated antifungal and antiviral abilities. The antibacterial effects of SBH are attributed to factors including hydrogen peroxide levels, as well as non-peroxide components like lysozyme, phenolic acid and flavonoids. The acidic nature of SBH, polyphenol concentration and protein content also contribute significantly to its antibacterial properties (Tuksitha *et al.,* 2018).

5. Antidiabetic activity of stingless bee honey: SBH demonstrates potential for diabetes treatment by mitigating histopathological abnormalities, oxidative stress, inflammation and apoptosis in pancreatic islets, while enhancing insulin expression. *Trigona iridipennis* honey exhibits enzyme inhibitory properties against amylase and glucosidase, facilitated by bioactive components like caffeic acid and catechin. This ability aids in lowering blood sugar levels by impeding the rapid conversion of complex starch molecules into simple sugars, as the phytochemicals in the honey compete with α-amylase and α-glucosidase (Krishnasree and Ukkuru, 2017).

6. Other Therapeutic values: In addition to its diverse therapeutic applications, SBH has been employed in treating neurological ailments, infertility and eye disorders. It retards the advancement of cataracts and shortens the duration of eye infections caused by *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Consumption of honey can elevate levels of follicle-stimulating hormone (FSH), luteinizing hormone (LH) and testosterone. Continuous intake of honey by children can decrease the duration of diarrhoea and address gastrointestinal problems and challenges. Moreover, it aids in averting dementia and other cognitive disorders while enhancing memory through the promotion of neuron growth in the hippocampus.

Conclusion

Stingless bee honey presents a potent natural remedy, rich in antioxidants and bioactive compounds, offering a wide array of therapeutic benefits. From its role in wound healing and cancer prevention to its antimicrobial and anti-diabetic properties, this unique honey showcases diverse health-promoting effects. Its versatile applications extend to neurological ailments, infertility and gastrointestinal issues, making it a valuable asset in holistic healthcare approaches. As research unveils its full potential, SBH stands poised to revolutionize health paradigms and enhance overall well-being.

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Plant Growth Regulators on Strawberry Cultivation

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Introduction

Strawberry (Fragaria × ananassa Duch.) is an important fruit crop belonging to family Rosasea. Its chromosomal no. is 2n=2x=56. The species is octaploid and it is short-lived (3-5 years), perennial, robust, stoloniferous herb that grows to a height of 10-20 cm and a spreading of 30-50 cm. The genuine strawberry fruit is an achene, a little, dry seed that is loosely linked to the swelling ovary wall. The strawberry's flesh is actually the ovary wall, which has many fruits/seeds on its surface. Because of shallow roots, plants require regular watering but not standing water (Vishal et al., 2016). Strawberry usually grows in temperate zones, and it is classified as a short-day plant based on its behaviour and eco system.

The presence of attractive red colour, pleasant aroma and high nutritional value in terms of vitamins (A and C) and minerals (Fe and K) make this fruit very special in global markets. Strawberry fruits are also being used to prepare jam and jellies because of the presence of high amount of pectin. Strawberry fruits also have a high amount of antioxidants which are found to be useful for relieving the oxidative stresses (Sharma and Thakur, 2008). Consumption of strawberry prevents the causing of various types of cancers and heart related problems. This fruit is also reported to be beneficial in reduction of inflammation and obesity related disorders (Arfin et al., 2016). For these reasons the demand of strawberries in the markets is increasing gradually and the growers are also encouraged to cultivate this crop to gain higher income.

Common plant growth regulators used in fruits include auxin, gibberellins, cytokinin, abscissic acid, ethylene, brassinosteroids, salicylic acid, polyamines, methyl jasmonates and triacontanol There have been a lot of scientific evidences that have suggested that the strawberry plant responded well to growth regulator application (Sharma and Sharma, 2004). For their suitability of application at cheaper rate naphthalene acetic acid (NAA) and gibberellins (GA3) have been widely tested in modern agricultural system among the plant growth regulators and the role of these plant growth regulators has been investigated in several fruits (Bisht et al., 2018).

Characteristics of Strawberry Plant Ready for the Application of Plant Growth Regulators

It should be healthy, well developed, almost uniform. It should also be pest and disease-free runner plantlets of strawberry cv. Winter Dawn which is planted at second week of October.

When and how to apply PGR?

Application of PGR can be done at 30 and 60 days after planting. The most coomon method of application is foliar spraying of plant growth regulators (NAA and GA_3)

Effect on Growth and Flowering of Strawberry Plant

The foliar spraying of plant growth regulators significantly influenced the plant growth of strawberry. Foliar spraying of 100mg l-1 of GA3 results in maximum plant growth in terms of plant spread . This treatment had also found to be the best for producing the highest number of leaves, crowns and runners in strawberry. The exogenous application of plant growth regulators failed to influence any significant effect on days taken to 50 per cent flowering in strawberry. However, the plants received 100 mg l-1 GA3 exhibited earliest flowering with significantly maximum number of flowers in strawberry.

Gibberellic acid plays a regulatory role in the mobilization of metabolites from source (foliage) to sink (developing fruits) (Iqbal et al., 2011). Excessive biomass in GA3 treated plants might able to produce more metabolites through the activity of photosynthesis which ultimately sank in to the developing fruits and resulting berries with maximum weight. Increase in berry weight with the application of GA3 is also reported in strawberry (Sharma and Singh, 2009).

The exogenous application of GA3 might regulate this balance in favour of fruit forming metabolic processes by inducing enzymes required during post fertilization stage and thus improve the fruit setting which finally resulted the maximum number of fruits plant-1 (Sharma and Sharma, 2004). Further, better pollen germination in strawberry flowers is reported with the application of GA3 (Paroussi et al., 2002). A major portion of non-marketable fruit in strawberries includes the malformed and underweight fruits (Kirschbaum et al., 2014).

Usually, a malformed (misshapen) fruit is developed when ovaries fail to elongate due to poor pollination or partial pollination of strawberry flowers (Zaitoun et al., 2006). The unpollianted ovaries of strawberry flowers might be elongated through the foliar application of GA3 and produced fruits of marketable size (Sharma and Singh, 2009).

Additionally, the exogenous application of GA3 had an indirect effect on the auxin metabolism and resulted higher number of marketable fruits and thereby increased the fruit yield (Kappel and McDonald, 2007). Enhancement of fruit yield with the application of GA3 is also reported earlier in strawberry (Paroussi et al., 2002).

NAA, GA3, and CEPA had a major impact on the growth and flowering parameters. The number of fruits, flowers, and fruit productivity all significantly increased after GA3 application, according to their observations of plant height, leaf count, leaf area, and fruit productivity. The evidence of (Qureshi et al., 2013), who also discovered that the application of GA3 greatly improves plant height, leaf area, fruit setting percentage, and the number of runners is consistent with the study's findings as well.

Effect on Fruiting and Yield of Strawberry

The strawberry fruiting was adversely affected by the plant growth regulator treatments. The plant absorbs foliar spray of 75 ppm GA3 produce maximum no of fruit (28.1), fruit length (4.81 cm), fruit weight (14.35 gm), fruit diameter (4.01 cm), fruit set (83.86 %), and yield were recorded in treatment T1 followed by treatment T2. When minimum observation was found in control T0. In foliar spray with GA3, additional biomass may be able to generate extra metabolites during photosynthesis, which eventually sank into the producing fruits and generated berry with the most weight. In strawberries, the use of GA3 has been observed to boost berry weight (Sharma and Singh, 2009). A higher number of marketable fruits were produced as a result of the exogenous application of GA3, which also indirectly affected the Effect on Fruit Quality of Strawberry.

In terms of strawberry quality, the use of growth regulators altered the quality features of the strawberry fruit. The plant absorbs foliar spray of 75 ppm GA3 produce maximum Total soluble solid (8.44 0B), Acidity (0.52%), Ascorbic acid (65.47mg), Total sugar (9.48 %), Reducing sugar (5.1%), non-reducing sugar (4.38%) were recorded in treatment T1. When minimum result show in control T0. Gibberellic acid was applied to fruits, which massively improved total soluble solids and decreased titratable acidity. With foliar treatment of 75 ppm GA3, the highest total soluble solid was recorded. However, in the current investigation, the control group had the lowest levels of total soluble solids. These results support those of Prasad et al. (2013), who demonstrated that GA3 concentrations responded favourably to a strawberry quality measure.

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Nanotechnology in Vegetable Crops

Article ID: 48904

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Introduction

The development and use of materials, tools, and systems via manipulation of matter's characteristics and structure at the nanoscale is known as nanotechnology. The Greek term "nano," which means dwarf, is where the name "nanotechnology" originated. Nanotechnology is the study of science, engineering, and technology at the nanoscale (about 1 to 100 nano meters). The emergence of nanotechnology is deeply connected to a historic statement by the Nobel Prize winner Richard Phillips Feynman, Father of nanotechnology which all begins with the talk entitled “There is plenty of room at the bottom”. Professor Norio Taniguchi of the Tokyo Science University, introduced the term "nanotechnology", in a paper 1974. It is also the science of manipulating, organizing, manufacturing and engineering products and materials at the nanoscale. In agriculture, novel nanomaterials have shown high potential for the development of new crop varieties through genetic engineering, hybrid varieties of crops, and novel high efficient agrochemicals for the nutrition and protection of crop plants. Furthermore, the application of nanomaterials improves food processing, packaging, food safety, plant nutrition, efficiency of pesticides and fertilizers, and the reduction of environmental pollution and the production of nutraceuticals.

Nanotechnology in Vegetables

Nanotechnology shows high promise in the improvement of agricultural productivity thus aiding future food security. In horticulture, maintaining quality as well as limiting the spoilage of harvested fruit and vegetables is a very challenging task. Various kinds of nanomaterials have shown high potential for increasing productivity, enhancing shelf-life, reducing post-harvest damage and improving the quality of horticultural crops. Antimicrobial nanomaterials as nanofilm on harvested products and/or on packaging materials are suitable for the storage and transportation of vegetables. Nanotechnology is found useful in all stages of production, storage, processing, packaging of vegetables and helps to revolutionize horticulture and food industry. The benefits of nanotechnology in vegetable production are enormous. These include control of insect pests using nano pesticides and nano insecticides, increase in vegetable production and productivity using nanoparticles encapsulated fertilizers and biofertilizers.

Properties of Nanotechnology

Crop Growth: Nanomaterials enhance the productivity of crops by increasing the efficiency of agricultural inputs to facilitate site-targeted controlled delivery of nutrients, thereby ensuring the minimal use of agricultural inputs. The mechanism behind promotion of plant growth and enriched quality is explained by the potentialities of nanomaterials to absorb more nutrients and water that in turn helps to enhance the vigor of root systems with increased enzymatic activity.

Seed Priming: Nano-priming has the added advantage of being able to trigger certain metabolic processes that are normally activated during the early phase of germination. Seed nano-priming is an efficient process that can change seed metabolism and signalling pathways, affecting not only germination and seedling establishment but also the entire plant lifecycle. The various benefits of using seed nano-priming, such as improved plant growth and development, increased productivity, and a better nutritional quality of food

Stress tolerance: Nanotechnology has emerged as a promising avenue for addressing stress challenges in agriculture. Nano-technology can help plants tolerate different abiotic stress conditions, such as drought, salinity, heavy metal toxicity, heat, cold and nutrient deficiency. Engineered nanoparticles can be tailored to deliver specific nutrients, hormones, and other bioactive compounds directly to plant cells, thereby improving stress response mechanisms. Additionally, nanomaterials can enhance water and nutrient uptake, reduce oxidative damage, and modulate gene expression, all of which contribute to enhanced stress tolerance.

Production of Quality transplants: Nano particles is effective in improving plant growth, development and vigour. The use of different NMs, e.g., gold, silver, copper, silicon, zinc, titanium nanoparticles showing diverse effect on germination efficiency, seedling growth and development. Nanoparticles of many metal oxides absorb water, oxygen and nutrients and having the antimicrobial properties can affect the seed germination %, improve growth and plant metabolism.

Nano-fertilizers: The application of nano-fertilizers in agriculture should have a greater concern to society. Nano-fertilizers have greater role in enhancing crop production and this will reduce the cost of fertilizer for crop production. Effective use of nano-fertilizers enhance fertilizer nutrient use efficiency in crop production. Nano-fertilizers provide more surface area for different metabolic reactions in the plant, which increase photosynthesis rate and produce more dry matter and yield of the crop and also prevent plant from different biotic and abiotic stress.

Nano-Pesticides: Nano pesticides are nanostructures with two to three dimensions between 1 to 200 nm. The development of nano pesticides can reduce pesticide use and human exposure to pesticides, which is environmentally friendly in terms of crop protection. Therefore, the development of non-toxic pesticides promises to increase the global food supply while reducing negative environmental impacts on ecosystems.

Scopes of nanotechnology: It is an emerging area and engages almost every technical discipline from basic sciences to applied science. The success of nanotechnology is achieved in satisfying certain conditions that includes reduction of plant protection products, minimizing nutrient losses in fertilization and increasing the yield through optimized nutrient management. Its emergence gives rise to socio economic issues in terms of health and environmental safety, consumer perception and intellectual property rights. But the main factors limiting the development of these applications are low investments in manpower training and in research infrastructure. The scopes of nanotechnology are:

a. Rapidly expanding area of research in agriculture
b. Used across all the basic science fields, such as chemistry, biology and physics
c. Used in materials science, engineering sciences and microscopic sensors
d. It is one of the top ranked subject related to academic and research
e. Provides technological solutions in the field of energy
f. Huge potential to solve our problems in environment sciences
g. Aspirants can create their career in this field to pursue higher studies.

Advantages of Nanotechnology

1. Increased crop yields: Nanotechnology can be used to improve plant growth and yield, allowing farmers to produce more food with less land and resources.

2. Reduced use of pesticides and fertilizers: By using targeted delivery systems for pesticides and fertilizers, farmers can reduce the amount of these chemicals needed and minimize their impact on the environment.

3. Enhanced food safety: Nanotechnology can be used to develop sensors and monitoring devices that can detect contaminants and pathogens in food, improving food safety and reducing the risk of foodborne illness.

4. Soil remediation: Nanoparticles can be used to remove pollutants and heavy metals from soil, improving soil health and reducing contamination of crops.

Disadvantages of Nanotechnology

1. Environmental risks: The use of nanoparticles in agriculture may pose environmental risks, such as soil contamination or unintended impacts on non-target organisms.

2. Health risks: There is still limited understanding of the potential health risks associated with exposure to nanoparticles, particularly over the long term.

3. Regulatory challenges: The regulation of nanotechnology in agriculture is still evolving, and it can be difficult to assess the safety and efficacy of new nanotechnology-based products.

4. Ethical concerns: There are also ethical concerns related to the use of nanotechnology in agriculture, such as potential impacts on small farmers or the exacerbation of social inequalities.

Conclusion

The application of nanotechnology in agriculture and food systems can contribute immensely to livelihood sustainability and food security. Nanomaterials are simple, cost-effective, and eco-friendly, allowing them to be produced in a minimum time and with less effort and without causing any harm to the environment. The major contribution of nanotechnology in agriculture is realized in nutrient management, precision farming, insect pest and disease management, agronomy and crop improvement schemes. Nanotechnology can have positive and diverse effects on living organisms. Because of the possibility of a negative impact of nanoparticles on plant growth, it is necessary to carefully examine the relationship of NPs and plant organisms. Undoubtedly, nanotechnology can provide "tools" to improve the properties of plants, their productivity and their resistance to many internal and external factors. However, because of the possibility of harmful effects of NPs on plants, there is a need for a great deal of research that would allow wise use of this new technology.

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Unveiling the Heat Warriors: The Quest for High Temperature Tolerance in Chilli Plants

Article ID: 48905

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Introduction

Heat stress is a major abiotic factor limiting crop productivity worldwide. Even though temperature rises may be beneficial in some regions, crop yield reductions are likely unless adaptation strategies are implemented. Chilli peppers, renowned for their fiery flavor, are a staple ingredient in cuisines worldwide. Yet, these spicy gems face formidable adversary *viz.* high temperatures especially in tropical countries. Chilli growth, fruit set, and yield are optimal under average day and night temperature ranges of 21 °C to 29.5 °C and 18.5 °C to 23 °C, respectively. A few degrees increase (1 °C) above an average daily temperature of 25 °C can greatly impair reproductive organs, especially pollen viability and female fertility, resulting in drastic decreases or even total failure of fruit setting. As a consequence, heat stress reduces the chilli growing window (the number of days per year with optimal temperatures for tomato production), especially in open field and non-controlled growing conditions, which are the prevailing chilli cropping systems in tropical regions. As global temperatures continue to rise due to climate change, the cultivation of chilli peppers is increasingly challenged. However, through innovative breeding techniques, focused trait selection, and strategic management practices, researchers and farmers are unlocking the secrets to enhancing heat tolerance in chilli plants.

Worldwide, there have been calls for developing heat tolerant cultivars to adapt to current and predicted increases in heat stress. However, breeding for heat tolerance in general has been plagued by the complexity of heat stress and plant responses to the stress as well as the limited understanding of the genetic basis of heat tolerance traits. Rapid advances in genotyping and its decreasing cost have enabled the widespread application of high-throughput genotyping while accurate phenotyping has become the biggest constraint to unravelling the genetic basis of important and complex traits, thus slowing down progress of breeding programs. In order to increase efficiency of plant breeding programs, it is important to develop reliable, precise, cost-effective, less labor-intensive, and easily applicable phenotyping methods for important traits. In recent years, efforts have been made to develop high-throughput phenotyping devices, including hyperspectral, multispectral, and thermal sensors and fluorescence, which can be deployed as stationary platforms or imagers.

Screening for Heat Tolerance

Interest in screening chilli genetic resources for heat tolerance is on the rise. This screening process occurs in various environments, such as phytotrons, growth chambers, greenhouses, and open fields. Phytotrons and growth chambers provide controlled conditions ideal for investigating the physiological and molecular mechanisms of thermo-tolerance. However, findings from controlled environments may not always apply to real-world field conditions due to uncontrollable factors like soil variation and biotic stress. In open field screening, understanding the specific heat stress conditions is crucial, including day and night temperatures and daily variations. This method better reflects the target environment for developing varieties. Several studies have conducted open field screening for chilli heat tolerance, often including genotypes with established thermo-tolerant status as references. The integration of high-throughput field phenotyping platforms promises to enhance the efficiency and accuracy of field screening processes.

Key Traits for Heat Tolerance Screening in Chillies

1. Male Fertility: Pollen viability, number, and release are crucial for fruit production under heat stress. Assessing these factors helps reveal thermo-tolerance in chili genotypes, with recent advancements enabling automated analysis.

2. Female Fertility: High temperatures affect the female reproductive organs, impacting seed set and ultimately yield. Combined sensitivity of male and female organs to heat stress can lead to significant yield reductions.

3. Biochemical Traits: Various metabolites accumulate under stress, affecting pollen development and viability. Soluble sugars, proline, polyamines, and other compounds play vital roles and can be profiled to aid in selecting heat-tolerant lines.

4. Membrane Stability: Ion leakage reflects cell membrane integrity, with higher leakage associated with decreased stability. Membrane thermostability serves as a reliable parameter for heat tolerance screening.

5. Chlorophyll Fluorescence: Heat stress affects photosynthetic activities, particularly photosystem II (PSII). Chlorophyll fluorescence serves as an indicator of stress response and can help evaluate heat tolerance.

6. Canopy Temperature: Reflects evaporative cooling from the canopy surface, integrating various physiological parameters. Widely used as a water stress indicator, canopy temperature measurement is adaptable for high-throughput phenotyping to identify heat-tolerant genotypes.

7. Heat Shock Proteins (HSPs): Crucial for protecting plant cells from heat-induced damage by stabilizing cellular structures and preventing protein denaturation.

8. Efficient Water Use: Heat-tolerant chili varieties efficiently manage water resources, reducing the risk of heat-induced drought stress.

9. Root System Development: A robust root system is essential for accessing water and nutrients, particularly in hot and dry conditions, contributing to heat tolerance in chilies.

Exploiting Genetic Resources to Enhance Heat Tolerance in Chili

The limited genetic diversity in cultivated chilli plants for heat tolerance has spurred interest in tapping into the genetic pool of wild chili relatives, known for their resilience to various stresses and desirable yield traits. There's a pressing need to uncover new sources of heat tolerance genes in chili. Despite the vast diversity present in chilli germplasm collections, they have not been extensively utilized in breeding programs.

Breeding Efforts for Improvement of Tolerance to High Temperature

The quest for high temperature tolerance in chilli begins with selective breeding. Traditional breeding methods involve crossing different chilli varieties to create offspring with desired traits, such as heat tolerance. However, modern biotechnological tools, including marker-assisted selection and genetic engineering, have revolutionized the breeding process. Marker-assisted selection allows breeders to identify specific genetic markers associated with heat tolerance and incorporate them into breeding programs. This targeted approach accelerates the development of heat-tolerant chilli varieties by enabling breeders to select plants with the desired traits at an earlier stage of development. Genetic engineering offers another avenue for enhancing heat tolerance in chilli plants. By introducing genes from heat-tolerant species or modifying existing genes involved in stress responses, researchers can create genetically modified (GM) chilli varieties with improved resilience to high temperatures.

Some cultivated chilli varieties have shown promising potential for heat tolerance, particularly in terms of fruit set percentage, under heat stress conditions (add reference). However, systematic screening for heat tolerance in chili genetic resources has been relatively sparse. To address this gap, various methods can be employed to broaden the genetic base of chili plants. These methods include advanced backcross QTL analysis, chromosome segment substitution lines (CSSL), backcross inbred lines (BIL), and introgression lines (ILs). These techniques involve the incorporation of small segments of genetic material from wild or donor parent chromosomes into cultivated varieties, thus increasing the likelihood of breaking linkage drag and enhancing genetic diversity. Advanced backcross QTL analysis, in particular, has proven successful in improving several crop species. However, the efficacy of marker-assisted breeding hinges on the availability of reliable QTL information. While a few studies have mapped QTL associated with heat tolerance in chili, further research in this area is needed to fully exploit the potential of genetic resources for enhancing heat tolerance in chili varieties.

In addition to breeding for heat tolerance, implementing effective management strategies is crucial for mitigating the impact of high temperatures on chilli cultivation:

1. Irrigation Management: Adequate and timely irrigation is essential for cooling the plant and maintaining optimal moisture levels in the soil. Drip irrigation and mulching can help conserve water and reduce evaporative losses.

2. Shade Netting: Installing shade netting over chilli fields can provide relief from direct sunlight and reduce heat stress on plants, especially during the hottest hours of the day.

3. Soil Modification: Improving soil structure and fertility through practices such as composting and mulching can enhance water retention and nutrient availability, supporting plant growth and resilience to heat stress.

4. Timing of Planting: Planting chilli crops during cooler periods or choosing early-maturing varieties can help mitigate the impact of high temperatures during critical growth stages.

5. Crop Rotation and Diversification: Rotating chilli crops with heat-tolerant or complementary species can help break pest and disease cycles while diversifying income streams for farmers.

Conclusion

As the planet continues to warm, the cultivation of heat-sensitive crops like chilli faces mounting challenges. However, through innovative breeding approaches, focused trait selection, and strategic management practices, agricultural researchers are making significant strides in enhancing the heat tolerance of chilli plants. By harnessing the power of science and technology, we can ensure a spicy future for chilli lovers everywhere, even in the face of rising temperatures.

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Insitu Soil Moisture Conservation Techniques

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Abstract

To enhance moisture availability for agricultural crops, integrating in-situ moisture conservation techniques alongside large-scale soil and moisture conservation efforts and water harvesting structures within the watershed is crucial. This recommendation stems from the principle of augmenting infiltration by mitigating runoff rates, temporally detaining water on soil surfaces to prolong infiltration opportunities, and altering land configurations for inter-plot water harvesting. Traditionally endeavours for moisture conservation focused on constructing various types of bunds along the land slope to curb erosion and preserve soil. However, these erosion control measures often led to water accumulation against structures, rather than uniformly distributing it across inter-terraced areas, sometimes resulting in reduced crop yields. To address these issues, in-situ moisture conservation techniques are now advocated. In-situ soil moisture conservation encompasses various methods, including agronomical and mechanical approaches. Agronomical methods such as summer ploughing, contour ploughing, and mulching aim to enhance moisture retention. Mechanical methods, like bunding, broad bed furrow, basin listing, and tie ridging, also contribute to soil moisture conservation. Overall adopting in-situ conservation practices holds the potential to diminish soil and water losses significantly. Studies have indicated that in-situ soil moisture conservation can conserve 38-50% of moisture, stabilize crop production, and augment crop yields. In the case of fodder crops, it can even amplify fodder yield by up to 40%

Keywords: In-situ soil moisture, crop yield, erosion and crop production.

Introduction

Dryland areas cover a significant portion of India's agricultural land, with Chhattisgarh, Uttar Pradesh, Tamil Nadu, and Madhya Pradesh being major states practicing dry farming. Dryland farming faces challenges such as inadequate soil moisture due to low and erratic rainfall, light/medium textured soils with low water holding capacity, and rolling topography leading to runoff and soil erosion. Importance of in-situ soil moisture conservation involves storing rainfall in the soil where it falls, aiming to increase infiltration and reduce runoff. This method is efficient and cost-effective, as it minimizes evaporation losses and makes water readily available to plants without the need for large investments in water collection structure. Benefits and Principles of in-situ soil moisture conservation techniques help increase moisture availability to crops by intercepting raindrops, reducing splash effects, and improving water intake by soil through better soil-organic matter contact and soil structure. There are two methods in in-situ soil moisture conservation techniques *viz.,* agronomic methods and mechanical methods. Mechanical methods involve shaping the land surface manually or with implements to reduce runoff velocity, prolong rainfall standing time on soil surfaces, and facilitate deeper infiltration into soil layers. Need for technology adoption is given the finite land area and the necessity to improve land productivity and farmers' income, there's a call for adopting technologies in dryland farming to increase production and moisture retention. Overall, the adoption of in-situ soil moisture conservation methods is essential for enhancing moisture availability and crop productivity in dryland farming areas, where rainfall is theprimary water source for agricultural activities.

In-Situ Soil Moisture Conservation Techniques

1. Agronomical / Cultural Methods:

a. Contour Ploughing:

i. Ploughing along the contour helps in-situ moisture conservation.

ii. Plough furrows hold water in depressions, increasing infiltration.

b. Cover cropping:

i. Fully covering the land surface with foliage, such as black gram, green gram, groundnut, or fodder grasses like *Cenchrus ciliaris* and *Cenchrus glaucus*, reduces erosion.

ii. Suitable or slopes less than 2 percent.

c. Mulching:

i. Covering the soil surface with crop stubbles, straw, coir pith, groundnut shell, or husk conserves moisture (up to 40-60%) and prevents erosion.

2. Mechanical Methods:

Bunding

a. Contour bunding:

i. Construction of permanent bunds or barriers along contours to arrest soil loss and runoff

ii. Suitable for tropical regions with a distance of 10-12m between bunds and slope less than 1 per cent.

iii. Successful with 270 mm rainfall for sorghum crops (Itabari and Wamuongo, 2023).

b. Compartmental bunding:

i. Formation of small bunds (15cm width and height) to divide fields into small basins or compartments (40sq.m size)

ii. Suitable or red and black soils with a slope of 0.5-1%

c. Broad Bed Furrow:

i. Consists of broad beds separated by sunken furrows.

ii. Beds are 1.5 m wide, 15 cm high, and of convenient length, separated by furrows of 30 cm width and 15 cm depth.

iii. Can be prepared using a multiple tool like 'Tropiculture'

iv. Suitable or land with a slope of 0.4-0.8%

v. Higher total soil moisture content up to 60 cm deep and better moisture availability, crop yield, and cost-benefit ratio compared to flat bed systems (Maurya and Devadattam,1987)

d. Tide ridging:

i. A modification system of ridges and furrows where ridges are connected by small bunds at 2-3 meter intervals along the furrow.

ii. Suitable for well-drained soils.

iii. Gichangi et al. (2007) reported that tied-ridging with manure or fertilizer application increased maize grain yields from 100 to 359% in semi-arid regions of eastern Kenya.

e. Basin listing:

i. Formation of small depressions (basins) of 10-15 cm depth and width at regular intervals using an implement called a basin lister.

ii. Basin collect rainfall and improve storage.

iii. Suitable for all soil types and crops.

iv. Elmaeni and Elsahookie (1987) found that sowing maize on ridges with basin listing yielded higher grain yields compared to other treatments, with yields ranging from 7.37 to 11.9 t/ha.

f. Bench terracing:

i. Conversion of sloped land into terraced fields to increase arable land by 20%-40%

ii. Construction involves creating step-like fields to reduce erosion.

iii. The riser is protected by vegetation cover and sometimes faced with stones or concrete.

iv. Hu et al. (2005) noted that bench terracing can increase grain yield by about 20%-40%.

Conclusion

The challenges faced in dryland agriculture, such as low yield and unstable production, cannot be ignored due to the significant number of farmers and vast cultivated areas involved. While increasing production from drylands remains a daunting task, it is essential for sustaining agricultural livelihood. Fortunately, various technologies for in-situ rainwater harvesting exist, and their effectiveness can be further enhanced by integrating them with soil fertility improvement practices. These in-situ rainwater harvesting technologies have the potential to significantly increase crop and fodder productivity, offering

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viable solutions for adoption by the farmers. In summary, addressing the challenges of dryland agriculture requires concerted efforts to implement and combine technologies for in-situ rainwater harvesting with soil fertility improvement practices. By doing so, we can work towards achieving more stable and productive agricultural systems in dryland regions, benefiting both farmers and the agricultural sector as a whole.

	
Contour Ploughing	**Cover Cropping**
	
Mulching	**Contour Bunding**
	
Compartmental Bunding	**Broad Brd Furrow**

Tied Ridging

Basin Listing

Bench Terracing

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Rural Women Entrepreneurs Strategies for Time Management and Decision-Making in Agriculture

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Introduction

Rural entrepreneurship is a sector with high potential to undertake various business, industry, agriculture and allied activities that can play a significant role in economic growth of the nation (Prabhakar et al. 2023a). Due to their combined duties as farmers and household managers, female agricultural women entrepreneurs have unique obstacles in time management and decision-making. Time-use surveys indicate that the amount of time spent by women in agriculture varies depending on the crop, the production cycle, the age of the worker, and the ethnic group. Generally, women work in weeding and harvesting. More unpaid domestic tasks, such as food preparation and water and fuel collection, fall under the category of rural women's labour than that of men. Women in agriculture who are also entrepreneurs might use a variety of time-management and decision-making techniques to overcome the obstacles. Setting priorities and assigning duties, such as enlisting the help of other family members to help with housework or hiring help for agricultural work, are two examples of such strategies.

Additionally, women Entrepreneurs can use technology to increase productivity. For example, they can use mobile phones to get market intelligence or agricultural equipment to increase mechanization. When it comes to making decisions, female entrepreneurs might look for assistance from mentors or peer networks who can offer direction and counsel based on their personal experiences. Additionally, women company owners can take part in leadership and business skills training programs, which can assist them in making more educated decisions and negotiating better prices with suppliers or customers.

The challenges of life, job, and family that face female entrepreneurs in rural areas have an impact on their ability to perform well inside a business. Given the current circumstances, when people are constantly taking on more work, it is getting harder to manage time effectively (Sonam et al. 2020a; Patil & Deshpande, 2021). Men and women have distinct ideas about what constitutes success and labour. In addition to attaining objectives and making substantial profits, women's success also hinges on charting their own course, pursuing meaningful work, fostering stronger client relationships, and preserving a better work-life balance. Success also includes their empowerment, which gives them prestige and authority in their families, communities, and on the job (Omar et al. 2019).

For women entrepreneurs who want to maximize their productivity while balancing work and personal life, time management skills become essential. Six time-management techniques are useful for time-constrained women entrepreneurs in agriculture.

1. Time Assessment: It's critical to evaluate the present time management practises before putting any time management tactics into action. Examine the daily schedule and activities for a moment, looking for places where time is being spent or used inefficiently. Gaining awareness of time usage habits that can help to decide where changes and enhancements should be made.

2. Setting Task Priorities: Setting priorities for the projects is essential to time management success. It's critical for women entrepreneurs to prioritize doing the most vital chores that support their firm's objectives. Think about classifying tasks according to their urgency and importance by applying methods like the Eisenhower Matrix or ABC analysis.

3. Contracting out and assigning work: Acknowledge that women time and lessen the workload by outsourcing specific duties or delegating non-essential labour. Think about finding jobs that workers can complete successfully or outsourcing services to reputable vendors.

4. Scheduling and Time Blocking: Women entrepreneurs who lack time can greatly benefit from using time blocking tactics and implementing a regular program. Set aside particular time slots for various jobs and activities to facilitate improved organization and higher output.

5. Technology and Automation Instruments: One can save a lot of time and streamline farm operations by utilizing technology and automation. Technology provides a number of ways to improve operations, including record-keeping systems, communication tools, and farm management software in agriculture sector.

6. Establishing Limits and Engaging in Self-Care: Setting limits and giving self-care first priority are essential to preserving a healthy work-life balance. To prevent burnout and overworking, it's critical to set up boundaries between work and personal time. Always remember to prioritize for the well-being, take breaks in activities that revitalizes. Improve work-life balance, gain productivity, and take back control of the time by putting these time management techniques into practice.

In the socioeconomic growth of the family and society, women are acknowledged as being essential to agriculture and related fields as well. As an entrepreneur, they play a significant part in their business's expansion. According to previously published research studies, women entrepreneurs have demonstrated their ability to manage their work and time well, even with the demands of raising a family and making decisions. Majority of women have actively participated in mushroom production (packing and spinning on themselves), according to this research, but they have limited access to marketing. This could be because of the disorganized nature of the market, the dominance of male rivals, and the presence of middlemen.

However, the data on the distribution of jobs shows that most women are employed as workers or caregivers. Additionally, women are making maximum efforts and giving equal time to both family chores and entrepreneurial endeavours. It is noteworthy, however, that majority of women are making financial decisions or plans about mushroom growing in conjunction with their spouses, families, or groups. As a result, even though they play a crucial role in the cultivation of mushrooms, their influence over the choice of raw material type, frequency, location, source, mode of payment, mode of transportation, designating a person for the purchase, and marketing is still minimal and highly debatable.

In orderto accomplish a long-term development goal in the agricultural sector, comprehensive formal education and training as well as financial help to women entrepreneurs are critically needed. Getting accurate information about their socioeconomic situation is necessary before enacting laws to support women's economic independence and appraisal.

According to the study conducted by (Hussain et,al, 2021) explained that women entrepreneurs who invest their excess capital for the long term tend to be cautious and seek advice from legal professionals to reduce risk. The investment mindset, as well as social and behavioural factors, influence choices for different investment assets. Despite the many obstacles they face, they always aim for financial independence so they can make their own decisions. They are prevented from taking advantage of risky investment opportunities by their lack of understanding of capital budgeting, erratic circumstances, and unstable governments. The current research shows that individuals will invest appropriately if they have the necessary knowledge about alternative investment products, and if the market is stable, this will foster a good attitude about their financial decisions.

Kappal and Rastogi (2020) talked about how the decision-making approach helps women entrepreneurs to actively contribute through a variety of perspectives and make preferences among different alternatives. When a woman decides, she wants to start her own business, she acts decisively and proactively using a number of fundamental strategies that evolve over time and are developed by women to become independent contractors and competent business leaders in their industry. According to Yuvaraj and Sujatha (2019), women in business are naturally gifted with well-educated talents that support their abilities to lead their organizations successfully and make wise decisions.

An investor bases their decision on their investor decisions are made based on their mindset and cognitive styles, which allow them to consider the data either creatively or rationally, depending on the state of the financial market at the time. Therefore, the attitude that female entrepreneurs take when choosing between different alternative assets or chances during uncertain times is the focus of behavioural aspects that influence decision making. However, their views toward any financial investment activity are a reflection of how they view the business information that is accessible to them, keeping in mind how their company is structured and how they can effectively manage its survival in uncertain times. Specifically, values-driven decisions that support enduring uncertain conditions in the business environment are what define business-oriented women's decision-making. Thus, this research thoroughly examines that uncertainty and financial crises can have a significant impact on women's investment decisions when running their businesses.

Conclusion

Rural women agricultural entrepreneurs, if they use these an array of tactics , they can efficiently allocate their time and will be able to take proper decisions for the work with well-informed judgments. Rural women entrepreneurs play a crucial role in agricultural development, and understanding the strategies for time management and decision-making for creating inclusive and empowering environments that enable the success of women.

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Current Developments in Organic Farming

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Definition of Organic Farming

There are many definitions of organic farming, which is also known as ecological agriculture or biodynamic agriculture. Some have considered organic farming and sustainable agriculture synonymous, because they are both based on sustainability of agro-ecological systems. Sustainability can be defined as meeting the need of the present without compromising the ability of future generations. The word "organic" is legally protected in some countries, avoiding their indiscriminate use in non-organic products. In the European Union (EU), for example, this word has been protected since the early 1990s in English speaking countries. The equivalent in French, Italian, Portuguese and Dutch speaking countries is "biological", and "ecological" in Danish, German and Spanish-speaking countries.

Organic farming according to Henning is both a philosophy and a system of farming, grounded in values that reflect an awareness of ecological and social realities and the ability of the individual to take effective actions. In practice, it is designed to work with natural processes to conserve resources, encourage self-regulation through diversity, to minimize waste and environmental impacts, while preserving farm profitability.

Current Developments in Organic Farming

Organic farming uses almost exclusively biological and natural materials and processes to produce food. The practice aims to protect human health and conserve, maintain or enhance natural resources, with the goal to preserve the quality of the environment for future generations while being economically sustainable. Organic farming has grown rapidly throughout the world in recent years. Currently, Australia (Oceania) has the largest land areas under organic farming, Liechtenstein (Europe) the highest percentage of organic area, and Mexico (Latin America) the greatest number of organic farms worldwide. One of the most valuable benefits of organic farming is the improvement in soil quality, which can be expressed in terms of chemical, physical and biological properties and their interactions. In this article, we will discuss the properties, regulations and impacts of organic farming on human livelihood and the environment.

Overview of Organic Farming

Organic farming has expanded rapidly in recent years and is seen as a sustainable alternative to chemical-based agricultural systems. Its annual growth rate has been about 20% for the last decade accounting for over 31 million hectares (ha) and generating over 26 billion US dollars in annual trade worldwide. Nutrient management in organic farming systems is often based on soil fertility building via nitrogen (N) fixation and nutrient recycling of organic materials, such as farmyard manure and crop residues, with limited inputs from permitted fertilizers. Although organic farming has been criticized for relying on the build-up of soil phosphorus (P) and potassium (K) by past fertilization before converting to organic, its acceptance and popularity are growing due mostly to environmental and health related concerns. A recent polling of residents of Ontario, Canada reveals that more than half think organic food is more nutritious; two-thirds believe organic food is safer than conventionally grown food; and 9 out of 10 believe organic fruits and vegetables are grown without pesticides of any kind.

The aims and principles of organic farming, as presented in the International Federation of Organic Agriculture Movements (IFOAM) Basic Standards for production and processing A shift to organic agriculture brings about significant changes: restricted use of synthetic fertilizers and pesticides, increases of other inputs such as organic materials, labor, perhaps machinery, cultural practices (e.g., crop rotation), and better knowledge of biological processes. These changes have serious implications. Thus, farmers should consider the following issues before practicing organics.

The principal aims of organic production and processing:
1. To produce food of high quality in sufficient quality.
2. To interact in a constructive and life enhancing way with natural systems and cycles.
3. To consider the wider social and ecological impact of the organic production and processing system.
4. To minimize all forms of pollution.
5. To process organic products using renewable resources.
6. To produce textiles which are long lasting and good quality.
7. To develop a valuable and sustainable aquatic ecosystems.
8. To produce fully biodegradable organic products.
9. To maintain and increase long-term fertility of soil.
10. To give all livestock conditions of life with due consideration of the basics aspects of their innate behaviour.

Labor Inputs

Labor is important to the production process, and can be an impediment to the adoption of organic agriculture. Compared to large-scale mechanized agricultural systems, organic farming appears more labor intensive. Many techniques used in organic farming require significant labor (e.g., strip farming, non-chemical weeding, composting). In the developed world, labor scarcity and costs may deter farmers from adopting organic systems. This may also be true for cash-poor farmers and those supplementing their incomes with off-farm work. However, where labor is not a constraint, organic agriculture can provide employment opportunities, especially in rural communities. Furthermore, the diversification of crops typically found on organic farms, with their various planting and harvesting schedules, may result in more work opportunities for women and a more evenly distributed labor demand which helps stabilize employment.

Crop Rotation

This operation is required under organic certification programs and is considered essential in organic management. Agricultural pests are often specific to the host (i.e., a particular crop), and will multiply as long as the crop is there. Alternating crops in time (rotations) or space (stripcropping and intercropping) is therefore an important tool for controlling pests, and also for maintaining soil fertility. As the use of synthetic fertilizers and pesticides allows the farmer to grow the crop that is financially most rewarding, not using those inputs may limit the choice of crops. The success of an organic farm depends on the identification of end-uses and/or markets for all the crops in the rotation, as few farmers can afford to leave fields fallow. This remains one of the most significant challenges in organic agriculture.

Yield

Yields on organic farms, although may not be as high as those produced by conventional practices, fall within an acceptable range. Encouragingly, organically produced yields currently are significantly higher than those produced before the 1950s. Part of this progress can be attributed to new varieties and better knowledge of biological processes used in farming. For example, if N mineralization is slow because of cool/wet growing-conditions, crops on organic farms may not have sufficient N early in the season. However, better knowledge on N synchronization between N release by manures and N demand by crops could minimize or even eliminate this N deficiency problem.

Conclusion

The organic food movement apparently had its roots in a philosophy of life, beginning perhaps with Rudolf Steiner, a notable German thinker, in the 1920s. One of its common believes is that natural products are good, whereas man-made chemicals are not, or at least not as good as natural ones. This partially explains why organic farming avoids the use of synthetic fertilizers and pesticides. Certainly, organic farming has many benefits ranging from reduced environmental pollution to increased soil quality. Let us hope that organic farming will lead all farmers, and their consumers, toward a more productive, prosperous, sustainable, and healthy future.

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SpatGRID: R Package for Spatial Grid Generation from Longitude and Latitude List

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SpatialGridR

Description: The developed function facilitates the creation of spatial grids based on user-defined latitude and longitude coordinates. It ensures the validity of input longitude and latitude values, verifying that they fall within appropriate geographic ranges. By utilizing the provided hemisphere and longitude values, the function identifies the corresponding Universal Transverse Mercator (UTM) zone. Subsequently, it constructs a polygon from the coordinates and transforms the input shapefile to the UTM projection if necessary. The function then generates a spatial grid with the specified interval and saves it as a shapefile (Brus, 2022; Hijmans, 2022; Kumar *et al.,* 2023). This efficient tool streamlines the process of generating empty spatial grids, offering utility in various applications such as geostatistical analysis and digital soil mapping product generation.

Usage: SpatialGridR(lon_list, lat_list, hemisphere, interval, outputShape)

Arguments:

> **lon_list:** A list or vector containing the longitude coordinates of the spatial grid. These coordinates define the vertical extent of the grid.
>
> **Lat_list:** A list or vector containing the latitude coordinates of the spatial grid. These coordinates define the horizontal extent of the grid.
>
> **hemisphere:** A character indicating the hemisphere in which the coordinates reside. It can take two values: “north” for the Northern Hemisphere and “south” for the Southern Hemisphere.
>
> **interval:** Define the desired interval for the grid in meters.
>
> **outputShape:** Provide the path to the output shapefile.

Values: Return a spatial grid as a shapefile.

Examples:

```
library(SpatGRID)
lon_list<-c(78,78,79,79,78)
lat_list<-c(20,21,21,20,20)
hemisphere <- 'north'
outputShape <- 'C:\\path\\to\\your\\data\\grid.shp'
interval <- 1000
Spatial_GRID <- SpatialGridR(lon_list, lat_list, hemisphere, interval, outputShape)
```

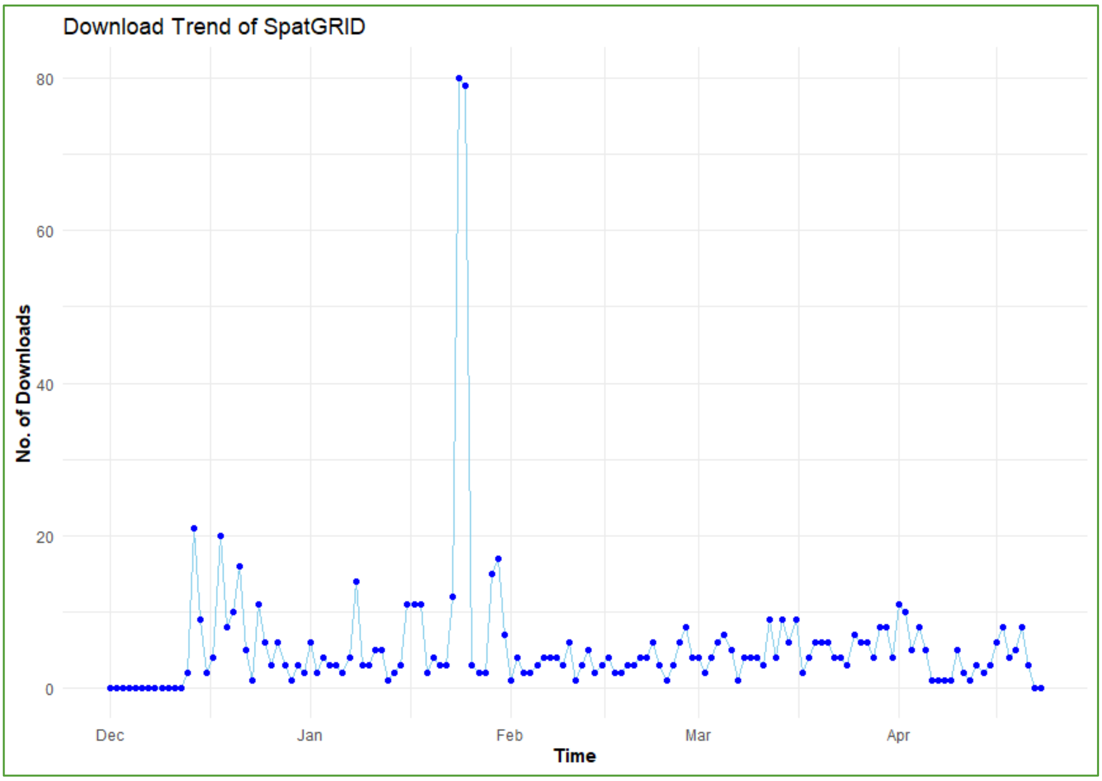
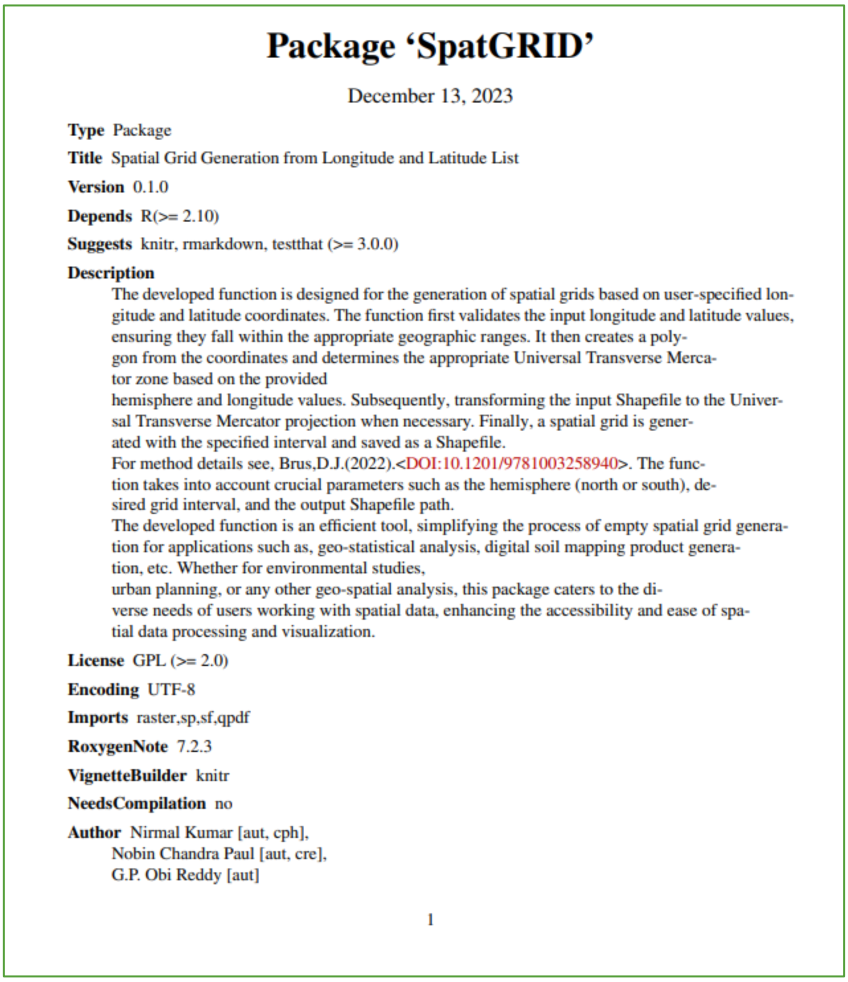


Figure 1. Schematic representation of the download trend of the R package "SpatGRID"



Package 'SpatGRID'

December 13, 2023

Type Package

Title Spatial Grid Generation from Longitude and Latitude List

Version 0.1.0

Depends R(>= 2.10)

Suggests knitr, rmarkdown, testthat (>= 3.0.0)

Description
The developed function is designed for the generation of spatial grids based on user-specified longitude and latitude coordinates. The function first validates the input longitude and latitude values, ensuring they fall within the appropriate geographic ranges. It then creates a polygon from the coordinates and determines the appropriate Universal Transverse Mercator zone based on the provided
hemisphere and longitude values. Subsequently, transforming the input Shapefile to the Universal Transverse Mercator projection when necessary. Finally, a spatial grid is generated with the specified interval and saved as a Shapefile.
For method details see, Brus,D.J.(2022).<DOI:10.1201/9781003258940>. The function takes into account crucial parameters such as the hemisphere (north or south), desired grid interval, and the output Shapefile path.
The developed function is an efficient tool, simplifying the process of empty spatial grid generation for applications such as, geo-statistical analysis, digital soil mapping product generation, etc. Whether for environmental studies,
urban planning, or any other geo-spatial analysis, this package caters to the diverse needs of users working with spatial data, enhancing the accessibility and ease of spatial data processing and visualization.

License GPL (>= 2.0)

Encoding UTF-8

Imports raster,sp,sf,qpdf

RoxygenNote 7.2.3

VignetteBuilder knitr

NeedsCompilation no

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Figure 2. Snapshot of the published 'SpatGRID' R package (Repository: CRAN)

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Measuring Learning Impact Through Pre-Post Training Assessments

Article ID: 48910

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Introduction

In recent years, the agricultural sector has faced numerous challenges due to the increasing impact of abiotic stresses such as drought, salinity, and extreme temperatures (Pathak *et al.,* 2022; Paul *et al.,* 2024). To address these challenges, a High-End Workshop (KARYASHALA) was conducted at ICAR-NIASM, Baramati, focusing on "Advanced Instrumentation in Abiotic Stress Assessment, Monitoring & Management for Sustainable Agriculture" sponsored by the Science and Engineering Research Board (SERB) under the Department of Science and Technology (DST), Government of India, this workshop aimed to enhance the research productivity of postgraduate (M.Sc.) and doctoral (Ph.D.) students by providing them with essential knowledge and practical skills in the field of abiotic stress management (https://niasm.icar.gov.in/node/1050). The workshop, which spanned over ten days, was meticulously designed to incorporate theoretical sessions, hands-on practical exercises, and exposure visits to deepen participants' understanding of the subject matter. One notable aspect of the workshop was the inclusion of an impact assessment mechanism, which aimed to evaluate the effectiveness of the training program in enhancing students' knowledge and skills.

Assessment Methodology

As part of the impact assessment, during one of our sessions on the topic "**Research and Publication Ethics**", participants were asked to complete a Google Form-based multiple-choice questionnaire (MCQ) before and after the lecture sessions. This pre-training and post-training test allowed the organizers to gauge the extent of knowledge acquisition and skill development among the students. By comparing the responses from both tests, the gain percentage was calculated, providing insights into the overall effectiveness of the particular workshop session. The use of pre-training and post-training assessments is an effective way to measure the impact and learning outcomes of such workshops. The gain percentage was calculated by comparing the scores of the pre-training and post-training tests. It represents the percentage increase in knowledge or understanding achieved by the participants as a result of the lecture session.

Results and Discussion

The results of the impact assessment revealed a significant improvement in participants' understanding of the subject matter following the workshop session. The pre-training test revealed the baseline knowledge level of participants, while the post-training test gauged the extent of knowledge enhancement (Figure 1). The histogram overlay of pre-training and post-training scores provided a visual representation of this improvement, illustrating a shift towards higher scores post-training (Figure 2). The gain percentage, obtained by comparing pre and post-test scores, showcased the tangible benefits accrued from the workshop (Figure 3). The substantial gain percentage observed underscores the efficacy of the workshop in augmenting participants' understanding of advanced instrumentation in abiotic stress management.

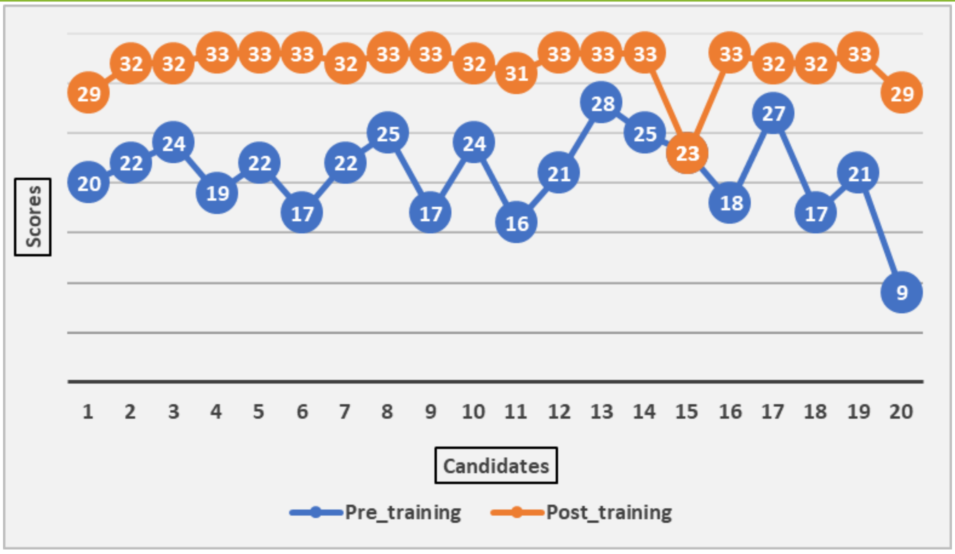

Figure 1. Pre and Post-training scores of the candidates

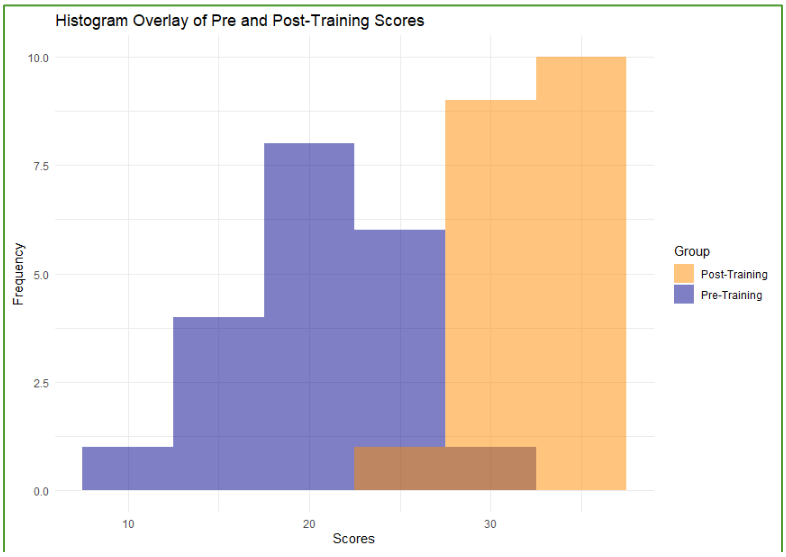

Figure 2. Histogram overlay plot of the Pre and Post-training scores of the candidates

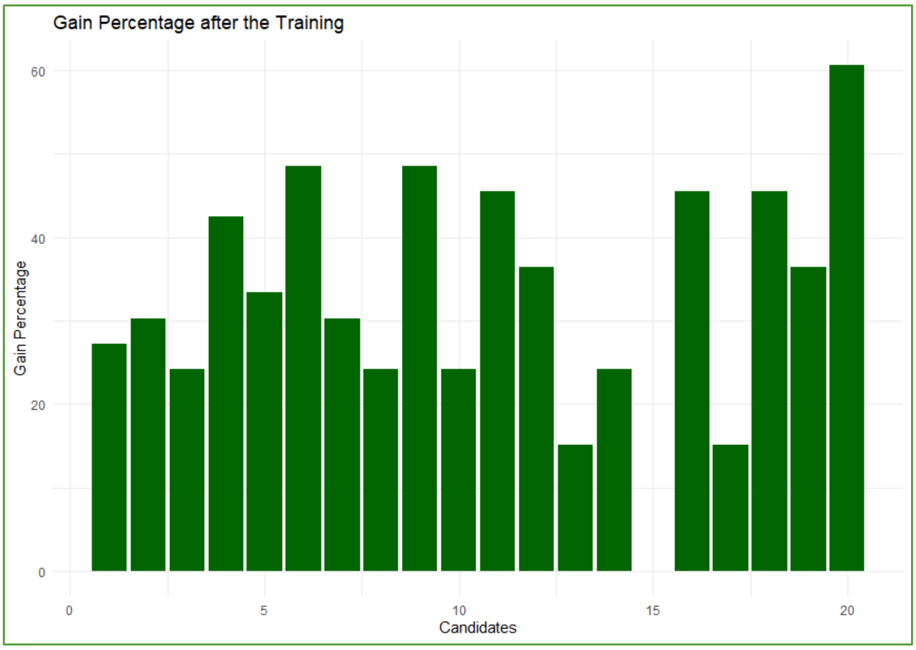

Figure 3. Gain percentage plot: comparison of Pre and Post-training scores

Conclusion

In conclusion, the success of this workshop exemplifies the potential of initiatives like KARYASHALA to bridge the gap between academic knowledge and practical application and also underscores the importance of continued investment in capacity-building initiatives aimed at addressing pressing challenges in agriculture. By empowering the next generation of researchers with the necessary knowledge and skills, such initiatives play a crucial role in driving sustainable agricultural development and ensuring food security in the years to come.

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Plant Growth Regulators and their Physiological Effect: A Review

Article ID: 48911

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Introduction

Plant growth regulator or phytohormones are organic compounds, other than nutrients that produced naturally in higher plants, controlling growth or physiological functions. Plants naturally produce hormone in response to their surroundings that regulate their growth, development. There are many types of hormone in which some are natural and some synthetic. Hormones control cell division, cell elongation, seed germination and dormancy; they obtain multiple responses even if it is at low concentration. Plant hormones are dividing into five classes: Auxins, Cytokinins, Gibberllins, Abscissic acid, Ethylene.

Auxins

The term auxin was introduced by Kogl and Haagen- smit in 1931. Auxins are widely distributed throughout the plant however abdundant in the growing tips such as tip, buds, roots, leaves. Auxins are produce naturally and synthetically. Natuiral auxins are IAA (Indole Acetic Acid), IBA (Indole Butyric Acid) and synthetic are 2, 4, D (2, 4 Dichlorophenoxyacetic acid).

Physiological effect of Auxins:

a. Root initiation: The higher concentration of auxin inhibits the elongation of roots but the number of lateral roots is considerably increased i.e., higher concentration of auxin induces more lateral branch roots. Application of IAA in lanolin paste (lanolin is a soft fat prepared from wool and is good solvent for auxin) to the cut end of a young stem results in an early and extensive rooting. This fact is of great practical importance and has been widely utilized to promote root formation in economically useful plants which are propagated by cuttings.

b. Cell division and elongation: The primary physiological effects of auxin are cell division and cell elongation in the shoots. It is important in the secondary growth of stem and differentiation of xylem and phloem tissues.

c. Prevention of lodging: The primary physiological effect of auxin is to promote the elongation of cells. Auxin stimulates cell enlagement, cell elongation in the apical region there is lodging. Lodging effect quality and quantity of crop.

d. Weed control: Synthetic auxins especially 2, 4- D and 2, 4, 5-T are useful in eradication of weeds at higher concentrations.

e. Callus Formation: Auxin may also be active in cell division. In tissue cultures, where the callus growth is quite normal, the continued growth of such callus takes place only after the addition of auxin.

Cytokinines

The discovery of cytokinins can be traced back to activities in the lab of Folke Skoog at the University of Wisconsin in the late 1940. Skoog and Miller were studying cell division factors using a tobacco pith callus culture system. Cell division factors were found in coconut milk and yeast extracts and analysis of the active region on chromatograms suggested that the active factor was a purine (Jablonski and Skoog, 1954). Some cytokinines are Kinetin, Zeatin, benzyladenine.

Physiological effect of Cytokinines:

a. Cell Division: The most important biological effect of kinetin on plants is to induce cell division especially in tobacco pith callus, carrot root tissue, soybean cotyledon, pea callus etc.

b. Morphogenesis: Skoog and Miller observed response of cytokinins in the formation of organ. It has been shown that high auxin and low kinetin produced only roots whereas high kinetin and low auxin could promote formation of shoot buds.

c. Cell enlargement: Like auxins and gibberellins, the kinetin may also induce cell enlargement. Significant cell enlargement has been observed in the leaves of Phaseolus vulgaris, pumpkin cotyledons, tobacco pith culture, cortical cells of tobacco roots etc.

d. Breaking seed dormancy: Cytokinins are quite effective in breaking the dormancy of seeds ans some other plant organs. Cytokinins are not only effective on breaking of seed dormancy but also neutralize the inhibitory effect of Caumarin and Xanthain (Khan *et al.* 1965).

Gibberellins

The discovery of gibberellins can be traced back to Japanese pathologist in the 1920s who studied the foolish rice disease, a disease that caused rice plants to grow so rapidly that stems were too weak resulting in lodging. The production of a growth stimulating substance produced by the fungus *Gibberellia fujikuroi*. Yabuta, Hayashi and Kahnbe first isolated the active principle toxin from the fungus which was called Gibberelin by them. In 1938 Yabuta and Sumuki isolated Gibberelins A and B in the form of Crystals from the higher plants.

Physiological effect of Gibberelins:

a. Fruit setting: Gibberellic acid affects positively on fruit setting. It is widely used to increase in fruit setting and size of grapes, citrus, pear, and apple.

b. Dormancy of buds: In temperate regions the buds formed in autumn remain dormant until next spring due to severe cold. This dormancy of buds can be broken by gibberellin treatments. In potato also, there is a dormant period after harvest, but the application of gibberellin sprouts vigorously.

c. Stem elongation: The most important effect of GA is the stem elongation. It includes intermodal and apical elongation. Significant elongation of internodes is observed in plant like pea, bean, sweet corn, cucumber etc.

d. Seed germination: Gibberellins play essential role in seed germination of cereals. During seed germination it induces synthesis of alpha amylase, sugar and other hydrolytic enzymes. It is also useful for enhancing germination in case of seed require cold and light treatment.

e. Parthenocarpy: Germination of the pollen grains is stimulated by gibberellins; likewise, the growth of the fruit and the formation of parthenocarpic fruits can be induced by gibberellin treatment. In many cases, e.g. pome and stone fruits where auxins have failed to induce parthenocarpy, the gibberellins have proven to be successful. Seedless and fleshly tomatoes and large sized seedless grapes are produced by gibberellin treatments on commercial scale.

Abscissic Acid

Abscissic acid is a compound associsted with a specific process the shading of plant ograns such as leaf, flower and fruit. In 1955 Osborne found a diffusible substance from senescent leaves. This compound was quite different than the known growth substances. In 1961 Liu and Cars isolated stimulating substances from mature fruit of cotton, showed effect on abscission of cotton leaf. In 1963 Eagles Wareing extracted such substance and applied to birch seedlings and observed that apical growth is completely stopped. They term \ed it as dormancy inducer or dormin.

Physiological effect of Abscissic acid:

a. Bud dormancy: The bud dormancy is controlled through changes in the levels of endogenous growth inhibitors which are influenced by day length and chilling effects. ABA also influenced by effect of short days.

b. Growth Inhibiters: ABA inhibits shoot growth but has less effect on root growth.

c. Stress reisitance: A very different of ABA has been recorded in plants growing under stress environment, such as drought, flooding, injury mineral deficiency etc. A fairly high concentration of ABA is found in leaves growing under moisture stress condition.

d. Stomata Closure: Water shortage brings about increase in ABA level, leading to stomata closure as a response to water stress.

Ethylene

Neljubow (1901) observed that ethylene gas alter the tropistic responces of roots. Denny (1924) observed that ethylene is highly effective in inducing fruit ripening. Ultimately Gane(1934) established that ethylene is natural product of ripening fruit.

Physiological effects of ethylene:

a. Ripening of fruit: Ethylene in the form of gas helps ripens fruits under natural conditions.

b. Shelf life of fruits: Green citrus and banana fruits are not acceptable to market if artificial degreening is observed. During degreening fruits are exposed to 5- 10ppm ethylene in an air conditioned room.

c. Inhibit Vegetative Growth: Ethephon may be used for inhibiting vegetative growth of grape vines resulting in higher yield and better quality.

d. Leaf and Fruit Abscission: Accelerates fruit abscission for mechanical harvesting in fruit crops such as grapes, cherries and citrus.

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The Success Story: "Enhancing Value through Organic Cultivation of Exotic Fruits and Vegetables"

Article ID: 48912

J. V. Chovatia[1], B. V. Patoliya[1], N. M. Kachhadiya[1]
[1]Junagadh Agricultural University, Junagadh-362001, (Gujarat) India.

Name of farmer: Jesadiya Vishal Lavjibhai
Address: Village- At.- Anandpur, Ta. Kalavad Dist.- Jamnagar
Mobile Number: 9558379098
Age: 29
Education: Graduate
Size of land holding : 2.09 ha

Description of Innovation

Jesadiya Vishal Lavjibhai is a youthful and passionate agriculturist hailing from Anandpar village in the Kalavad Taluka of Jamnagar district. Anandpar is conveniently situated on the Kalavad-Rajkot highway, in close proximity to Rajkot, the capital city of the Saurashtra region. This village lies 22 km from Kalavad and 27 km from Rajkot. It falls under the North Saurashtra Agro-Climatic Zone, characterized by erratic rainfall ranging from 350 to 400 mm annually. Anandpar lacks irrigation facilities and reservoirs, relying solely on rainfall for agriculture.

After completing his graduation, Vishal embarked on a career in marketing with a corporate company specializing in pesticides and seeds. During this tenure, he interacted with various progressive farmers and observed diverse cropping patterns, fostering a keen interest in organic farming and horticultural crops. Concurrently, he began experimenting with new fruit and vegetable crops on his family farm, initially encountering resistance from his father. However, his persistence led him to collaborate with scientists from Junagadh Agricultural University, Junagadh during fieldwork in the district. He also participated in the ATMA project, visiting different states for further study. Additionally, he engaged with the Department of Horticulture at JAU, Junagadh, and sought guidance from the Deputy Director of Horticulture, Jamnagar, to promote organic farming and cultivate exotic vegetables and fruits.

Utility of Innovation

Jesadiya Vishal Lavjibhai is a young, dynamic, and inventive farmer. In the present era, there is a resurgence of interest in organic farming across the country, driven by a growing demand for chemical-free and high-quality food products. Over the past three decades, there has been a significant increase in the economic status of Indian citizens.

During his academic years, Vishal engaged in traditional farming practices such as cultivating groundnut, cotton, onion, wheat, etc., alongside his father. After completing his studies, he ventured into the corporate sector, but continued experimenting on his farm with his father. Despite facing initial resistance from his father regarding new fruit and vegetable experiments, Vishal decided to think outside the box and initiated a separate farming venture.

His dedication and quest for knowledge led him to explore the cultivation of exotic vegetables and fruits. He embarked on cultivating crops like dragon fruit and strawberries, even establishing a dragon fruit nursery to supply high-quality saplings to fellow farmers. His efforts were recognized when his nursery received approval from the Central Horticultural Board, Government of India.

Furthering his knowledge, Vishal participated in interstate tours as part of the ATMA project, attending seminars on strawberry cultivation and exploring diverse agricultural practices. He successfully introduced strawberry cultivation on his own farm in Anandpar, demonstrating the adaptability of tropical crops to subtropical regions. Utilizing attractive packaging, he effectively marketed his produce.

Not content with his achievements, Vishal expanded his endeavors by establishing "Gujarat Green Organic Farm." Here, he cultivates a wide array of exotic fruits such as avocado, persimmon, and apple, alongside various local and exotic vegetables including purple flower, Thai basil, broccoli, green kale, lettuce, American red kale, zucchini, knolkhol, and celery on his fields in Anandpar. His innovative approach and dedication to organic farming have made him a trailblazer in the agricultural sector.

Output

Vishalbhai sales all these produce to the hotels, direct consumers and earn.

Economics of cow unit:

Year	Crop	Area ha.	Production kg/ha	Total Income Rs.	Total Cost Rs.	Net Income Rs.
2018-19	Dragon Fruit	0.3	500	180000	20000	160000
2019-20	Dragon Fruit	0.3	1200	240000	20000	220000
	Strawberry	0.16	3000	300000	60000	240000
2020-21	Dragon Fruit	0.3	1500	300000	20000	280000
	Strawberry	0.16	3500	350000	60000	290000

Spread of Innovation

Vishalbhai sells all exotic fruits and vegetables to hotels and directly to consumers, generating substantial earnings. In addition to fruit and vegetable production, he also sells saplings from his certified nursery, yielding significant profits. Approximately 15 farmers have visited his nursery and initiated their own fruit and vegetable cultivation, indicating a high level of horizontal spread of technology. Through his relentless efforts, Vishalbhai has achieved remarkable success and attained significant heights in his endeavours.

The Success Story: "Diversified Farming Emphasizing on Lucrative Crop – Papaya"

Article ID: 48913

J. V. Chovatia[1], B. V. Patoliya[1], N. M. Kachhadiya[1]
[1]Junagadh Agricultural University, Junagadh-362001, (Gujarat) India.

Name of farmer: Narayanbhai Gangaramabhai Lakum
Address: Village: Chuda, Surendranagar, 363410
Mobile Number: 8530959951
Age/ D.O.B.: 43
Education: 09 Standard
Size of land holding: 4 ha
Crops grown:

Kharif	Cotton
Rabi	Chick-Pea, Wheat
Summer	Groundnut and Seasame
Papaya	

Livestock: Cow-1, Buffalo -3

Situation Analysis and Problem Statement

In Chuda village, farmers are mostly growing cereals, pulses, oilseeds, vegetables and plantation crops. Narayanbhai is a small land holder of Chuda village of Surendranagar. Earlier, he was growing cotton, groundnut, cumin, wheat and vegetable crops in traditional way of farming. He was getting very low crop yield, hence earned less income. Due to such reasons, he would like to grow other economic crops for getting higher income. He heard about papaya crop which was earlier grown at nearby village of Chuda. To know the detail information regarding papaya cultivation, he comes in contact with KVK, Surendranagar and JAU Junagadh.

Support by JAU

KVK, Surendranagar conducts various extension activities and training programmes for the farmers to improve their economic condition through farming. To know the details information about scientific cultivation of papaya, he visited KVK, Surendranagar and discuss with the KVK scientists about various queries related to farming. He regularly visited KVK through various programmes like trainings, meetings and other extension activities to satisfy the hunger of his knowledge about latest agricultural technology. He adopted the recommendations of agricultural university like selection of quality planting material, time of sowing, Integrated nutrient management, Integrated pest and disease management, right application of recommended fertilizers and irrigation in his farm.

Output

Vishalbhai sales all these produce to the hotels, direct consumers and earn.
Economics of cow unit:

Diversification through Papaya Cultivation

KVK, Surendranagar more emphasize on modern optional of agriculture to enhance the farmer's income. Assured irrigation after availability of Narmada canal water, Surendranagar District has vast scope of crop diversification. Papaya is one of the economically and commercially most important fruit crop of India. It is gaining popularity due to high yielding potential as well as year-round fruiting. Narayanbhai started to growing papaya in an area of 0.4 ha in the year, 2016. He has grown 1000 plants of papaya var. Red Lady Taiwan – 786 and Madhu Bindu at a distance of 2 m x 2 m. He has adopted integrated approach for papaya cultivation to increase the production as well as getting higher net profit. Harvesting was done manually. After harvesting, papaya fruits were wrapped in newspaper to avoid bruising injuries during transport. Then, it was transported to local market. The details regarding interventions adopted by Narayanbhai is given below in Table 1.

Table 1. Interventions Adopted Through Technical Farming of Papaya:

Practices	Traditional farming	Technical farming
Soil Testing	-	Done
Seed Selection	Use of commercial variety Red Lady Taiwan - 786	Use of High yielding varieties Red Lady Taiwan - 786 and Madhu Bindu
Seed Treatment	-	Seed treatment with Thiram
Nutrient Management	Use of chemical fertilizers	Integrated nutrient management
Weed Management	Manually	Mechanized and manually
Pest & Disease Management	Use of chemical pesticides	Use of Integrated approach of pest and disease management i.e. physical, chemical and bio control methods

Outcome

Narayanbhai has invested Rs. 72,850/- in the year, 2016 for papaya cultivation. From the year 2016 to 2020, the detail information regarding cost of cultivation, production and income are given below in the Table 2.

Table 2. Cost of cultivation, Production and Income of Papaya:

Particulars	Year				
	2016	2017	2018	2019	2020
Area (Ha)	0.4	0.5	0.4	0.8	0.4
Production (Kg)	30,600	40,360	46,540	67,320	21,560
Avg. Market Rate (Rs. /Kg)	11	8.5	8	12	19
Cost of Cultivation (Rs.)	72850	85300	88260	256750	63940
Gross Income (Rs.)	336600	343060	372320	807840	409640
Net Income (Rs.)	263750	257760	284060	551090	345500
B:C Ratio	3.62	3.02	3.22	2.15	5.41

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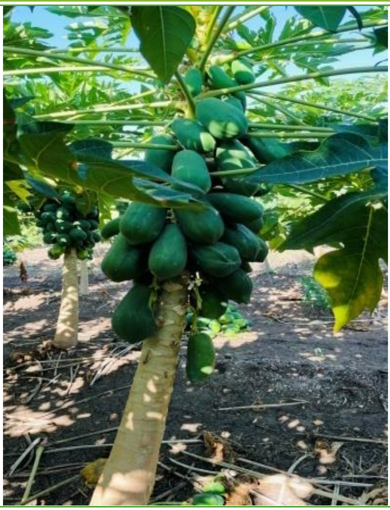	
Papaya Plant	**Packaging through Wrapping of Newspaper**

Field of Papaya (Red Lady Taiwan – 786)

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The success story: "Agripreneurship Enhancement through Sustainable Farming & Product Diversification"

Article ID: 48914

J. V. Chovatia[1], B. V. Patoliya[1], N. M. Kachhadiya[1]
[1]Junagadh Agricultural University, Junagadh-362001, (Gujarat) India.

Name of farmer: Khatrani Baldevbhai Bhanjibhai
Address: Village: At. Kanpur (Latipur), Ta. Dhrol, Dist. Jamnagar
Mobile Number: 98982554396; 9825992543
Age/ D.O.B.: 11.11.1981
Education: 09 Standard
Size of land holding: 2.4 ha
Crops grown: Groundnut, rose, wheat, cotton, palak, turmeric, Brahmi, *Javera* (Green Tender Wheat), Carrot, Tomato, beet, etc.
Livestock: Cow-3 Gir breed
Business: Organic Farming, Animal keeping & marketing with Value addition
Special recognition: Innovative and Progressive farmer.

Problem/ Challenge Faced

Khatrani Baldevbhai Bhanjibhai is only 9 class educated, having 3 Gir cow, having 2.4 ha land with different ordinary cropping pattern. He lived in very interior village Kanpur, part of Latipur Village Ta. Dhrol of District Jamnagar. He faces many challenges in his life like low education (9 Std.), labour chrysies & high cost, poor understanding, lack of marketing, high production cost, high chemical fertilizer and pesticides etc. usages, resurgence of pest & disease, poor soil fertility and lack of scientific technology know how from starting, grow traditional cropping pattern *viz.,* groundnut, cotton, wheat, he used more pesticide and chemical fertilizer due to that increase cost of cultivation and reduce net profit.

Description of Innovative Practice/Technology

Following the completion of his high school education in the village, Baldevbhai embarked on a journey into agriculture alongside his father. However, he soon realized the limitations of traditional farming methods, which yielded minimal income while incurring substantial labor expenses. Possessing a keen intellect and a passion for photography, he ventured into professional photography. Over time, he connected with various stakeholders including fellow farmers, KVK scientists, and the ATMA project. These interactions ignited his interest in rose cultivation, value addition, and cow-based organic farming. Supported by his wife, he embraced a multifaceted approach to farming, incorporating practices such as multi-cropping, diversified farming, mixed cropping, and organic methodologies.

The hallmark of his innovation lies in his pioneering efforts in rose cultivation and strategic marketing endeavors. He capitalized on the market demand for direct dehydrated rose petals, fetching a premium price of 600 per kilogram. Additionally, he ventured into producing gulkand, a rose petal preserve, which he successfully exported to various countries despite his limited formal education. Rather than selling groundnut directly to the market, he opted to produce and sell cold-pressed oils, sourced from kachchi Ghani, directly to consumers at a competitive price of 3700 per 15-liter tin. Furthermore, he adopted a similar approach with wheat, where he graded and packed the produce into 20-kilogram bags for direct sale in different cities. Expanding his product range, he processed turmeric into powder, packaged it, and marketed it directly to consumers as an organic product. Additionally, he diversified into cultivating various vegetables including carrot, tomato, and beet, along with promoting the medicinal usage of Javera (Green Tender Wheat) and Brahmi among discerning consumers. Through his innovative farming practices and astute market strategies, Baldevbhai has transformed his agricultural pursuits into a thriving enterprise, showcasing the power of vision, determination, and ingenuity in rural entrepreneurship.

Silent Features

1. One step chemical less produce
2. Export of the product
3. Health and hygienic produce
4. Best farmers award (Sardar Puraskar Award)
5. Acting as ambassador for value addition
6. Support to other farmers for marketing
7. Farmers to farmers' dissemination of technology

Practical Utility

1. Labour saving,
2. High marketing price
3. Consult him for value addition
4. Sales petals of rose directly in market
5. Rose "gulkand" prepare and directly sales in market as well as export in different countries

Source of Information

Continuous contact with KVK and ATMA also visit exposure training at JAU, Junagadh he motivates for vegetable cultivation. Then, she started horticultural crop cultivation viz., rose, turmeric, beet, tomato, etc. He has continuous active with social media and watch different video information from different channels and you-tube.

Economics/Profitability of innovative practice/ technology (costs and return) (per intervention or area or household).

The comparison of innovative practice and non-innovative practice is 40% more profit given below along with profitability.

Year	Crop	Area ha.	Production kg	Total Income Rs.	Total Cost Rs.	Net Income Rs.
2018-19	Groundnut	1.4	2625	118125	76781	41344
	Cotton	2	4250	212500	138125	74375
	Wheat	1	5000	75000	48750	26250
					Total	141969
2019-20	Rose	0.32	280	112000	16800	95200
	Groundnut	1.6	2800	151200	98280	52920
	Cotton	0.8	1500	67500	43875	23625
	Wheat	1.6	7000	119000	77350	41650
					Total	213395
2020-21	Rose	0.32	220	88000	57200	30800
	Beet	0.32	6800	136000	88400	47600
	Groundnut	1.4	2975	148750	96688	52062
	Cotton	1	2125	110500	71825	38675
	Wheat	1	4375	218750	142188	76562
					Total	245699

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2021-22	Rose	0.32	240	96000	62400	33600
	Beet	0.32	7200	144000	93600	50400
	Groundnut	1.08	2430	121500	78975	42525
	Cotton	1	2125	116875	75969	40906
	Wheat	1	5625	112500	73125	39375
					Total	206806
2022-23	Rose	0.32	280	112000	72800	39200
	Beet	0.32	8000	160000	104000	56000
	Turmeric	0.32	1000	200000	130000	70000
	Groundnut	1.92	4320	216000	140400	75600
	Palak	0.08	800	16000	7200	8800
	Carrot	0.08	2500	12500	8125	4375
	Wheat	1.92	10800	216000	140400	75600
					Total	**329575**

Potential: Acceptance Level, Horizontal Spread of Innovation and Number of Farmer Adopting

During the era of organic farming, she has appreciated for the cultivation of organic vegetable cultivation and started one steps in an innovative work. Many farmers of the district were visited her farm. She got many awards for the animal keeping and vegetable cultivation. TV channels has special recorded his success story and broadcast. Thus, horizontal of the technology in district as well as whole state through telecasting.

Turmeric cultivation

Chips preparation of turmeric

Dehydration and directly selling of rese petals

Value addition and marketing of rose gulkand

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Speed Genomic Selection: A Turbocharged Breeding Approach

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Introduction

Genomic selection (GS) is a keystone of modern breeding, utilizing genomic data to assess the genetic potential of individuals within breeding populations. Unlike traditional methods relying on phenotypic and pedigree data, GS integrates genome-wide molecular markers to estimate breeding values based on genotypic profiles. It aims to capture additive genetic variance by analysing numerous genetic markers across the genome, constructing predictive models to evaluate individuals' genetic tendencies for specific traits. Speed genomic selection (SGS) combines traditional GS with complementary techniques, accelerating genetic progress within breeding programs. This integrated approach combines marker-assisted selection (MAS) and GS to forecast genetic values using comprehensive genome-wide marker data, moving beyond reliance on specific markers or Quantitative Trait Loci (QTLs). By developing prediction models using a training population with both genotypic and phenotypic data, breeders can extrapolate genomic estimated breeding values (GEBVs) for targeted traits. High-throughput phenotyping and genotyping expedite data collection and analysis, while machine learning algorithms enhance prediction accuracy. Speed breeding strategies shorten breeding cycles and hasten generation progression. Through meticulous optimization of selection intensity and genotype-environment interactions, this integrated approach aims to expedite breeding and amplify genetic gains across diverse crop varieties.

The Breeder's Equation and Genetic Gain

The Breeder's Equation, a fundamental concept in crop breeding, delineates genetic gain (ΔG) as a function of selection intensity (i), narrow-sense heritability (h), additive genetic variance (σ^2_a), and the length of the breeding cycle interval (L). Accelerating genetic gain necessitates condensing breeding cycle intervals, allowing for more breeding cycles within a designated timeframe. This acceleration, particularly crucial for crops with prolonged breeding cycles like oil palm, has the potential to significantly enhance annual genetic gains. By expediting breeding cycles, recurrent selection can be intensified, leading to greater genetic progress. GS further enhances this process by swiftly identifying superior genotypes, thus expediting the overall breeding cycle.

Genomic Selection

The introduction of GS by Meuwissen and colleagues in 2001 marked a pivotal moment in capturing total additive genetic variance through genome-wide molecular markers. While GS has gained prominence in animal breeding, its integration into plant and tree breeding remains relatively new. Unlike conventional marker-based approaches, GS predicts individual phenotypic expression such as breeding value by utilizing genome-wide marker data to estimate GEBVs. This is achieved by training prediction models on a representative cohort of individuals, known as the training population (TP), which possesses both genotypic and phenotypic traits. Unlike traditional methods, GS does not focus on specific markers but relies on calibrated models to encompass a broader range of genotypic variation, including minor QTL effects. A key advantage of GS is its ability to predict individuals' GEBVs before phenotyping, thus accelerating genetic progress compared to phenotypic selection. The breeding population (BP), although genotyped but not phenotyped, relies on the TP for breeding value predictions. Ideally, the BP consists of progeny or closely related elite lines of the TP. The effectiveness of GS depends on the genetic relatedness between TP and BP, particularly in the linkage disequilibrium between markers and trait loci. A diverse, extensively phenotyped, and genotyped TP is essential for robust calibration of prediction models.

GEBVs, derived from desirable loci dispersed across the BP's genome, serve as guides for selecting superior lines, which may become parents in breeding programs without requiring field trials.

Integrated GS: New Tools Enhancing Genomic Selection

The comprehensive implementation of GS requires its integration with high-throughput technologies, supported by statistical robustness. This integration entails a comprehensive understanding of phenotypes across various growth stages, encompassing complex pathways alongside physiological and biochemical traits. Recent advancements include the deployment of hyperspectral cameras and mechanical devices to expedite and refine the study of complex traits. Long-read sequencing platforms such as PacBio SMRT, Illumina TruSeq, and Oxford Nanopore sequencing overcome genome assembly challenges. Additionally, the synergy of next-generation sequencing (NGS) techniques with machine learning (ML) and deep learning (DL) tools enhances SNP mining, GS model refinement, and validation, thereby improving prediction accuracy in a high-throughput environment. Once standardized for crop, speed breeding holds promise in accelerating genetic gains by shortening the selection cycle. An integrated approach combining high-throughput phenotyping, genotyping, machine learning, and speed breeding bodes well for maximizing the potential of GS (Fig. 1).

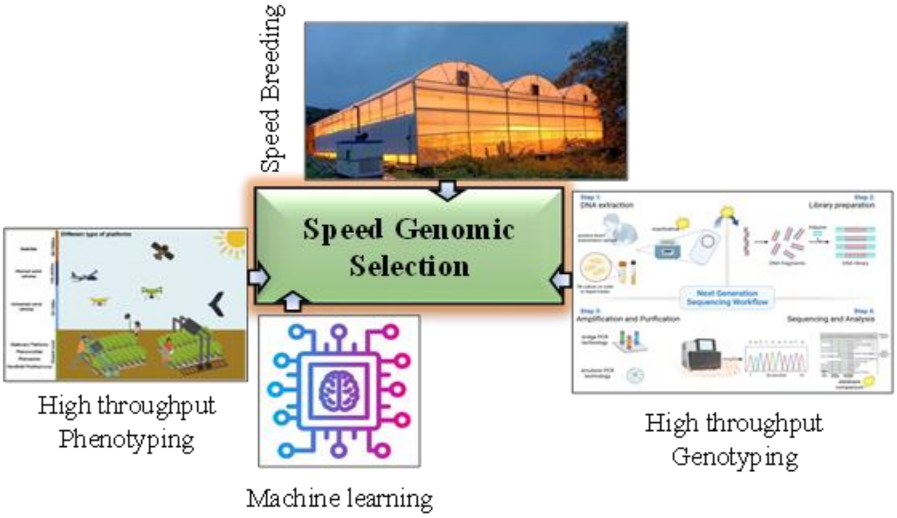

Fig. 1: Various approaches which could be integrated in genomic selection for accelerated genetic gain

Speed Breeding

Speed breeding aim to expedite the growth, flowering, seed set, and maturation of crop plants under controlled conditions with supplemental lighting. This leads to a reduction in generation time compared to field or glasshouse conditions. Watson *et al*., (2018) demonstrated the effectiveness of SB by achieving up to six generations of diverse crops annually, surpassing the two to three generations feasible under glasshouse conditions and the single generation viable under field conditions. These protocols offer the prospect of standardization across crops with varying growth requirements. Integrating GS with SB in breeding programs promises increased genetic gains by facilitating efficient selection of breeding lines within shorter timeframes. This synergistic integration enhances genetic gains per generation, with GS expediting breeding cycles while SB shortens generation periods. However, combining GS and SB may lead to higher inbreeding rates, particularly in allogamous species, necessitating mitigation measures. Recent studies have explored Speed GS in crops like tall fescue, resulting in significant reductions in breeding cycles and increased genetic gains annually, particularly for traits with low heritability (Jighly *et al*., 2019). In wheat, SB traits have shown correlations with field-based yield under water stress conditions, indicating their potential utility in GS analysis. Multivariate GS models, incorporating both field-based traits and SB traits, have demonstrated improved yield prediction compared to univariate models. Validation of combined GS and SB strategies in spring wheat has resulted in substantial increases in yield prediction accuracy (Watson *et al*., 2019). Efforts are underway to standardize SB methods across various food crops, highlighting the potential of SpeedGS in enhancing crop production to meet growing population demands.

High Throughput Genotyping (HTG) and High Throughput Phenotyping (HTP)

The integration of GS into breeding programs presents economic challenges due to the high genotyping costs incurred for both the TP and BP, surpassing traditional pedigree selection costs. Single nucleotide polymorphisms (SNPs) are the predominant genomic markers, suitable for various genomic analyses. However, high throughput genotyping (HTG) for numerous SNPs can be prohibitively expensive and time-consuming. To address this challenge, high-throughput NGS technologies, particularly Genotyping-by-sequencing (GBS), have emerged as cost-effective alternatives. GBS enables rapid and cost-effective genotyping of large populations, even in crops without sequenced genomes. Despite its advantages, NGS-derived markers may have higher missing rates compared to alternative platforms. Genotype imputation with GBS has been proposed to further reduce genotyping costs, showing promising results in maize populations (Technow and Gerke, 2017). The efforts of SNP chips are underway to address ascertainment bias issues by utilizing wild relatives and developing second-generation chips. Genotyping by target sequencing (GBTS) is another promising approach alongside SNP chips. Overall, advancements in genotyping technologies like GBS and SNP chips offer cost-effective avenues for integrating GS into crop breeding programs, increasing genetic gains per unit time compared to conventional methods.

Reliable phenotyping is equally crucial for improving prediction accuracy in GS modelling. While initial accuracy with HTP data may lag behind manual measurements, refinements in experimental methodologies and HTP technologies can reduce errors and enhance prediction accuracy. Combining HTP data with genotyping further increases prediction accuracy, especially in scenarios with adverse weather conditions hampering field phenotyping. Integrating HTP into GS investigations faces challenges such as data handling and processing issues, but the concept of "envirotyping" offers a promising avenue to enhance phenotypic prediction by incorporating the effects of environmental variables on agronomic traits.

Machine Learning

The GS offers a time-efficient alternative to traditional breeding cycles in crops with long breeding periods, predicting GEBVs using marker-based statistical methods. However, the accuracy of these predictions is influenced by various factors, including genome size, ploidy level, and genetic complexity. The ML and DL techniques show promise in improving prediction accuracy by navigating complex data relationships. Parametric and non-parametric methods have been developed to enhance predictability across large datasets, with non-parametric methods performing well in scenarios involving dominance and epistasis. In breeding applications, GS is implemented through two strategies. The first strategy involves early generation selection, where the additive genetic variance component predicts breeding values, allowing early identification of genotypes without waiting for complete breeding cycles. The second strategy considers all variance components, including additive, dominance, and epistasis effects, to predict the comprehensive genetic value of a genotype. This methodological approach accommodates genetic, environmental, genotype-environment interaction, and meteorological components within predictive models. ML and DL models have demonstrated superior performance in predicting comprehensive genetic gain across various crop species, particularly cereals.

Conclusion

Accelerating genetic gain is crucial to meet rising demands for food, textiles, and biofuels. GS stands out as a key approach to accelerate these gains and improve traits like yield. Despite challenges, a decade of research highlights GS's potential to boost genetic gains while reducing time and costs, especially for complex and less heritable traits. Efforts are focused on shortening breeding cycles and enhancing selection accuracy to expedite genetic progress. GS also aids in uncovering hidden genetic diversity in gene bank accessions, facilitating the transfer of valuable genes to elite breeding lines. Simulation studies suggest GS can introduce exotic alleles into elite germplasm, aiding crop improvement. Advances in cost-effective genotyping platforms and empirical GS studies are poised to integrate GS into large-scale breeding initiatives. Challenges include genotype-environment interaction, requiring multi-trait and multi-environment modeling to enhance prediction accuracy. Integrating pedigree and genomic data in early-generation testing can intensify selection and genetic gains. Combining SB with GS could further expedite selections and improve genetic gains. High throughput genotyping and phenotyping costs hinder GS application in large breeding programs, emphasizing the need for innovative high-throughput technologies and cost-effective field-based phenotyping strategies.

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Avenue Plantation

Article ID: 48916

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An avenue tree is a type of tree that is planted in a line along a road, street, or path. The term "avenue" describes the grouping of trees that form a visual axis, leading the eye from one end of the road to the other. Avenue trees serve multiple purposes, including creating a sense of grandeur, providing shade, adding greenery, and connecting urban and suburban areas to nature.

Ancient Roots

The concept of avenue trees dates back to ancient times. In historical India, avenue trees were often planted in front of palaces and temples, symbolizing the ruler's generosity and concern for the welfare of the people. These trees also lined roads, offering shade and beauty in bustling cities. Similarly, ancient Persia, Greece, and Rome used avenue trees to create impressive approaches to important cities, sacred places, and public buildings.

Emperor Ashoka's Legacy

Emperor Ashoka, who ruled the Mauryan Empire in India during the 3rd century BCE, played a significant role in the history of avenue planting. Known for his philanthropy and concern for his subjects, Ashoka recognized the aesthetic, environmental, and social benefits of trees. He ordered the planting of trees along roads and in cities throughout his empire. These trees—such as the banyan, peepal, and mango—provided shade, beauty, and improved the environment. Ashoka's legacy lives on in the many trees that still stand along Indian roads and in cities today.

Modern Efforts

Avenue planting continues to thrive in India. Here are some noteworthy initiatives:

National green highways mission: Over 5,000 kilometers of avenue plantation work has been done so far, enhancing the aesthetic value of highways and providing shade to travellers and animals[1].

Lutyens' Delhi: In the early 20th century, when British India's capital shifted from Calcutta to Delhi, avenue tree plantations were meticulously planned. These trees, lining the streets of New Delhi, contribute to the city's character and heritage[2].

Diverse variety: India boasts a rich botanical heritage with diverse avenue trees. From the majestic banyan to the fragrant jacaranda, these trees play a crucial role in our ecosystem and cultural landscape.

Most Useful Trees for Avenue Plantation in India

1. Neem (*Azadirachta indica*): Neem is hardy, drought-tolerant, and can withstand extreme temperatures. It's also known for its medicinal properties and is used to treat various ailments.

2. Peepal (*Ficus religiosa*): Also called the sacred fig, it holds religious significance in Hinduism. Peepal trees thrive in tropical climates and are drought-tolerant.

3. Banyan (*Ficus benghalensis*): Banyan trees have extensive canopies, providing ample shade. They are well-suited for avenue planting.

4. Golden shower tree (*Cassia fistula*): Known for its bright yellow flowers, the golden shower tree is a popular choice. It's drought-tolerant and adaptable to various soils.

5. Indian coral tree (*Erythrina indica*): With its striking red flowers, this tree adds vibrancy to avenues. It grows well in tropical climates.

6. Indian laurel (*Ficus microcarpa*): Recognizable by its glossy green leaves, the Indian Laurel thrives in tropical climates and is an excellent choice for avenue planting.

7. Rain tree (*Samanea saman*): Rain trees have a wide canopy and provide excellent shade. They are well-suited for urban environments.

8. Flame tree (*Delonix regia*): The Flame Tree's fiery red flowers make it a stunning choice for avenues. It prefers warm climates.

9. Jacaranda (*Jacaranda mimosifolia*): Jacaranda trees, with their purple-blue blossoms, create a picturesque avenue. They thrive in subtropical regions.

10. Ashoka tree (*Saraca asoca*): Ashoka trees have beautiful orange-yellow flowers and are revered for their cultural significance. They grow well in various soil types.

11. Palms: Various palms are also useful for avenue planting, where less space is available for larger trees to grow. Some useful palms are foxtail palm, champion palm, areca palm etc.

Remember to consider local climate, soil conditions, and maintenance requirements when selecting avenue trees. Proper care ensures their longevity and benefits for years to come!

In conclusion, avenue plantation in India is not merely about aesthetics; it's a testament to our historical legacy, environmental consciousness, and the enduring impact of thoughtful tree planting. Let's continue to nurture and celebrate these green corridors that connect us to nature and our past.

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Antagonistic Role of Entomopathogenic Fungi in Major Agricultural Pest Control

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Abstract
Entomopathogenic fungi (EPFs) are enlisted under the biological (*i.e.*, microbial) control agents of the key and major agricultural pests, which are substitutes for synthetic inorganic chemical pesticides. They are extremely eco-friendly, sustainable, and easily degradable after a certain period of shelf-life. Unlike chemical insecticides, they do not harm the non-target pests or beneficial insects like, predators, pollinators, parasitoids etc. Nowadays EPFs have been commercially cultured in biocontrol laboratories in larger quantities for distribution among progressive farmers, state and central universities, and research institutes. The sustainable effects on several crop pests along with the mode of action of EPFs have been discussed here.

Keywords: Biological control, Eco-friendly, EPFs, Sustainable.

Introduction
Insect pests are regarded as major deterrents which have accounted for an estimated 10.80% of crop losses on a global scale in the era of post green revolution (Dhaliwal *et al*., 2015). To reduce these losses, insecticides have become an essential method for suppressing insect pests due to minimal application effort, high usefulness, and expediency but the concentrated application of chemicals has brought about the advancement of resistance to insecticides in as many as 500 species of pests.

The over-dependence on synthetic fertilizers is another constraint faced by agriculturists. This is because these chemicals pose several side effects to users, non-target organisms, and the environment (Fadiji and Babalola, 2020b). Due to the natural occurrence of EPF, it is thought that they are generally environmentally friendly with low to no mammalian and residual toxicity. As a result, they have been developed as microbial insecticides for controlling many major arthropod pests in agriculture, forestry, and urban settings in several countries, including the United States (Gul *et al*., 2014).

Entomopathogenic fungi are a major component of IPM techniques as biological control agents against insect pests and other arthropods in horticulture, forestry, and agriculture. As a result, entomopathogens are viewed as regulatory operators of pest infestations representing different species of fungi, viruses, protozoa, and bacteria. These EPFs, due to eco-friendliness and bio-persistence, are preferred to kill insects at various stages of their life cycle (Gul *et al*., 2014). The use of EPFs is not only effective against insect pests but also environmentally safe and sound for humans as well as non-target organisms.

Entomopathogenic Fungi
Out of all the other microbial control agents, EPFs are the most imperative due to
1. Easy distribution,
2. Easy manufacturing techniques,
3. Availability of a large number of already identified strains, and
4. Over-expression of exogenous toxins and endogenous proteins.

The first efficacious mass-produced microbial control application on large scale was carried out by Krassilstschik (1888) against *Bothynoderes punctiventris* (Germar) (Coleoptera: Curculionidae) (sugar beet weevil) by making use of the antagonistic nature of the conidiospores of *Metarhizium anisopliae* (Metchnikoff) (Hypocreales: Clavipitaceae) in Russia.

Epidemiology and Mode of Action: (Meyling and Eilenberg, 2007)

1. Unlike, other potential biocontrol agents, fungi invade directly through the cuticle and so they can be used for control of all insects including sucking insects.

2. Entomopathogenic fungi cause lethal infections of insects and can regulate their populations in nature by epizootics.

3. Entomophthoralean fungi actively eject spores when conditions are favourable (high humidity) that can rapidly infect a susceptible insect, even when these conditions only prevail for short periods.

4. EPF species are mostly isolated from the soil, which protects them from damaging solar radiation.

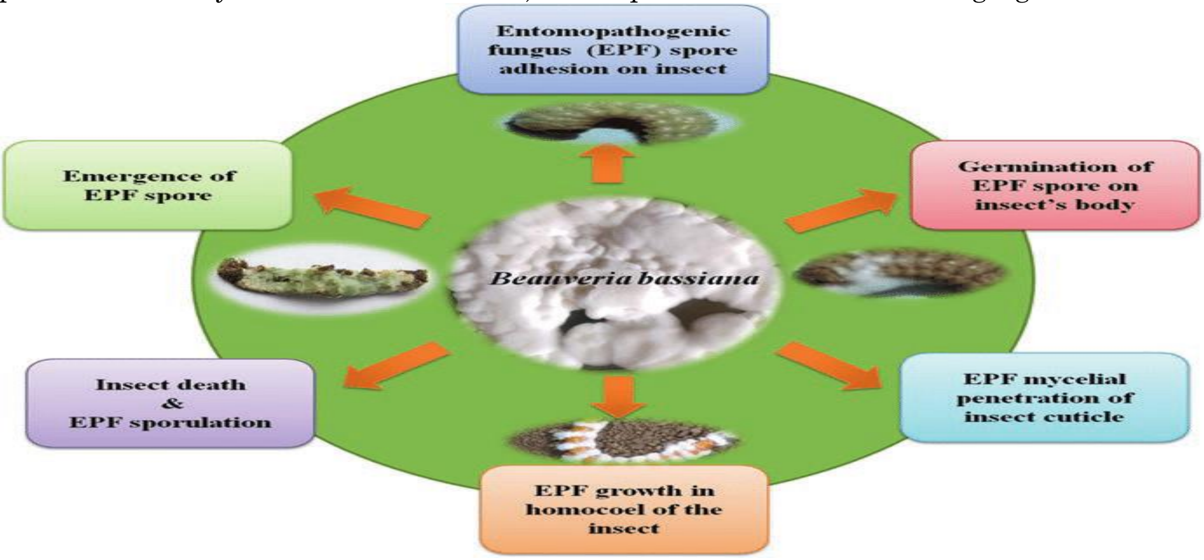

Figure 1. Mode of action of entomopathogenic fungus *Beauveria bassiana* (Sharma *et al.*, 2020)

Application of EPFs in Agricultural Pest Control

1. About 1800 associations between fungi and different insects were recorded. To date, more than 700 species from approximately 90 different genera have been established as insect-pathogenic fungi.

2. These include the most popular strains belonging to the genera *Beauveria*, *Metarhizium*, *Isaria*, *Hirsutella*, and *Lecanicillium*. Among them, *Beauveria bassiana* (Balsamo-Crivelli) Vuillemin, *Isaria fumosorosea* Wize, *Metarhizium anisopliae* (Metschnikoff) Sorokin, and *Lecanicillium lecanii* (Zimmerman) Viegas are the most commonly studied fungal species (Chen *et al.*, 2015).

3. *Beauveria bassiana* and *M. anisopliae* are commonly found on and have been isolated from infected insects in both temperate and tropical regions throughout the world (Zimmermann, 2007a).

4. Several of the EPF species, for example, *I. fumosorosea* and *I. farinosa*, can infect multiple hosts without showing any of the numerous harmful effects.

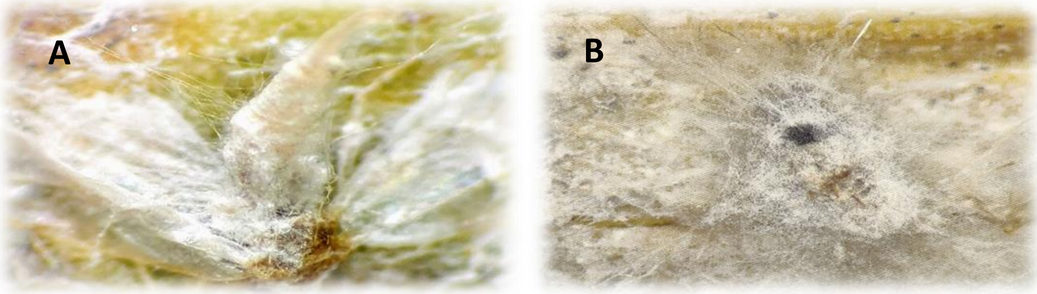

Fig 2. Fungal Spores of A. *Beauveria bassiana*; B. *Isaria fumosorosea* on adult and pupa of Coconut rugose spiraling whitefly

5. It has been noted that certain species of Beauveria and Metarhizium can infect and kill insects in the soil and also EPF interacts with the roots of plants for their growth and survival which predominately relies on insects for carbon and not on soil.

6. These fungal species together with other known hypocrealean fungi, such as *I. fumosorosea*, *M. brunneum*, *M. robertsii*, and *Hirsutella thompsonii* Fisher, are commonly used against a broad range of arthropod pests (Dara, 2019b).

7. They are mostly applied through inundative approaches and have been reported to be effective against several insects of different feeding guilds including aphids, locusts, thrips, grubs, moths, mites, mosquitoes, whiteflies, and tephritid fruit flies (Gulzar *et al*., 2021).

Entomopathogens as Myco-Pesticides

The most common mycopesticides are products formulated from *B. bassiana*, *M. anisopliae*, *B. brongniartii*, and *I. fumosorosea*. Fungal pathogens, particularly *B. bassiana,* Vuillemin, *Isaria fumosorosea* Wize, and *M. anisopliae*, are currently being evaluated for use against agricultural and urban insect pests. Several species belonging to the orders Isoptera, Lepidoptera and Diptera, Coleoptera, and Hemiptera (Hussain *et al*., 2011), are susceptible to various fungal infections. This has led to several attempts to use EPF for pest control, with varying degrees of success.

1. For instance, the ability of *B. bassiana* to antagonize plant disease-causing pathogens in tomato, squash, cotton, grapevine, and many other economic crops has been reported (Vega, 2018).

2. *Beauveria* sp. inhibiting various plant pathogens, including *Fusarium oxysporum*, *Botrytis cinerea*, *Septoria* sp., *Gaeumannomyces graminis*, *Pythium* sp., *Rhizoctonia solani,* and Zucchini yellow mosaic virus in squash (Jaber and Salem, 2014).

3. *M. anisopliae* was found to minimize the spread of Dutch elm disease (DED), a vascular wilt disease caused by the ascomycete fungus, *Ophiostoma ulmi* Buisman (Karthiba *et al*., 2010). Entomopathogenic fungal endophytes activate the production of plant defense proteins in their colonized host (Fadiji and Babalola, 2020a).

4. Their ability to increase the production of pathogenesis-related proteins and other defense enzymes has been demonstrated by Karthiba *et al*. (2010) in rice and peanut, following dual treatment of both plants with *B. bassiana* and *Pseudomonas fluorescens*.

Conclusion

As the chemical insecticides pose serious environmental issues infecting both insect pests as well as beneficial organisms including the human population, the entomopathogenic fungi are very suitable substitutes for them to counter the negative impact on the environment and they are also highly bio-degradable keeping themselves in the category of eco-friendly management practices. This is the need of the hour to educate and make the farmers understand the benefits of these EPFs.

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Fall Armyworm: Its Infestation and Management on Maize, *Zea mays* L

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Summary of Article
Fall armyworm infestations are characterized by rapid reproduction and feeding habits that result in severe damage to maize crops. The larvae feed on leaves, tassels, and developing ears, leading to reduced yields and sometimes complete crop loss if not managed effectively. This article brings into account its distribution, life cycle, damaging symptoms and beaviour that makes a proper understanding towards the management of the pest.

Introduction
The fall armyworm (FAW), scientifically known as *Spodoptera frugiperda*, is an invasive pest originally from tropical and subtropical America. It has rapidly spread across Western Africa and most Sub-Saharan African countries, infiltrating over 44 nations on the continent **(Bueno *et al* 2010; and Nagoshi *et al*, 2018)**. Its invasion journey began in India during 2018–2019, swiftly extending its reach to various Asia-Pacific countries, including Korea, Japan, and Australia **(Pogue *et al,* 2002; and Prasanna *et al,* 2018).** This voracious pest poses a significant threat to new ecosystems in Africa and Asia, as well as to the economic viability of numerous crop plants. With a wide appetite, the FAW can inflict damage on over 350 plant species, with maize being its preferred target **(Cock *et al,* 2017)**. Other susceptible crops include sorghum, rice, sugarcane, cabbage, beet, groundnut, soybean, onion, cotton, pasture grasses, millets, tomato, potato, and cotton. Displaying both migratory and localized dispersal tendencies, the FAW can cover considerable distances before laying eggs, with moths capable of traveling up to 1600 km under favorable wind patterns. While its presence may be seasonal in some regions, under favorable conditions and with alternative host availability, it can perpetuate its lifecycle year-round, spreading continuously. Typically congregating in large numbers, especially following dry spells, the most destructive stage of the FAW is its larvae. These larvae exhibit diverse feeding patterns, often hiding in the plant foliage or soil during the day and emerging at sunset to feed. Some strains of FAW are even active during daylight hours. Unchecked infestations of FAW can lead to substantial maize yield losses, estimated by **(Day *et al.*, 2017)** to range from 8.3 to 20.6 million tonnes annually, representing a significant portion of total production (21–53 percent).

Damage Symptoms
The primary damaging stage of the FAW is its larvae. These immature larvae have a specific feeding pattern, initially targeting the dorsal section of the leaf blade while leaving the opposite epidermal layer untouched. As they progress to the second or third instar, they begin boring holes in young leaves. As the larvae mature, they transition to grazing from the leaf edge inward. During the initial larval phase, the damage is concentrated within the leaf whorl, resulting in characteristic shot hole symptoms once the affected plants fully expand their leaves **(Du *et al,* 2020).** While the population of young larvae tends to be high initially, cannibalistic behaviour typically reduces larval densities in later instars, with usually only one to two larvae per plant. However, mature larvae can cause extensive defoliation, consuming all green leaves rapidly and leaving only leaf ribs and stalks behind. The sensitivity of maize to FAW infestation varies depending on the growth stage, with the late whorl stage being the most vulnerable. Mean larval densities of 0.2 to 0.8 per plant during this stage can result in production losses ranging from 5 to 20%. In severe cases, larvae may ascend to the ear and feed on kernels, leading to complete yield loss.

The growing demand for maize kernels in local, domestic, and international markets has incentivized its production, often commanding premium prices. This demand, coupled with maize's resilience to environmental factors and market attractiveness, has led to its widespread adoption, replacing several other crops and cropping systems in many African and Asian countries. However, continuous monocropping and monoculture practices have made maize vulnerable to numerous pests, with FAW being one of the most detrimental. With its broad host range and ability to cause substantial yield losses across large areas, FAW poses a significant threat to maize production in affected regions. **(Pogue *et al,* 2002).**

Life Cycle

A comprehensive grasp of the life cycle of insect pests is crucial for devising effective management strategies. The life cycle of the FAW varies depending on environmental conditions. In the USA, under summer temperatures averaging around 28°C, the insect completes its life cycle in approximately 30 days. However, in spring and winter, this duration can extend to 60–90 days **(Pogue *et al,* 2002).** The developmental thresholds for FAW range from 13.01°C to 30°C. The number of generations of FAW in a particular area is influenced by the emergence of dispersing adults and prevailing meteorological conditions **(Day *et al*, 2017)**. Each female adult lays eggs in clusters on either side of leaves, with an individual capable of depositing around 1500–2000 eggs. These eggs, measuring 0.3 to 0.4 mm in diameter, hatch after an incubation period of 2–3 days. During summer, six larval instars have been observed, with immature larvae exhibiting a greenish hue and black heads. Notably, invasive populations of *S. frugiperda* have been found to adopt a bet-hedging strategy in their life history, enabling earlier reproduction and an extended reproductive lifespan, thereby enhancing their invasive success. Mature larvae display a brownish coloration with a reddish-brown head, often identified by a distinctive white inverted "Y" shape marking. Pupation occurs within a cocoon in the soil at a depth of 2–8 cm, with the cocoon typically oval-shaped and measuring 20–30 mm in diameter. The reddish-brown pupa measures 14–18 mm in length and 4.5 mm in width, with a pupal phase lasting 8–9 days. The adult FAW has a grey and brown coloration with silvery-white hind wings featuring a small dark mark around the margins. Nocturnal in nature, adults emerge in the evenings, particularly in hot and humid weather conditions. The average lifespan of an adult ranges from seven to ten days.

Management

Biological control emerges as a promising alternative to chemical management for FAW **(Gowda *et al,* 2021)**. Numerous natural enemies have been identified in various regions as potential allies against this pest. Molina-Ochoa et al. documented a staggering 150 species of parasitoids and parasites associated with FAW across the Americas and the Caribbean basin. Similarly, in India the presence of egg, larval, and larval–pupal parasitoids, as well as predators, targeting different stages of FAW on maize crops has been found **(Baudron *et al,* 2019)**. Among the predators identified, various ground beetles (Coleoptera: Carabidae), the striped earwig (*Labidura riparia*), the spined soldier bug (*Podisus maculiventris*), and the insidious flower bug (*Orius insidiosus*) were found to be effective biocontrol agents against FAW infestations in maize fields. While predators play a crucial role in reducing FAW populations, parasitoids outnumber them and exhibit greater efficacy in causing mortality among FAW. Notably, solitary parasitoids from the Hymenoptera genera *Chelonus* and *Campoletis*, as well as Trichogramma parasitoids, have shown promise as highly effective biocontrol agents, particularly for inundative biological control programs **(Zhang *et al,* 2021)**. The application of varieties of chemicals in the management of crop pests is an ambiguous practice **(Baranek *et al,* 2021)**. The FAW larva eats by remaining in the whorl of maize, avoiding contact with insecticides that have been administered. The application of emamectin benzoate 5 SG has been seen to show the highest acute toxicity, followed by chlorantraniliprole 18.5 SC and spinetoram 11.7 SC, whereas toxicities of flubendiamide 480 SC, indoxacarb 14.5 SC, lambda-cyhalothrin 5 EC, and novaluron10 EC are also effective.

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United Growth: Agriculture and Manufacturing Paving the Way Forward

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Abstract

Agriculture and manufacturing are two industries that are particularly important growth drivers in the field of economic development. As countries work towards balanced and sustainable development, their seemingly divergent trajectories are beginning to converge. United Growth: Agriculture and Manufacturing Paving the Way Forward" is all about how farming and making things can work together to make countries better. It's like saying that if farmers and factories team up, they can create more jobs, make new stuff, and help everyone do well. This project looks at how farmers and factories can help each other out and come up with ideas to make things even better. By working together and making smart decisions, we can make sure that farming and making things keep getting better and help everyone have a brighter future.

Keywords: Agriculture, Manufacturing, Growth, Development.

Introduction

The phrase "United Growth: Agriculture and Manufacturing Paving the Way Forward" captures the mutually beneficial link that propels sustainable economic development between the manufacturing and agricultural sectors. Through innovation, job opportunities, and technical improvement, this synergy maximises the potential of both sectors to drive overall growth. Countries can improve value chains, maximise resource utilisation, and increase export competitiveness by combining agricultural output with manufacturing operations. This all-encompassing strategy boosts rural economies while quickening modernization, diversification, and resilience to external shocks. Underscoring the crucial role of manufacturing and agriculture as the twin engines of prosperity, this paradigm, which places an emphasis on strategic investments and collaboration, shapes a prosperous and inclusive future for nations worldwide through industrialization, diversification, and resilience in the face of global challenges.

Two types of growth models are proposed for sustained economic development

1. **Balanced growth:** Here the investment is made in both the sectors at a time.
2. **Unbalanced growth:** Here investment must be made in one sector after its development it will automatically take care of the other sector through the development of the infrastructure by the former.

As India is developing countries where the investment cannot be done in both the sectors simultaneously due to the lack of the financial and other resource constraints so that investment can be made in one sector so development can take place in one sector after some period of time this developed sector will take care of other sector. Suppose investment is made in the manufacturing sector it will lead to the development in the infrastructure facilities, roadways, railways, ports with this facilities it will help for other sector like agriculture.

Agriculture and Manufacturing are Two Pillars of Economic Development, and their Growth Often goes Hand in Hand for Several Reasons

1. **Diversification of Economy:** It can be dangerous to depend entirely on one industry for economic growth. Growth in both manufacturing and agriculture guarantees a more diversified economy that is better able to absorb shocks and downturns in any one sector same case as been observed during the Covid-19 pandemic.

2. Output-Input linkage: Both the sectors are interconnected. The output of agricultural sector will the input of manufacturing sector by this growth of manufacturing sector drives the demand for the growth of agricultural sector. So, the investment should be made proportionally in both sectors if not unbalanced growth will take place that lead to further consequences like inflation of food products.

3. Employment generation: There exists a disguised employment in agriculture who add no additional output in the agriculture, with this investment opportunities should be made in the manufacturing sector to employ the disguised employment so their income can be raised by this they will demand higher quantities of food products.

4. **Market expansion:** A growing manufacturing sector can provide a larger market for agricultural products. As people in urban areas typically have higher incomes, they can afford to purchase more food products, creating opportunities for farmers to increase production and income.

5. Income generation: Growth in agriculture and manufacturing can contribute to increased household incomes Farmers can earn more from selling their produce, while workers in the manufacturing sector can earn wages, leading to higher overall purchasing power in the economy.

6. Infrastructure Development: Both sectors require infrastructure such as transportation, storage, and communication networks. The development of infrastructure to support one sector often benefits the other, leading to improved efficiency and productivity in both agriculture and manufacturing.

Through Research, Policy Advocacy, and Stakeholder Engagement, "United Growth" Aims to

1. Identify key challenges and opportunities in integrating agriculture and manufacturing sectors.
2. Explore innovative solutions and best practices for promoting synergy between these sectors.
3. Advocate for policy reforms and investment incentives to support the growth of agriculture and manufacturing industries.
4. Facilitate knowledge exchange and capacity-building initiatives to empower stakeholders and promote inclusive growth.

Conclusion

United Growth: Agriculture and Manufacturing Paving the Way Forward" are urging decision-makers, business executives, and development professionals to adopt a cooperative strategy for economic development. Through combining the complementary advantages of manufacturing and agriculture, countries can open up new avenues for innovation, job development, and poverty alleviation. They can create robust and inclusive economies that fully utilise the potential of their manufacturing and agriculture sectors by forming strategic alliances, implementing regulatory reforms, and making targeted investments. Let's take advantage of the chance to shape a future where shared growth is the foundation of prosperity for everybody as we negotiate the complexity of the global economy of the twenty-first century.

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The Next Wave of Pollution: Understanding Emerging Contaminants in India

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Introduction: The Unseen Threat

Emerging contaminants (ECs) are a growing environmental concern worldwide and include a wide range of chemicals and substances that are not commonly monitored or regulated but have potential ecological and human health impacts (Puri et al., 2023). As populations expand and increasing industrial activities, the introduction and spread of new chemicals have become more prevalent. According to a 2021 report by the United Nations Environment Programme, over 350 new chemicals are registered daily at a global scale. Many of these could become tomorrow's ECs. In India, rapid urbanization and industrial growth have led to an increase in the use of diverse chemicals in agriculture, industry, and daily life, significantly raising the risks associated with these contaminants. Many recent studies in heavily contaminated basins in India have focused on a range of water quality parameters such as biological, geogenic contaminants, heavy metals, and nutrients, but have notably excluded emerging contaminants from their analyses (Ansari and Kumar, 2022; Gao et al., 2024; Jadav et al., 2024; Mishra et al., 2024). Therefore, it's crucial to research the sources and occurrence of emerging contaminants in the water, air and soil matrices.

Sources of Emerging Contaminants

ECs are chemical compounds that have been detected in the environment without a clear understanding of their potential impacts. The primary categories of emerging contaminants include pharmaceuticals, personal care products, hormones, perfluorinated compounds, agricultural pesticides, microplastic, artificial sweeteners, endocrine-disrupting chemicals, perfluorinated compounds, phthalates, and various industrial by-products.

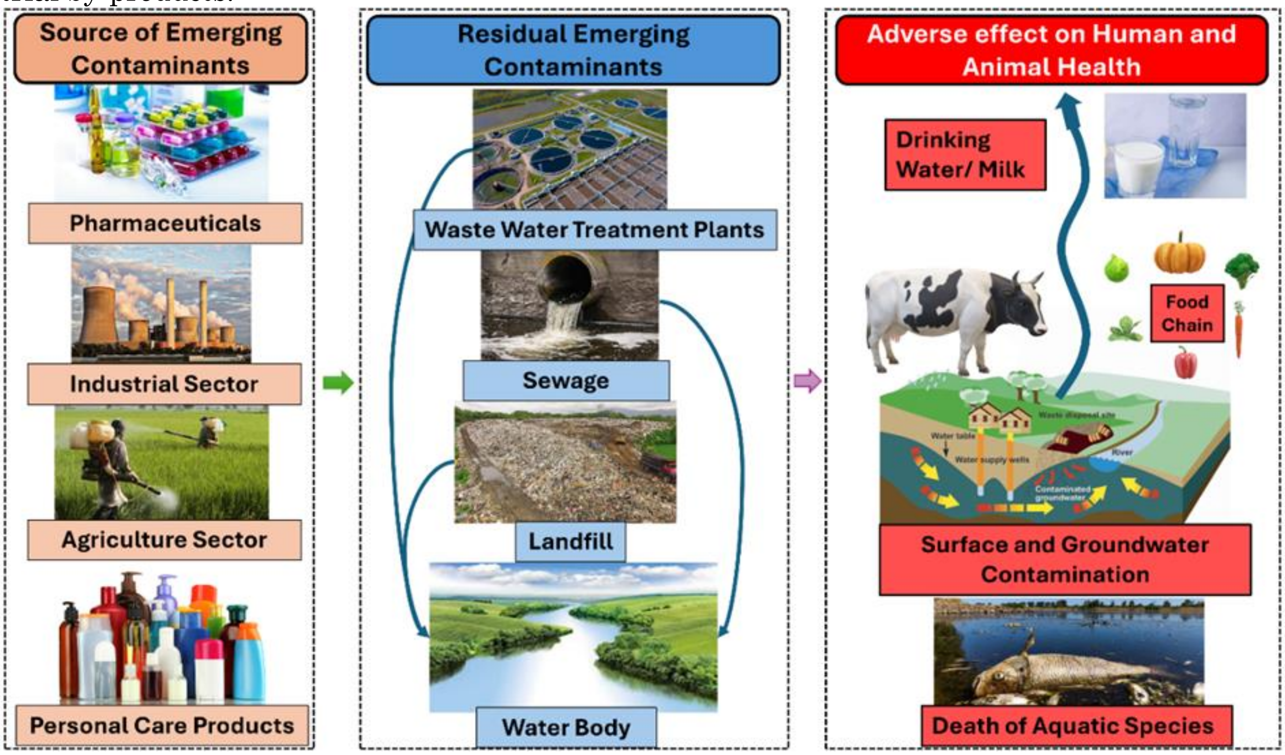

Fig. 1: Emerging contaminants sources and their effects on human and animal life

These substances enter the environment through multiple channels, including agricultural runoff, industrial discharges, improper waste disposal, and leaching from landfills (Philip et al., 2018; Puri et al., 2023). Also, residual emerging contaminants can leak into various parts of the environment from places like landfills, wastewater treatment plants, and rivers, which adversely affect human and animal health (Fig. 1).

Although there is currently no standard categorization for these substances, various studies have analysed their distribution in Indian water systems. Research by Mathew & Kanmani (2020) indicates that in Indian water systems, pesticides make up 57% of detected ECs, followed by surfactants and pharmaceuticals, each account for 17%, and personal care products represent 7%. The remaining contaminants include artificial sweeteners, endocrine-disrupting chemicals, and perfluorinated compounds." Endocrine-disrupting chemicals are particularly concerning as they have the potential to harm the endocrine system of vulnerable populations like pregnant women, children, and the elderly.

Importance of Addressing these Pollutants in India

In India, concentrations of ECs are found in surface water, groundwater, untreated wastewater, and drinking water, mainly belonging to pesticides, pharmaceuticals, and personal care products (PCPs). In surface water, the maximum concentration of pesticides exceeds their standard limit. Pharmaceuticals such as cetirizine, ciprofloxacin, and citalopram have been found in untreated wastewater, as shown in Fig. 2. The least research is carried out in groundwater, where only pharmaceuticals and pesticides are found. The health implications of exposure to ECs are profound as it can disrupt hormonal functions, lead to toxicity in humans and wildlife, and contribute to chronic health conditions. Therefore, understanding their removal in water and wastewater treatment processes should also be considered for the betterment of the ecosystem and human health.

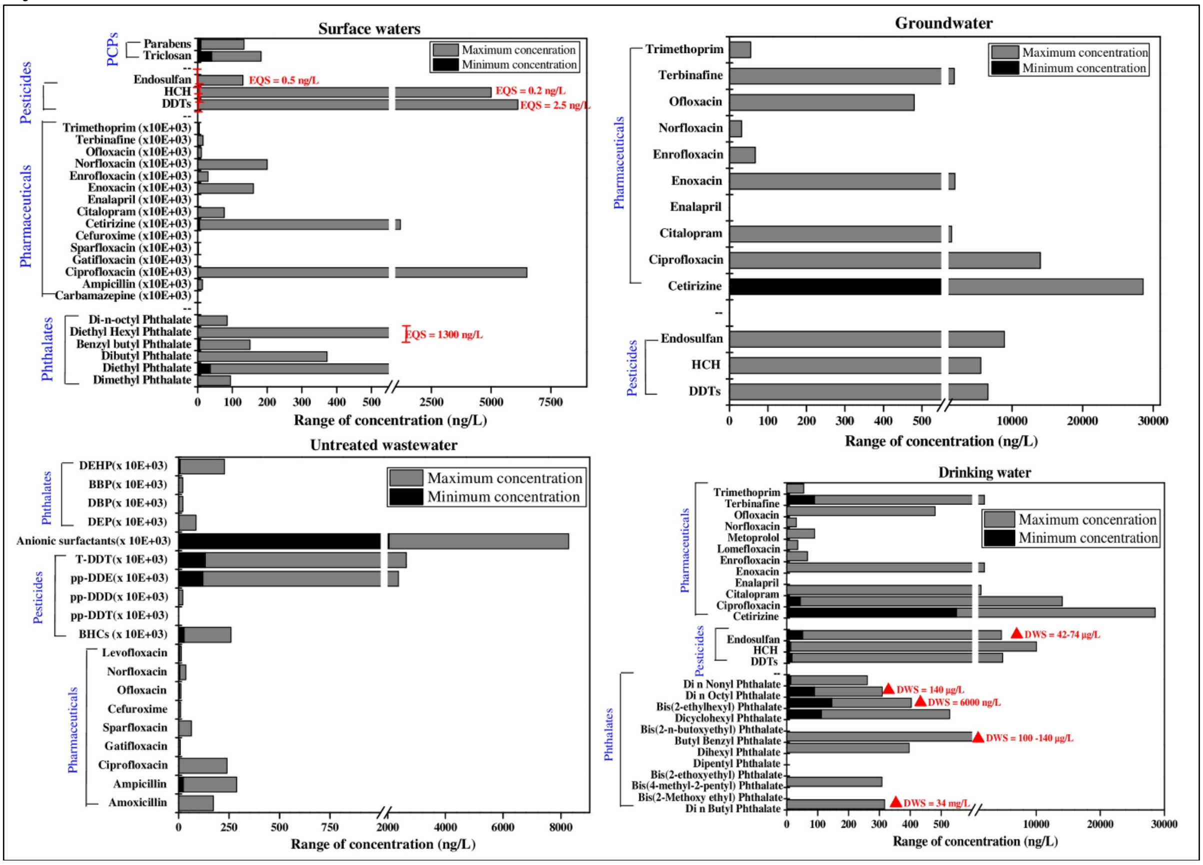

Fig. 2: ECs concentration in different water sources in India (Gani and Kazmi, 2017)

Impact on Human Health

ECs pose significant risks to human health. For example, many are known endocrine disruptors, which can interfere with hormonal functions and potentially lead to reproductive issues, developmental problems, and hormonal imbalances (Gwenzi et al., 2018). Neurological effects are also a concern, as some pharmaceuticals and chemicals in personal care products can cause cognitive impairments and developmental delays in infants and children's. Additionally, some ECs are linked to an increased risk of cancers and immune system suppression. Furthermore, the improper disposal of antibiotics can promote the development of antibiotic-resistant bacteria, complicating the treatment of bacterial infections. Exposure to ECs can also result in developmental and reproductive toxicity if it occurs during critical developmental periods. There is even emerging evidence that some contaminants may increase the risk of cardiovascular diseases, affecting heart health and blood vessels (Pereira et al., 2015). Given these diverse and significant health risks, there is a crucial need for improved monitoring, robust regulatory frameworks, and further research to mitigate the impacts of these contaminants and safeguard public health.

Barriers and Challenges

1. Limited Data on Diffuse Pollution Source: One major challenge in managing ECs is the limited data on diffuse sources of pollution. Studies often focus on regional scale near point sources, meaning that broader environmental impacts might be underestimated.

2. Challenges in Detection and Regulation: ECs are not consistently monitored or regulated due to the difficulties in detecting them in environmental matrices, as they are often present at low concentrations that traditional detection methods might miss.

3. Ecological and Toxicological Unknowns: The ecological and toxicological profiles of many ECs are not well understood, which complicates risk assessment and appropriate mitigation strategies.

4. Persistence and Bioaccumulation: Despite their relatively low concentrations in the environment, ECs can be highly persistent and bio accumulative, leading to long-term effects on both ecosystems and human health.

5. Regulatory Gaps: Existing regulations may not cover all types of emerging contaminants, and there is a need for global cooperation to create standardized methods for monitoring and treatment.

6. Research and Technological Challenges: Addressing these contaminants requires advanced research and development of new technologies for detection, analysis, and removal. However, funding limitations and the need for interdisciplinary collaboration to develop effective and sustainable solutions often hampered research.

Looking Ahead: Strategies and Innovations

In conclusion, the challenge posed by emerging contaminants is daunting but not insurmountable. Managing ECs in India involves a complex and multifaceted approach that spans environmental science, public policy, and community engagement. As our knowledge of these contaminants increases, so must our strategies for monitoring, regulating, and mitigating their impacts. Research in areas such as improved monitoring methods, understanding the movement and persistence of ECs, and developing advanced treatment technologies is crucial. This will deepen our understanding and lead to more effective interventions. Moreover, a comprehensive approach that includes ecotoxicological studies and health risk assessments will enhance our ability to predict and manage the associated risks.

India must pursue policy reforms and improvements by updating existing regulations, implementing regular and rigorous monitoring, and fostering international cooperation. Additionally, community engagement is essential, as it bolsters monitoring efforts, raises awareness, and encourages public participation in decision-making, thus strengthening our collective response to ECs. Therefore, by enhancing scientific research, strengthening regulations, and promoting community involvement, India can protect its environmental and public health from the threats posed by emerging contaminants."

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Post Harvest Management of Cut Flowers

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Introduction

Floriculture is considered a viable option for diversifying agri-business, showing a notable annual growth rate of over 15% over the past two decades. The highly perishable nature of flowers distinguishes them from other agricultural or horticultural crops, resulting in significant post-harvest losses, particularly when compared to other sectors (Kumar *et al.,* 2022). In India, various flower crops, such as roses, chrysanthemums, orchids, anthuriums, tuberoses, carnations, dahlias, and gerberas, are cultivated for cut flower production. Certain species and varieties of flowers have very short freshness durations, making them unsuitable for use as cut flowers. Many farmers and horticulturists cultivate cut flowers for export, decoration, gardening, floral markets, farm share, and domestic use. The quality of a flower depends on factors such as shelf life, vase life, and overall longevity, which are influenced by genetic, environmental, pre-harvest, and post-harvest practices. In India, approximately 20% of cut flowers are lost during the harvesting, handling, and marketing stages, underscoring the importance of proper care and management post-harvest to prolong the shelf life and quality of flowers, ultimately reducing losses effectively.

Factors Influencing the Post-Harvest Quality of Cut Flowers

1. Pre harvest factors: Enhancement of fresh produce quality and postharvest conditions is not feasible. Pre-harvest factors have the potential to prolong the post-harvest lifespan of crops.

a. Genetic / varietal factors: The genetic composition of a crop plays a crucial role in determining the duration of flower longevity. Cultivars that exhibit lower respiration rates and decreased ethylene production typically demonstrate extended storage lifespans.

b. Environmental factors: Environmental factors, such as light, temperature, and humidity, play a crucial role in influencing the quality of cut flowers after harvest. The effective control and regulation of these factors are also pivotal in determining the lifespan of flowers once they have been harvested.

c. Cultural factors: Human and material resources contribute to post-harvest losses in cut flowers through factors such as planting, irrigation, and fertilizer application. The losses in produce can also be attributed to pests, microbial infections, natural ripening processes such as ethylene, as well as environmental conditions, including heat, drought, and inadequate post-harvest handling, (Vijayakumar *et al.,* 2021).

2. Post-harvest factors: In addition to pre-harvest factors, various post-harvest factors influence the quality of cut flowers after harvest. These post-harvest factors include the following.

a. Temperature: The process of respiration in cut flowers, which is essential for their growth and aging, leads to heat production. Additionally, an elevation in ambient temperature results in an increase in the respiration rate.

b. Light: The consideration of light exposure during storage is typically insignificant, with the exception of situations where leaf yellowing may arise as an issue. Foliage discoloration can occur in certain varieties of chrysanthemum, alstroemeria, marguerite daisy, and other plant species when kept in dark environments at elevated temperatures.

c. Humidity: Transpiration rates decrease at high humidity levels, thereby extending the vase life of flowers. When flowers are maintained at 90-92% humidity, they are able to maintain turgidity.

d. Water relations: The lifespan of cut flowers is determined by their genetic makeup and water relationships, with the latter being a vital and integral aspect of their endurance.

e. Water quality: Water quality is determined by pH, EC, hardness-inducing substances, phytotoxic elements, and microbial populations that affect flower durability. Saline water usage decreases the lifespan of cut flowers.

f. Ethylene: Ethylene can be described as a compound with a low molecular weight consisting of two carbon atoms, typically found in a gaseous state at concentrations of 3-5 parts per billion in the atmosphere. The plant species that exhibit the highest sensitivity to ethylene include alstroemeria, carnation, freesia, orchids, and petunia.

g. Mechanical Damage: In India, approximately 20–40% of the quality degradation in the production of cut flowers is attributed to physical damage. Therefore, meticulous attention is required during handling to enhance the quality of cut flowers.

h. Pest and diseases: Post-harvest diseases have the potential to diminish the quality of cut flowers by approximately 15-20%. The quality of flowers can be compromised by pests, such as mites, thrips, aphids, and bud worms. In vase water, prevalent postharvest diseases include, gray mold, and erwinia

3. Methods for managing cut flowers to enhance longevity after harvest: There are important postharvest protocols for cut flowers to enhance quality and increase export potential. Flowers should be harvested at the right time and undergo appropriate post-harvest procedures. Various techniques have been used for postharvest management.

a. Harvesting: Approximately 70% of cut flower quality is determined during harvesting. Harvesting stage, technique, and timing had a significant impact. It is recommended that cut flowers be harvested early in the morning or late afternoon.

b. Pre cooling: Pre-cooling is conducted to extract field heat from agricultural produce, thereby facilitating a rapid reduction in the temperature of the flowers. This process may entail the use of ice-cold water, cold water, or forced air.

c. Storage: The flowers last longer at low temperatures. Cold storage involves two methods: wet and dry storage. The wet method involves temporary stems in water. Dry storage is a complex and expensive technique.

d. Conditioning with chemical preservatives: Before being packed, flowers undergo a process known as pulsing to prolong their shelf life. This term describes a brief treatment applied to flowers prior to shipment by producers or distributors, involving the application of elevated levels of specific chemicals.

e. Grading: The grading process involved the classification of flowers according to their quality. It is imperative that every bunch exhibit uniformity in terms of size, weight, and overall quality prior to being introduced into the market. Grading criteria primarily focus on the visual characteristics of the flowers.

f. Bunching: The graded stems were assembled into groups of 20 with each bundle loosely fastened with a rubber band. The floral bud must be enveloped in 2-ply gentle corrugated paper, either white or brown, and then loosely secured in place with a rubber band.

g. Cold storage: Upon pre-cooling the flowers to eliminate field heat, it is imperative to subject them to this treatment before placing them in cold storage to prevent cold injury.

h. Packing and transport of the flowers: The packing method varies based on the crop, flower, transport method, and the market. An ideal packing must be airtight, resistant to moisture, and durable to endure handling, transportation, and stacking.

Conclusion

India's production of cut flowers for the year 2023-24 is estimated to be 958 thousand metric tons, with a cultivation area of 258 thousand hectares yielding 2236 thousand metric tons. (Anonymous, 2024). It is crucial to evaluate the postharvest handling of cut flowers to maintain quality factors such as pre- and post-harvest conditions, crop demand, and post-harvest life of the harvested flowers. The establishment of cold storage facilities can help improve cold chain management and extend flower longevity. It is also essential to provide training on flower harvesting, handling, packing, and transportation to growers to prevent losses during handling.

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Cultivation Practices of Tree Bean

Article ID: 48922

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Tree Bean

Introduction

Tree bean is a perennial legume tree vegetable of Northeastern India. This tree is multifunctional and may have commercial and ecological value. Tender pods are used to make fries, chutney and salad dishes. Compared to other legumes, this plant's edible flowers, sensitive podsand seeds are a good source of proteins, carbohydrates, vitamins and minerals. It is high in fiber and low in fat, both of which are good for health.

Scientific name- *Parkia roxburghii*
Family - Fabaceae
Chromosome no- 2n= 24,26

Production Technology

Climate and Soil: The tree grows well in a wide range of soil including clay loam, deep clay loam and lateritic/acidic soils and climatic conditions from colder hilly to hotter plains regions. 15 to 27°C is ideal for luxuriant development, while it can withstand temperatures as high as 35°C. It thrives in areas with annual rainfall of roughly 3500 mm, but it can survive with just 1750 mm. The pH range of 5.5 to 7.5 is optimal for soil growth.

Seed and Sowing: The most common form of propagation of tree bean is through seed and vegetative propagation. However, vegetative propagation encounters several difficulties particularly due to the low rooting percentage. The crop can be easily propagated from the fully matured seeds. Before propagation, seeds are soaked in water for 48 hr then treated with carbendazim 12% + mancozeb 63% @ 2 g/L of water for 2 min and allow for drying in airy places under shade for 15 min. Instead of chemical fungicide, the seeds can be treated with *Trichoderma sp.* @ 20 g + acacia gum @ 1 tablespoonful per kg of seed. Biofertilizers like *Azospirillum* and *Pseudomonas* can also be used for seed treatment.

Seeds are sown in the polybag (8 cm x 10 cm) containing potting mixture of soil, sand and FYM in ratio 1:2:4 and covered with moist gunny bags for 3-4 days under polyhouse to enhance germination. The ideal sowing time ranges from the last week of April to the first week of June. One-month old seedlings should be transferred to a naturally ventilated polyhouse or agro-shade net house for about 6 months for hardening.

Land Preparation and Planting: Tree beans are sensitive to floods and water stagnation, so waterlogged and marshy areas should be avoided. For planting, a pit of 60 cm x 60 cm x 60 cm in size should be dug and kept exposed to sunlight for 10-15 days before planting. The pits are filled with topsoil thoroughly mixed with FYM or vermicompost (1:1). Planting operation is generally carried out during monsoon (June-August). A light watering is required after planting.

Seed rate: 100 to 156 seedlings per hectare (Roy *et al.*, 2016).

Spacing: 10m × 10m

Nutrient management: A sufficient amount of fertilizer is necessary for healthy growth and excellent yield production in plants. Since tree beans develop quickly, more care should be taken to maintain the ideal level of NPK. During the vegetative phase (February–March), flowering phase (July–August) and fruiting phase (September–October), the manures and fertilizer should be applied in a circular drain (8 inches wide and 6 inches deep) around the tree in three splits.

Plant age (year)	FYM (kg/plant)	Urea (g/plant)	SSP (g/plant)	MOP (g/plant)	Lime (g/plant)
1st	5	100	200	50	500
2nd-3rd	10	150	400	100	1000
4th-5th	10	200	600	150	2000
6th-7th	15	300	800	200	3000
8th -above	20	350	1000	250	4000

Water management: Although a rainfed crop, tree beans should be watered after planting and nutrient application. Watering young plants during the lean season encourages growth and development. In hilly terrains, water conservation measures should be taken.

Intercultural operations: It is advised to regularly remove weeds, particularly in the early phases of a plantation when weed competition for water and nutrients stunts plant growth. Before the rain starts, the area surrounding the base should be earthed up. Mulch around the base of the tree with dry leaves, paddy strawor black polythene (100 microns) to keep the soil moist, inhibit weed growth and lessen soil erosion. Intercropping with small fruit and vegetable crops, such as papaya and lime, is recommended. Since it takes many years for tree beans to reach the bearing stage, intercrops can be employed during the gestation period to generate additional revenue. For fully matured plantations, shade-loving crops should be employed as intercrops.

Training and Pruning: Pruning tree beans is only advised for dry, diseased or unintended shoots. However, training is seen as a crucial procedure since the junction, where primary branches emerge from the main stem, is where stem-boring insects prefer to enter. A single trunk must be maintained up to 150–180 cm above the ground before it may support two to three primary branches.

Plant protection: Tree bean decline was first reported from Manipur state of India in 2002 and the death of plantations was linked to a stem borer. Common signs of tree bean decline include wilting, severe gummosis, drying out of the branches, leaf drop, the appearance of bore holes and trash emissions (Singh *et al.,* 2018). Abscission of the infected tree starts from the tip progressing downwards with dieback being seen as the most prominent symptoms. Once these symptoms start appearing the entire tree dries up in the next few days (Singh *et al*., 2018). As a result, the supply of nutrients and water is blocked causing leaf shedding, loss in vigour, wilting and ultimately death of the tree. It was also observed that the young plants (up to 10 years) are more prone to decline as compared to older plants (more than 30 years).Roy *et al.*(2016) reported that the incidence of insect-pests and diseases has been found to be the major cause of tree bean decline. An array of insect-pests *viz.* aphids (*Aphis craccivora*); thrips (*Scirtothrips dorsalis*); green stink bug (*Nezara virudula*); Asian long (*Anoplophora glabripennis*); jassid (*Empoasca kerri*); bark eating caterpillar (*Indarbela spp*. borer (*Cadra cautella);* Coreid bug/tur pod bug (*Clavigralla gibbosa*) etc. infect the tree bean associated with the decline of tree bean. A frequent association of Asian long horned beetle, bark eating caterpillar and spotted pod borer has been observed with the declining tree bean trees.

Proper sanitation module should be followed to keep the site neat and clean. Light traps can be used for field management of Asian long horned beetle, bark eating caterpillar and spotted pod borer/ almond moth. Application of Imidacloprid and Carbendazim mixture to the tree trunk is recommended.Application of Bordeaux paste on the main trunk up to 5 ft height from the ground is always considered a good practice.

Harvesting and Yield: The plantspod production starts at the age of 6 years; however; the full bearing stage is 10 years. Tree bean pods are generally harvested from September to March. Harvesting should be done either in the early morning or in the late afternoon with a help of a sharp chisel or sickle fitted on bamboo or wooden stick. For long term storage, the matured pods are more preferred. A single stalk flower bears 10-30 pods and each pod contains 12-18 seeds. Tree bean can bear 500-1500 pods/plant (90-260 kg/plant) depending upon the age and growing condition. During the favourable season, it can bear 9000-13000 pods.

Post-Harvest Management: Normally, pods can be stored at low temperature of 0℃ - 4℃ for 3 to 4 weeks.

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Ancestral Knowledge in Mitigating Insect Pests

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Introduction

Knowledge from our ancestors being inherited to numerous generations which cater various needs of people. In this exploration of ITK in pest management, we come to know about the importance of age-old practices, deeply rooted in culture and ecology, that have sustained indigenous communities for centuries.

Integrated Technical Knowledge (ITK)

Indigenous Technical knowledge (ITK) refers to the local or area specific practices or knowledge of the farmers which are inherited traditionally from their ancestors. This indigenous knowledge can be in the form of tools, implements, preparations, traditional cultural practices which is based on belief of local people. As the traditional practices were built upon constant observation and interaction with environment , these are eco-friendly and maintains sustainable farming environment. ITK's which aids agriculture were formulated for various purposes, one of which is mitigating the pest population in agro-ecosystem. This method of pest control maintains the ratio pest and its natural enemies.

Crop-Wise ITK Practices

1. Rice:

a. Spraying Cow-dung suspension to control thrips.
b. Erection of bamboo sticks to attract predatory birds which controls yellow stem borer and Swarming Caterpillar
c. Dragging of Kerosene dipped rope to control Rice caseworm.
d. Slices of Pummello, chopped leaves of Indian rhododendron, grounded bark of drumstick spread over the field to repel yellow stem borer.
e. Burning of bicycle tyres and fermented snail bait used to repel Rice ear head bug.

2. Pulses and stored grains:

a. Leaves of Naithulasi and chilli fruits are stored along with gunny bags to control storage pests.
b. Red earth treatment followed by Sun drying prevents bruchids.
c. Mixing of Ash before storage
d. Storing of Split grains to prevent internal feeders of grains.
e. Coconut oil mixed with black gram or green gram to control bruchids.

3. Coconut:

a. Meat trap- Abnominal part of female crab filled with poison made of *Croton tigliuum*
b. Fire flames to attract and kill moths
c. Palmyrah leaves to repel rodents in coconut field
d. *Coleus aromaticus* planted in coconut plantation to avoid.

ITK-Based Botanicals

Coriander extract: It is prepared by crushing 200 gm of coriander seeds and soaked in 1 litre of water for 10 minutes and add 2 liters of water before spraying. To control spider mites.

a. Marigold and chilli extract: It is prepared by soaking 500g of chopped marigold and 10 chilli pods in 15 litres of water overnight. Filter and dilute with water in the ratio of 1:2 ratios and add few drops of soap solution at the time of spray.

b. Turmeric extract: Soak 20 gm of shredded rhizome in 200 ml of cow urine and dilute with 2-3 litres of water and add few drops of soap solution before spray. To control aphids, caterpillars and red spider mites.

c. Chinese chaste tree Vitex: 2 kg of vitex leaves soaked overnight in 5 litres of water and boil the mixture for 30 minutes and add few drops of soap solution before spray. To control Diamond backed moth, hairy caterpillars, rice leaf folder and rice stem borer.

d. Neem decoction: It is prepared by mixing 1 to 3 gm of ground neem seed/leaf in a litre of water and soak it for 12 hrs. To repel lepidopteran pests in paddy field.

ITK-Based Traps and Baits

1. Rhinoceros beetle trap: Mud pot containing 250g of castor cake mixed with water in the ratio 1:3 is buried near to base of coconut tree in such a way a that mouth of mud pot is levelled with soil. It attracts rhinoceros' beetle. It is also added with few pineapple pieces. 2-3 pots are placed per hectare.

2. Rice Ear head bug trap: Few pieces of jackfruit and dead crabs are fixed in bamboo sticks are placed in the rice fields before milking stage, it attracts Ear head bugs.

3. Red palm weevil trap: Chopped mid rib of coconut leaf mixed with 1 litre of water, 100 gm jaggery and 10 gm tobacco powder is filled in a mud pot. 3-4 such pots with a hole at its base placed in the plantation.

ICAR's Initiative on Documenting ITKs

The Indian Council of Agricultural Research (ICAR) implemented a Mission Mode Project on 'Collection, Documentation and Validation of Indigenous Technical Knowledge' under National Agricultural Technology Project (NATP) during 2000 to 2004. This project aims to collect, document and validate the ITK's practiced and followed in different sectors of agriculture in various parts of country.

As a part of this initiative, following documents have been published.

a. 3 volumes of inventory on ITK's
b. 1 volume on validation of ITKs
c. Cross-Sectoral Validation of Indigenous Technical Knowledge in Agriculture
d. Traditional Knowledge in Agriculture.

Conclusion

In modern agriculture, traditional knowledge is still playing a vital role in pest Scientific validation of these ITKs to be done at greater extent to widen the usage of these practices as most of which are based of easily available natural resources and could be able to adopted in various parts of the country.

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Nematode Problem and their Management in Protected Cultivation

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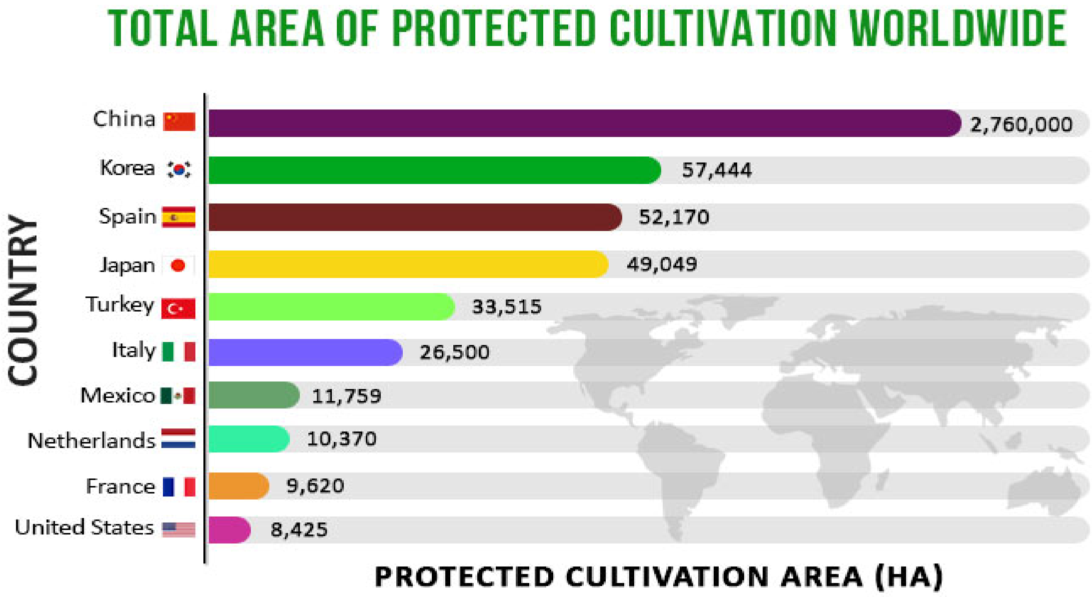
Protected cultivation is a process of growing crops in a controlled environment which gives manifold increase in yield per unit area. This means that the temperature, humidity, light and such other factors can be regulated as per requirement of the crop. This assists in a healthier and a larger produce. This controlled environmental condition is managed with green house, shade net, plastic tunnel and mulch for the cultivation of high value crops.

The protected cultivation has shown high productivity & better quality produce round the year cultivation in a hostile environment and use of microclimate to fulfil the individual requirement of plant. Continuous growing of same crop increase problem of soil borne pest and diseases including plant parasitic nematodes .The problem of nematode after 3-4 crops increases due to build up of initial population of root-knot 15-20 L2/g soil. In polyhouses life cycle of root-knot is shorter (18-20 days) 5-6 generations than open field cultivation (25-30 days) 3-4 generations of root-knot nematode.

Protected cultivation is an emerging technology for raising vegetable and ornamental crops. Due to controlled environmental condition and continuous growing of crops, the root-knot nematode (*Meloidogyne*spp.) has emerged as a major problem, causing enormous yield loss. The damage progressively increases if proper INM measures are not followed during the polyhouse cultivation of crops.



India has shown an overall growth of around 70,000 ha area under protected cultivation with 10% increase every year.

Symptoms

General symptoms from nematodes include yellowing, stunting, and wilting, accompanied by a yield decline. Bulb and stem nematodes produce stem swellings and shortened internodes. Bud and leaf nematodes distort and kill bud and leaf tissue. In some cases, such as with SCN, yield loss may take place with no visible symptoms.

		
Water and Nutrient Stress	**Premature Wilting**	**Leaf Yellowing (Chlorosis)**
		
Plant Stunting	**Irregular Symptom (patches)**	**Galling on roots**

General Symptoms Caused by Nematodes after Infection

Integrated Management Practice of root-knot nematode.

a. Crop rotation with non-host crop (baby corn) & marigold as antagonistic crop.
b. Shifting of bed on path vice versa every season.
c. Use okra as trap crop before cucumber/tomato/capsicum.
d. Use resistant varieties if available.
e. Prepare enriched 10 Q FYM or Neem cake with 2 kg each of *Purpurocillium lilacinum, Trichoderma viride* & *Pseudomonas fluorescence* & apply @ 200g/m2 at the time of sowing or transplanting in polyhouses.
f. Also drench 1lt/pt of enriched FYM/Neem cake amounting 20 kg in 200 lt water after 20-20 days till last harvest.
g. Spot application of Nimitz @ 2 g/seed/pt at sowing or transplanting time or Vellum 250 ml/4000m2 polyhouse at sowing time with drip irrigation.

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Diseases of Vegetable Crops Under Protected Cultivation

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As per the 2 nd advance estimates for 2022-23, the total horticulture production is estimated to be 351.92 Million Tonne, surpassing the total foodgrain production of 329.69 Million Tonne during the year. At present, India is the second largest producer of vegetables and fruits in the world. Out of it India's contribution in terms of area, production and productivity is 634.4 thousand hectare, 12433.2 thousand tonnes and 19.6 t/ha respectively. Due to increasing demand and to maintain year round supply of vegetables, protected cultivation thus provides a better alternative with huge future prospects. Due to increasing demand and to maintain year round supply of vegetables, protected cultivation thus provides a better alternative with huge future prospects.

Polyhouse is a framed structure having 200 micron UV stabilized transparent or translucent low density poly ethylene or other claddings which create green house effect making microclimate favourable for plant growth and development. The structure is large enough for person to work inside, can be made in different shapes and sizes using locally available materials like steel, alluminium, brick or their combination for its frame. Insect poof net and shading materials are used to keep insects at bay and to lower temperatures in summer. Though greenhouse technology is more than 200 years old, but in India, the technology is still in its infancy stage. The area under green house cultivation is 2000 hactares including 500 ha net house, shed house and 1500 ha green house, which is mainly in Maharashtra, Uttarakhand, Karnataka, Jammu & Kashmir. There appears ample scope for increasing area under low cost polyhouse in many folds in peri urban areas for production of high value vegetables during off season for taking advantage of high price of available market in nearby cities. Crops like tomato, cucumber, capsicum etc. is being grown on large scale under polyhouse condition.

Fungal Diseases

Fungal diseases constitute one of the biggest group of foliar pathogens causing immense damage under protected environment. It was found that the incidence and severity of diseases vary considerably under protected environment when compared to open field. As observed in tomato, *Phytophthora infestans*, *Pseudocercospora fuligena* and *Fulviafulva* causing late blight, black leaf mold and leaf mold respectively were observed to be of higher significance under polyhouse condition. Further, the notion of early and late blight was found to be obscure under polyhouse condition. Since it was observed that late blight appears early in the crop season whereas early blight appears late during crop season. This may be attributedto the fact that temperature and humidity are nearly balanced inside protected structure, even when outside field temperature is comparatively low and so on. *Alternariaalternata* is found to be a major disease affecting fruits. Capsicum on the other hand is found to be infected primarily by *Colletotricum capsici, Cercospora capsici, Pythium, Fusarium* and *Phytophthora spp.*, *Stemphylium solani* and *Stemphylium lycopersici, Sclerotium rolfsii, Verticillum alboatrum and V. dahlie, Phytophthora capsici, Leveillulataurica* and *Botrytis cineria* causing anthracnose, leaf spot, damping off, grey leaf spot, stem rot, Phytophthora blight, powdery mildew and grey mold respectively. Cucumber also attracts a considerable quantum of fungal pathogens. Out of which downy mildew (*Pseudopernospora cubenses*), Powdery mildew (*Ersiphe cichoracirum and Sphacelotheca fuligena*), Alternaria leaf spot (*Alternaria cucumerina*), Anthracnose (*Colletotricum lagenarium*) and Damping off (*Pythium spp.*) are important. Survival of pathogen is also enhanced inside polyhouse due to availability of host because of longer growing season.

Bacterial Diseases

Bacterial diseases are less frequent but under high moisture and poor irrigated condition may cause huge damage. *Erwinia carotovora ssp. carotovora* (Bacterial soft rot) ,*Xanthomonas campestris pv. Vesicatoria*

(Bacterial spot), *Ralstonia solanacearum* (Bacterial wilt). *Pseudomonas syringae* pv. *lachrymans* (Angular leaf spot), *Erwinia tracheiphila* and *Ralstonia solanacearum* (Bacterial wilt) are pronounced to name some.

Viral Diseases

Tomato, cumcumber and capsicum are very sensitive to virus diseases under protected environment. It often spreads in the plantation by insect vectors such as whitefly, thrips and aphids. The damage caused by the virus is usually much greater than the mechanical injury caused by the insect vector. Plant tissue damaged by a viral disease does not die immediately. The most important symptom of viral infections is the light (white or yellow) colour of the leaves, or a mosaic pattern of light and darker shades of green on the leaves. In many cases, viral disease leads to dwarfed growth, rosette formation or other strange stem, fruit and leaf deformations. The symptoms of viral infections are often not found everywhere in a cultivated field but rather in patches and also sometimes without symptoms. Viruses prevalent among greenhouse crops include Tobacco mosaic virus or tomato mosaic virus (TMV or ToMV), Cucumber mosaic virus (CMV), Tobacco etch virus (TEV), Potato virus-Y (PVY), Potato leafroll virus (PLRV), Tomato spotted wilt virus (TSWV), Alfa- Alfa mosaic virus, Pepper veinal mottle virus (PVMV), Pepper mild mottle virus(PMMY), Chilliveinal mottle virus (CVMV Or Chivmv), Tomato yellow leaf curl virus (TYLCV), Tomato Big-Bud mycoplasma (TBB).

Management

Proper field sanitation is the one of most important management strategy, since once the build up of innoculum occurs inside polyhouse it is very difficult to manage it. So prevention is always better than cure. Use disease-resistant varieties. Reduced incidence of leaf wetness by staking plants providing ample spacing between plants to allow for good air movement, and avoiding overhead irrigation. Judicious use of chemicals with least toxicity recommended specially for polyhouse cultivation shoud be done. Chemicals like chlorothalonil, cymoxanil and azoxstrobulin are prohibited in polyhouse grown tomato and thus should be avoided. As for viruses scout fields for the first occurrence of virus disease. Where feasible, pull up and destroy infected plants, but only after spraying them thoroughly with an insecticide to kill any insects they may be harboring. Use reflective mulches to repel insects, thereby reducing the rate of spread of insect-borne viruses. Monitor vector population early in the season and apply insecticide treatments when needed. Minimize plant handling to reduce the amount of virus spread mechanically.

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Influence of Vascular Arbascular Mycorrhizal Fungi on Plant Health Management

Article ID: 48926

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What are Mycorrhizae?

The word Mycorrhiza originated from the Greek word "Mykes" means fungus and "Rhiza" means roots. Mycorrhiza is a symbiotic relationship between soil fungi and fine plant roots. Since, the association is mutualistic, both the organisms get benefited from the association. The fungus receives carbohydrates (sugars) and growth factors from the plants, which in turn receives many benefits, including increase nutrients absorption. In this association the fungus takes over the role of the plants root hairs and act as an extension of the root system. Among important plants that associate with mycorrhizal fungi are corn, carrot, potato, bean, soybean, other legumes, tomato, pepper, onion, garlic, sunflower, strawberry, citrus, apple, peach, grape, cotton, coffee, tea, cocoa, sugarcane, forest spp., wild plants and even weeds.

The members of *Glomu*s sp. are widely spread in their occurrence and distributed mostly in cultivated soil. Under natural condition about 90 % of all plant species are mycorrhizal.

Types of Mycorrhizal Association

1. Ectomycorrhiza:

a. Ectomycorrhiza
b. Ectendomycorrhiza
c. Arbutoid
d. Monotropoid

2. Endomycorrhiza:

a. Arbascular.
b. Ericaceous
c. Orchidaceous.

Significance of VAM

1. Increases overall absorption capacity of roots. Soil conditioning.
2. Increases mobilization and transfer of nutrients from soil to plants. VAM fungi have the capacity to breakdown phenolic compounds in soils which can interfere with nutrient uptake.
3. Increases establishment, nodulation and atmospheric N fixation capacity of plants in legumes.
4. Root colonization by VAM fungi can provide protection from parasitic fungi and nematodes by modification of plant pathogen relations.
5. Increases production of plant growth hormones.
6. VAM benefits can include greater yield, nutrient accumulation, and/or reproductive success. Impart greater drought tolerance to plants.

Interaction with Host Plants

1. Appressoria are formed by the fungal hyphae to gain entry into root epidermal or exodermal cells.
2. Hyphae are produced, which thread their way between the cortical cells of the root and propagate.
3. Most AM fungi produce intercellular hyphae once inside roots.
4. The hyphae run within air channels then cross the wall of cortical cells with the aid of penetration pegs to become intracellular.
5. This results in the initiation of arbuscule formation
6. The cell wall of the fungi becomes progressively thinner as the colonization develops.

Benefits of VAM Symbiosis

1. Environmental benefits: Application of VAM fungi show difference in growth performance of mycorrhizal and non mycorrhizal plants. Number of branches and yield improved significantly in VAM colonized plants compared to uninoculated plants.

2. Transfer and Uptake of Nutrients: VAM fungi improve in the uptake of nutrients i.e. N, P, Ca and Mg in all plant species.

3. Reduced Incidence of Root Diseases: VAM fungi help to reduce diseases incidence in crop plants. Ex. disease severity of banana root rot reduced due to inoculation of VAM fungi in banana.

4. Mechanism to Control Root Pathogens: It helps to control root or soil born pathogens. Ex. The development of nematode stages in the roots and the nematode numbers in soil were suppressed by VAM fungi. It also helps in plant growth and reduction in root galling and nematode population. Mycorrhizal inoculations not only reduced the percentage of disease incidence but also improved the fruit yield and fruit weight.

5. Protection Against Environmental Stress: VAM fungi also protect crop from environmental stress. Ex. mycorrhizal plants of salinity stress condition showed increase in root length, shoot length and plant fresh weight were found to be increased in mycorrhizal plants at salinity condition.

Conclusion

VAM are most important for the growth of agricultural crops as well as healthy ecosystem. Different species of VAM fungi viz. *Glomus fasciculatum, Glomus monosporum, Glomus etunicatum* differ in their ability to manage the fungal and nematode diseases in plants. Pre-inoculation with VAM fungi was found effective in reducing disease severity and enhanced the nutrient absorption capacity and improved the vigour of the plants. VAM can be used as a biological control agent in the development of package of practices under IPM regime. The benefits of VAM symbiosis can be enhanced by changing agricultural practices/cropping system which may increase colonization and mycorrhizal abundance. It is important to commercialize the VAM fungi and application of available VAM culture in sterilized nursery, raising of seedlings for early establishment of endophytes.

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Cropping System Approaches in Conservation and Utilization of Biocontrol Agents in IPM

Article ID: 48927

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Many of the tactics available today for insect pest management in agriculture, resulting in high productivity may have harmful effect on environment, farmers and consumers. Indiscriminate use of pesticides results in development of resistance in pests and creates new pest complex. So, there is an urgent need to find out alternatives to restore and maintain ecological integrity of the environment. Biological control is an important tool of IPM. Cropping system approaches, which in turn lead to vegetational diversity, play a central role for the conservation of bio-control agents. If one considers it broadly, cropping system is the crop production activity of farm. The goal of cropping system is to manage the habitat in such a way that create a suitable ecological infrastructure within the agriculture landscape to provide resources such as food for natural enemies, alternative preys or hosts and shelter from adverse condition. Various types of habitat manipulation such as cultural practices, trap crop, introducing weed strips, strip or border of flowering plants, cover crops, mixed cropping interspersing, intercropping etc. when carefully selected can encourages enemies and reduce pest incidence.

Cropping Pattern

1. Intercropping: Growing two or more crops simultaneously, on same piece of land, with definite row pattern is known as intercropping. The two crops should not have the same pest problems (like Tomatoes and Okra are affected by same fruit borer). If cotton intercropped with groundnut and mung bean, higher egg parasitism (*Trichogramma* spp.) and larval parasitism (Apenteles and Campoletis) was observed as well as higher number of predators was observed than the monocropping. While, more activity of predatory spider, was observed when cotton was intercropped with cluster bean, where as coccinellid was more in cotton+ cowpea intercropping system. whereas, egg load of *chrysoperla carnea (stephens)* also found higher in cotton in different intercropping system. It is better to have a row of crops which acts as pest repellent like Garlic, Marigold, Onion, etc.

2. Trap cropping: A trap crop is a plant that attracts agricultural pests away from nearby crops. It saves the main crop from destruction by pests without the use of pesticides and Establishment of a preferred host of a specific pest within or adjacent to main crop is useful to protect the main crop from the attack of key pest. A trap crop is a crop of a plant that attracts pests, diverting them from nearby crops. Pests aggregated on the trap crop can be more easily controlled using pesticides or other methods. Marigold as a trap crop planted with tomato gave higher rate of parasitism by *T. chilonis* in the eggs of *H. armigera* as compared to tomato alone. Whereas, alfalfa as a trap crop when strip intercropped and interplanted with cotton conserved the natural enemies and the benefit of these natural enemies could be transformed to the cotton. The higher parasitism of stem borers by *Cotesia sesamae* (Lin.) in maize was observed, when intercropped with molasses grass.

3. Border cropping: A crop grown on the border of the main crop help to regulate insect pest population by physical and biological interference. For example: maize supported greater number of predators as compared to cotton monocrop. The border crop can consist of a relatively tall species that is planted around the perimeter of a primary crop. Living barriers include graminaceous species, like sorghum (Sorghum bicolor), Johnson grass (Sorghum halepense), corn (Zea mays) and elephant grass (Pennisetum purpureum). Has been successful for vector management with non-persistent aphid transmitted viruses as aphids lose their infectivity few minutes after acquisition

4. Mixed Cropping: Growing two or more crops simultaneously on same piece of land. More number of predators were found in cotton interspersing with 10% cassia + *c. carnea* than cotton alone.

5. Relay Cropping: Growing two or more crops in sequence in the same piece of land during the season, helps in avoiding pest population and survival natural enemies. The relay cropping system involving advanced planting of maize prior to removal of cotton and sunnhemp, prior to removal of maize helped *G. ochropterous* to carry over its activity from one cropping season to another.

6. Crop Spacing: Spacing can affect the relative growth rate of plants and development of environments favorable to insect population growth. Ex. Aphids were found to be less of a problem when plant spacing was less than 0.8 m, whereas a spacing of 1.0 to 1.5 reduced flower thrips and the pod borer in cowpea.

7. Change in date of Sowing: If the crop phenology can be changed to be asynchronous with insect events like egg laying and larval development, insect numbers can be reduced drastically. Modifying planting dates is a classical example. Ex. Early sown sorghum escapes serious damage by the midge, *Contarinia sorghicola* (Coq.) whereas the late sown crop usually suffers heavy loss. Whereas, late transplanted rice crop is severely affected by gall midge, while early sown one escapes the infestation.

Other Methods

1. Manipulation of non-crop vegetation: Non-crop vegetation as ground covers or strips adjacent to fields may influence biocontrol by improving conditions or food availability within crops. Ground cover also lowers soil temperature and raises relative humidity, more favorable for some Natural Enemies. Nectar from flowers may serve as a food source for natural enemies (nectar and pollen).

2. Mulches: Reduces the insect's ability to find the crop. Inert ground covers such as plastics, sawdust, straw and rice husk mulches interfere with visual host-finding or suicidal attraction to the sun-heated mulch.

3. Soil Management: Soil management practices such as tillage, fertilizers, or p^H treatments may affect pests and /or natural enemies. Manure and fertilizer (instead of chemical fertilizer) has been shown to increase carabid beetles and some predacious mites. p^H of soil can affect persistence of viral pathogens. Ex. NPV of cabbage looper is more persistent in less acidic soils: recommend liming of soils.

4. Tillage: Tillage immediately after harvest of cereal killed 95% of the parasitoid (*Tetrastichus*) and lead to an outbreak of cereal leaf beetle compared to areas where cereal crops were used as a companion to alfalfa with no tillage.

5. Water Management: Irrigation increases humidity in the crop and may be beneficial to certain natural enemies, especially entomophagous fungi. Ex. outbreaks of two fungal pathogens (*Erynia spp*.) on pea aphids occurred on ground covers in pecan orchards on overhead irrigation, but not drip irrigation. Sprinkler irrigation has been found to be effective in suppressing foliage feeding insects like potato tuber moth, *Pthorimaea operculella* and *Plutella xylostella* in cabbage by deterring their mating process, egg laying and causing mortality of their neonatal stages

6. Crop Residue Management: Crop residues are often burned or tilled to gain some benefit, may be just traditional way of clearing soil. For natural enemies that over winter in residue, this may reduce population. Ex. in India, parasitoids of sugarcane leafhopper are eliminated when crops are burned: if residues are left, parasitoids control pest

7. Providing Artificial Diet: Direct addition of food source to the environment may be beneficial Ex: egg parasitoid of Colorado potato beetle is ineffective early in season when aphids don't provide honeydew so, application of sugar or molasses may increase parasitism Ex: application of hydrolyzed proteins mixed with water and sugar increased lacewing reproduction in cotton

8. Entomophage Park for in situ conservation of biological control agents: Host plant like Cassia, Maize, Marigold, Tobacco, Senna, Matsagandha, Amaranthus, Sun hemp, and Brinjal etc., harbor potential arthropod natural enemies. Entomophage park ensured conservation of as many as 30 species of arthropod natural enemies.

Conclusion

Natural enemies are vital part of agro-ecosystem which keep the pest population below equilibrium level by adopting various cropping systems namely intercropping mixed cropping, relay cropping and trap cropping. It is helpful in conservation and multiplication of various bio-control agents which will be helpful in reducing the pest population below the equilibrium level without any harmful effect on environment.

Future Thrust

Integration of the cropping system approach of conservation and manipulation techniques in IPM modules should be done and be tested for proper pest management practices for different crop pests.

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Insect Colour – Wellbeing in Social Insects

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Introduction

Insects have different colors that serve various purposes, such as protection, reduce visibility to enemies and signaling. There are two types of coloration: structural and pigmentary. Social insects belong to two orders; Hymenoptera and Isoptera have some advantageous features based on their colouration.

Body Protection (Physical, Immunological)

Darker insect cuticles are thicker and protect against pathogens and parasites. Melanin pigments help with coloration and immunity. For example, *Diacamma sp.* females have black cuticular pigmentation, while males have yellowish-brown, providing physical protection and sexual dimorphism.

Camouflage (Cryptic Coloration)

Ants use camouflage to blend in with their environment and reduce the risk of being preyed upon. They use colors such as black, brown, or grey to match tree bark, soil, and rocks. *Basiceros manni- Myrmicinae* species bonds soil particles with brush and holding hairs to achieve a greyish tint and blend in, a survival adaptation known as crypsis.

Basiceros manni

Warning Coloration

Coloration is associated with conspicuous outward appearance and poisonous mechanisms of self-defense. For example, the Intensity of black and yellow colors in *Polistes* wasps was connected to their toxicity level.

Batesian Mimicry (Mimic is Restricted to Palatable Species)

Some species of flies, beetles, and spiders started mimicking social insects to protect themselves from predators. The *Ecitomorpha* and *Ecitophya* beetles are examples of species that use mimicry to resemble the army ant *Eciton burchellii.*

		
Ecitomorpha	***Ecitophya***	***Eciton burchellii***

Less chemically defended social insects mimic those that are strongly protected e.g., the Australian carpenter ant *Camponotus bendigensis* resembles the Jack Jumper bull ant *Myrmecia fulvipes*in appearance and ability, possessing a powerful sting and capable of short-distance jumps.

	
Australian carpenter ant	**Jack Jumper bull ant**

Mullerian Mimicry

Model and mimic are unappetizing to predators and ingestion of eitherresults in predator avoidance of both. Chemically-defended species often have similar physical traits, e.g., bumblebees mimic a few well-defined species.

Individual Quality and Mate Choice

Color signals are used by wasps to assess the quality of rivals, choose mates, and recognize individuals. In *Polistes gallicus,* social status is assessed using color signals. Males of *P. dominulus* use yellow abdominal spots as sexual signals, with females preferring smaller and eclipsed shapes. In *P. satan,* brown facial color patterns indicate fertility and nest maintenance. In *P. simillimus*, males with more black pigmentation on their heads have a higher chance of mating.

Thermoregulation

Thermoregulation is closely linked to the physiology of insects. In colder environments, individuals tend to be darker in color, while in warmer environments, they tend to be lighter. For instance, the Australian ant species *Iridomyrmex purpureus* has a typical morph that prefers wet conditions, while the blue morph is better adapted to dry habitats. On the other hand, the North American ant species *Formica neorfibarbis gelida* has dark, small workers that prefer foraging in the morning when there is less sunlight and heat, while they tend to forage during the afternoon in warmer conditions.

UV Resistance

Individuals with darker skin or fur are better protected from exposure to sunlight. This applies to many species, including certain types of wasps and bees. For example, studies have shown that darker *Polistes* wasps tend to live in colder climates at higher latitudes. Similarly, dark-colored stingless bees can warm up faster than their lighter-colored counterparts.

The Assisting Role of Social Insect's Coloration

Species identification is important for ecological surveys and biomonitoring. For example, *Forelius damiani and Guyana*. Red wood ants (*Formica lugubris*) have less melanized heads in heavy metal-polluted environments, and *Vespula vulgaris* has decreased melanized facial color markings in industrial regions.

Conclusion

The evolutionary function of coloration in ants and bees remains one of the knowledge gaps.The current rapid development of databases, digital software, and artificial intelligence allows creation the of large-scale color research projects of high ecological importance. Further discovering coloration variability in social insects might favor progress in species identification, biomonitoring, and other research fields such as environmental ecology, biochemistry, biophysics, and biomaterial design.

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Environmental Sensors for Detection of Storage Pest

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Introduction

About 10% of India's grain is lost after harvest due to various factors. Insects alone cause 10-20% of storage losses. An IoT monitoring system with sensors was used to evaluate the atmosphere inside warehouses. The system records temperature, humidity, and time stamp data on a microSD card. This prophylactic measure can ensure a better way for food safety.

Kinds of Sensors Used in Grain Storage

There are multiple kinds of sensors and IoT systems available today for various activities inside the warehouse. Light, Temperature, Humidity sensors, Infrared sensors, Water Detection Sensors, Motion and occupancy sensors, Tilt sensors, Acoustic Sensors and gas sensors are generally used in storage structure for multiple reasons like detecting excess moisture to avoid fungal growth, excess temperature to avoid wrinkling and development of insect pest, to prevent entry of rodents, and to eliminate germination of grains in storage.

Environmental Sensing for Detection of Insect Pest

Monitor and assess the deviation of physical state, conditions and surroundings. Temperature, Relative Humidity, Moisture, Heat, Light, and Gases like CO_2, O_2, Pressure sensors were available for the prospecting of pest detection in large warehouses.

Temperature Sensor

It is an electronic device which provides an Analog voltage of the temperature on which it is mounted. A best example is a thermistor. Contact sensor and Non-contact sensor are the two types of temperature sensor used.

The working principle of temperature sensors is that they are incorporated with a digital interface that is used to receive data and send the alert to the IoT system if any deviation is shown from calibrated data. Wireless sensors were more convenient than conventional ones. When the temperature increases inside the storage structures, it supports the development of insect pest and heat is produced which is helpful in detection and the process is laid out for better prevention mechanisms.

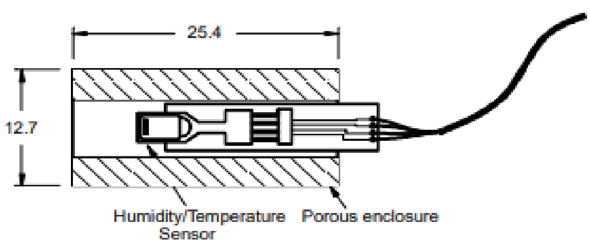

Figure 1. SHT75 Humidity / temperature sensor

Relative Humidity Sensors

Each sensor consisted of a capacitive polymer-sensing element for RH and a bandgap PTAT (proportional to absolute temperature) temperature sensor. RH and temperature outputs were internally coupled to a 14-bit analog to digital converter and a serial interface circuit on a singular chip. Rated absolute accuracy of the sensor was ±2.0% RH and ±0.4°C for most ambient conditions. Because sensors may be susceptible to grain dust and free moisture, individual sensors were enclosed in a porous plastic tube. These sensors are useful in detection of disease compared to pest detection.

Gas Sensors

It generally helps in monitoring the warehouse gas composition such as carbon dioxide, oxygen to maintain the appropriate environment inside the storage structure. Sensors such as Carbon sensor and Oxygen sensor are used as AQI monitoring systems for detectors of pest. Even a slight change in the gaseous state inside the warehouse leads to deterioration of grain apart from pest incidence. Instruments capable of sensing CO2 concentrations of 0.1% will detect spoilage during stored grain in 80% of deteriorating bulks in farm granaries. With the advent of microelectronic technology, CO2 micro-sensors can be fabricated and deployed inside grain bulk which will measure the intergranular air composition. Carbon di-oxide is also used as fumigant against pest, where the Carbon di-oxide level is measured and calibrated later the sensor near exhaust fan or ventilator will notify the change in CO_2 level. For oxygen sensors to detect the freshness of the grain and also to avoid respiration of grains the CO_2 level will be increased inside the storage structure, when there is change in the EC of Electrode used in the Oxygen sensor be metered and then get alarmed to the IoT system.

Conclusion

Wireless sensors can be used to measure grain quality parameters during storage. However, acoustic sensors lack the capacity to detect stages such as egg, pupa, and initial larval instars, which can be avoided by proper usage of environmental sensing.

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Fish Farming with the Help of Biofloc Technology (BFT)

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Biofloc technology indeed represents a significant advancement in aquaculture, particularly in addressing issues related to water quality and resource utilization. By fostering the growth of heterotrophic bacteria within the culture system, biofloc technology enables the efficient recycling of nutrients, thereby reducing the need for water exchange and minimizing pollution. The core principle of biofloc systems involves creating an environment where heterotrophic bacteria thrive on organic matter, such as uneaten feed and feces, within the water. These bacteria form aggregates known as bioflocs, which serve as both a biological filter and a source of additional nutrition for cultured organisms.

The BIOFLOC System

The biofloc system was created on the same premise as conventional waste water treatment facilities. According to this theory, microorganisms grow from the excrement of cultured organisms and convert it into simpler organic products that can be eaten by other organisms and eventually make their way back up the food chain (Avnimelech & Kochba, 2009). Because the "biofloc" system in aquaculture can be used as a food supplement for the commercial organisms being cultured, which adds value by increasing the food consumption rate, it lowers maintenance costs and functions as a retention trap for the nutrients in the pond (Azim & Little, 2008).

The compound known as "biofloc" is composed of 30 to 40% inorganic matter, such as colloids, organic polymers, and dead cells, and 60 to 70% organic matter, which includes a heterogeneous mixture of microorganisms (fungus, algae, protozoans, and rotifers). They are porous, asymmetrical, and have a maximum size of 1000 µm. They also permit fluids to pass through them. (Chu & Lee 2004).

Biofloc Development

Biofloc development involves the creation of a matrix to encapsulate microorganisms, providing protection from predators, facilitating access to nutrients, and serving as a substrate. This matrix is typically composed of biological polymer substances. These substances help bind the components of the biofloc together, creating a stable environment for the microorganisms to thrive. Additionally, the matrix plays a crucial role in maintaining water quality within the system by facilitating nutrient cycling and waste removal. Overall, the development of bioflocs relies on the presence of these biological polymers to support the growth and sustainability of the microbial community (De Schryer et al. 2008).

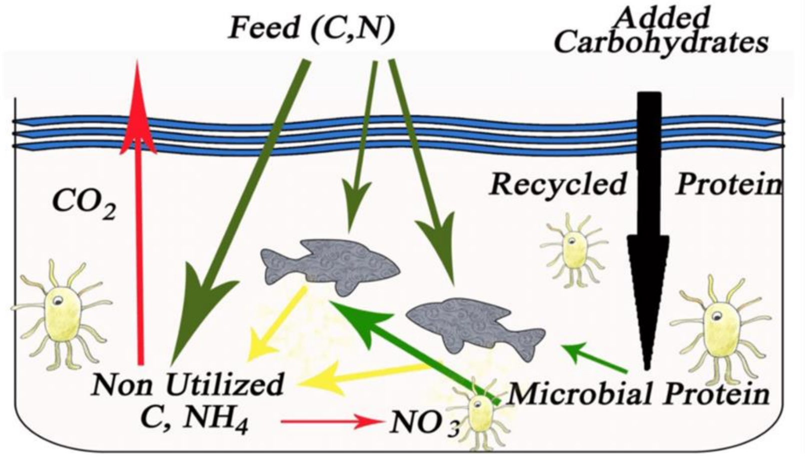

Fig. 1. "Biofloc" system operation in a pond (Avnimelech, 1999)

There are several key benefits associated with biofloc technology:

Water Quality Management: By maintaining high levels of microbial activity, biofloc systems help to rapidly metabolize organic waste, ammonia, and other nitrogenous compounds, thereby improving water quality and reducing the risk of disease outbreaks.

Water Conservation: Since biofloc systems minimize the need for water exchange, they significantly reduce water consumption and associated costs. This is particularly important in areas where freshwater resources are limited or expensive.

Nutrient Recycling: The microbial community in biofloc systems plays a crucial role in converting organic waste into biomass, which can then be utilized as supplementary feed for cultured organisms. This closed-loop approach enhances nutrient utilization efficiency and reduces the reliance on external inputs.

Enhanced Productivity: Biofloc technology has been shown to support higher stocking densities and faster growth rates compared to traditional aquaculture systems. This increased productivity can lead to higher yields and improved profitability for aquaculture operations.

Value-added Products: In addition to serving as a nutrient source for cultured organisms, bioflocs themselves can be harvested and processed into value-added products, such as protein-rich biomass for animal feed or microbial supplements for aquaculture systems.

Overall, biofloc technology represents a sustainable and economically viable approach to aquaculture that aligns with the principles of resource efficiency and environmental stewardship. As the industry continues to grow and evolve, innovations like biofloc systems are likely to play an increasingly important role in meeting the growing global demand for seafood while minimizing environmental impacts.

Conclusion

The biofloc technology (BFT) is a sustainable aquaculture practice that utilizes microbial communities to maintain water quality in aquaculture systems. In summary, biofloc systems employ dense populations of heterotrophic bacteria to convert organic matter, such as uneaten feed and waste, into microbial biomass known as bioflocs. These bioflocs serve as a natural food source for cultured organisms, reducing or eliminating the need for external feed inputs. Additionally, biofloc systems enhance water quality by removing nitrogenous compounds through microbial processes, thus minimizing the environmental impact of aquaculture operations. Overall, biofloc technology offers a promising approach for improving the efficiency and sustainability of aquaculture production systems.

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Effect of Entomopathogens on Storage Pests

Article ID: 48931

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Introduction

Advancement of technologies in agriculture has led to increased food production every year. In many countries, major portion of the food grains produced, were stored for contingency and regular supply. Food security is one of the major concerns in many countries. Many storage structures are available for grain storage. Long-term stored commodities are easily prone to many biotic and abiotic stress. Among biotic factors, pests play a major role in causing grain losses and deterioration of quality and quantity of grains. Insects cause both direct and indirect losses by its feeding nature. Its contamination leads to the further invasion of other microorganisms such as fungi, bacteria and yeast. Those microorganisms make products to completely unpalatable by producing toxins, foul odour etc. An ideal temperature, moisture, relative humidity should be maintained to avoid infestation. Apart from insects, rodents also cause damage to stored food through direct damage, wastage and contamination and so affect both grain quantity and quality but its faecal pellets, urines, body hairs etc. Many management practices have been used to control storage pests. Those pests can be managed by using pesticides. But its residual effects pose a major risk to environment and human health. To overcome these problems, entomopathogens are incorporated. These are parasitic microorganisms that are capable of killing wide range of insects. These are used as a biocontrol agent and serve as a safer, more effective and eco-friendly method than chemical insecticides. Entomopathogens (ENMs) have great potential for pest suppression due to their remarkable properties.

Entomopathogens

Entomopathogens are microorganisms that are pathogenic to arthropods such as insects, mites and ticks. Several species of naturally occurring bacteria, fungi, nematodes and viruses infect a variety of arthropod pests and play an important role in their management.

Groups of Entomopathogens

Bacteria Virus Protozoa	Fungi Nematodes

Group 1

1. Bacteria: Bacteria may multiply throughout the **tissues and body fluids** of the host causing septicemia.

The crystalliferous bacteria (*Bacillus thuringiensis*) may kill their hosts purely on the basis of the activity of their associated toxins.

Bacillus thuringiensis Berliner, used for the control of stored insect pests, was isolated from diseased larvae of the **Mediterranean Flour moth**, *Ephestia kuehniella* Zeller in 1911.

Demonstration by Mcgaughey:

a. In bulk wheat and corn infested by *P. interpunctella* and *E.cautella* –observed good control when treated surface layers of the bulk with dust or aqueous solution of *Bt.*
b. Depth of treatment-100mm. Mix well to ensure even treatment
c. Recommended dose : 125mg/kg (silos storage)
d. Viability is slightly reduced after one year storage

2. Virus: Viruses are quite specific in their sites of development and multiply only in certain tissues within the body of their host.

A **Nuclear polyhedrosis and a Granulosis viruses** have been isolated from *E.cautella.*

Both severely infect *P.interpunctella;* whereas GV from *P.interpunctella* does not cross-infect *E. cautella.*

Another NPV has been isolated from *C.cephalonica* but it is not known whether it will cross-infect other moths.

3. Protozoa: They are the severe pathogens of the coleopterans.

Nosema whitei - *Tribolium castaneum and T.confusum*

N.oryzaephili- *Oryzaephilus surinamensis*

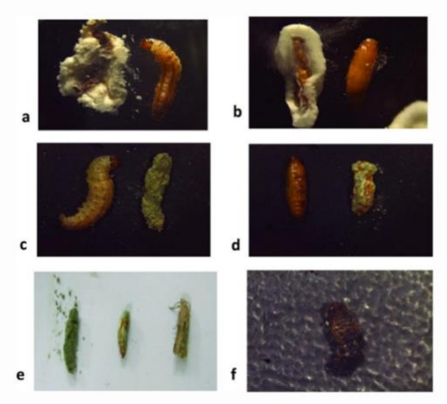
Mattesis trogoderma- *Trogoderma sp.*

Group 2

1. Fungi: It infests pest by saprophytic feeding, spore germination and sporulation.

Mostly belong to the genera *Baeuveria, Metarhizium* and *Isaria* and to a lesser extent *Aspergillus, Cephalosporium, Sorosporella and Hirsutella.*

The **commonest species is *M. anisopliae***. Penetrate the integuments of several insects.



a and b- Larva affected by White Muscardine fungi | c and d- Larva affected by Green Muscardine fungi.

Entomopathogenic *Fusarium keratoplasticum* isolated from *Tribolium confusum*

Entomopathogenic Fungi *Fusarium keratoplasticum* isolated from *Tribolium confusum*

Microbial Pathogens

Storage pests	Entomopathogens
• *Ephestia elutella*	• *B. thuringiensis*
• *Plodia interpunctella*	• Granulosis virus (Nut guard V)
• *Oryzaephilus surinamensis*	• *Nosema oryzaephili*
• *Trogoderma sp*	• *Mattesia trogodermae*
• *Tenebrio molitor*	• *Baeuveria bassiana*
• *Tribolium castaneum*	• *Nosema whitei*
• *Ephestia cautella*	• NPV

Conclusion

Entomopathogens have great potential to control insects in the storage environment. These have advantages over chemically synthesized insecticides as they are eco-friendly, precise and safe to use. They have advantages like cost-effective, self-sustaining and target specific.

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Mahua: An Economic Multifunctional Tree of India

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Abstract

Madhuca indica, also known as mahua, is an indigenous plant in the Indian subcontinent that serves as food, fodder, and fuel. Its flowers are used in the production of country liquor and value-added food products, as well as cattle feed and biodiesel. The plant contains bioactive phytochemicals, including primary metabolites like sugar and secondary metabolites like phenols and flavonoids. These phytochemicals have pharmacological properties like antidiabetic, antibacterial, anticancer, and antiulcer activities. The flowers, rich in sugar, can be used as a sugar substitute, leading to the creation of various value-added food products. This plant's multipurpose uses and potential in food and nutrition, pharmaceutical, and pharmacological sectors make it a worthwhile investment for large-scale cultivation, especially in unproductive wasteland.

Introduction

Mahua, also known as the Indian Butter Tree (*Madhuca longifolia* (Koenig) J.F. Macribide), is a valuable socioeconomic tree that thrives in tropical and subtropical regions of the Indian subcontinent. Mahua (*Madhuca indica* J.F. Gmel. syn. *Madhuca latifolia* Macb.) belongs to the Sapotaceae family. Mahua is one of Central India's most significant trees. Mahua trees have extensive root systems, but many are shallow. Wood ranges from hard to very hard, having a considerable sapwood. Hardwood is reddish brown in hue. The trees are huge, deciduous, and have a short, rounded crown. Mahua is unique among NTFPs since it is tied to tribal subsistence systems in several ways. In addition to satisfying basic needs, it also provides significant seasonal revenue. The flowers are used to make country spirits, which are popular in tribal communities around the country. The tree holds religious and aesthetic significance in tribal culture. Mahua flowers and seeds, with medicinal and nutritional benefits, are harvested and preserved. A mature tree may generate around Rs. 1500 in revenue from blossoms and seeds, among other benefits. Mahua is a source of revenue for low-income households, allowing them to acquire everyday necessities. In tribal communities, Mahua gatherers often receive undervalued products and exchange them for everyday necessities.

		
Tree	**Flower**	**Fruits and leaves**

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Flower	**Flowers, seeds and leaves**

This deciduous tree thrives in arid, tropical, and subtropical climates. This tough plant grows in rocky, gritty, salty, and sodic soils, even in gaps between bare rocks. This tree species serves several purposes, including food, fodder, and fuel. Fruits are consumed either raw or cooked. Fruit pulp may be used as a sugar source, whereas dry husk is ideal for alcoholic fermentation. Seeds are an excellent source of oil. The mahua tree yields edible blossoms and fruits. The leaves of the Mahua tree contain saponin, an alkaloid glucoside. Sapogenin and other basic acids were detected in the seeds. Mahua flowers are recognised for their high reducing sugar and nutritional content. Flowers from the plant are delicious. Mahua flowers, also known as corollas, are high in sugar, vitamins, and minerals. Flowers are also used to make distilled beverages, vinegar, and cattle feed. Mahua (*B. latifolia* Roxb.) flowers contain 2acetyl1pyrroline (2AP), which contributes to the pleasant aroma of scented rice. 2AP is exclusively synthesised in the fleshy corollas of mature flowers. In India's mahua-producing area, they are used to sweeten native foods such as halwa, kheer, puri, and burfi. They are also edible. Due to a lack of scientific inquiry and post-harvest processing technology, they are collected and sun-dried in open yards until about 80% moisture is removed before being stored.

Botanical Features: Description and Identification

This is a medium-sized to large deciduous tree found in India's green forests up to 1,200 meters high. It has a short, hole, and large rounded crown, thick, leathery leaves, and numerous branches. The bark is dark-colored, cracked, and milky, with a short trunk and numerous branches. The leaves are oblong and oblong, with glabrred tips and a coriaceous pube. The flowers are small, fleshy, and dull or pale white. The corolla is tubular and aromatic. The fruits are fleshy and greenish.

Tribal Medicine

Tribals treat diarrhoea by taking a cup of bark infusion orally twice a day. Additionally, the stem bark can treat chronic tonsillitis, leprosy, and fever. It is extensively used as an antidote for snakebite in southern Tamil Nadu, India. Stem bark decoction can treat skin diseases, including hydrocoel. Powdered bark is used to cure scabies. *Madhuca longifolia* leaves have expectorant properties and can be used to treat chronic bronchitis and Cushing's illness. The leaves are used as a poultice to treat eczema.

Applications of Mahua Trees

Trimmed leaves, flowers, and fruits serve as fodder for goats and sheep. Cattle are also fed seed cake.

1. Timber: The heartwood is reddish-brown, sturdy, substantial, and long-lasting. It is extremely thick (929 kg/cu. m) and takes a fine finish. Mahua is used to construct dwellings, cartwheel naves and felloes, as well as door and window frames.

2. Erosion: It also aids in erosion prevention because to its extensive superficial root system that holds soil together.

3. Shelter: The crown's widespread distribution provides animals with shade and shelter.

4. Reclamation: Mahua is cultivated in a wasteland in India with hard lateritic soils.

5. Nitrogen fixation: It has been proven to fix nitrogen through vesicular-arbuscular mycorrhizal linkages and root colonisation.

6. Fertiliser: Seed cake was used as fertiliser.

Decorative: Mahua can be planted as an avenue tree for decorative purposes. Boundary, barrier, or support: Grows along field edges.

Intercropping: *M. latifolia* may grow alongside crops.

Soil and Climatic Conditions for Growing

Mahua enjoys tropical climates. It can survive droughts well. This tree does not thrive in wet environments. This tree's hardiness allows it to flourish even in soil pockets between bare rocks. Trees may flourish in deteriorated rocky locations, especially salt-affected soils. For optimal growth and production, use well-drained, deep loam soil.

Propagation

Mahua trees reproduce vegetatively. In July, scions from the mother plant are grafted on one-year-old seedlings, which are then planted in September at 8 m intervals.

Commercialization of Mahua

Mahua flower, a significant source of income for indigenous peoples, is set to be introduced to the market for the first time. The central government plans to introduce a mahua-based alcoholic beverage, mahua nutri-beverage, in six fruit-based flavors. The beverage, priced at 700 for a 750 ml bottle, is excellent in nutritional value and contains only 5% alcohol. The initiative is part of the tribal affairs ministry's first involvement in bottling and selling alcoholic beverages. However, poor post-harvest storage and lack of modern equipment for value addition are significant challenges for poor tribal people and small local enterprises.

Conclusion

Mahua (*Madhuca longifolia*) is a nutrient-dense tree with medicinal properties, including antibacterial, anticancer, hepatoprotective, antihyperglycemic, and analgesic properties. However, there is limited experimental research on its use as a food or food additive. The quality of the flower is deteriorating due to tribal people's preservation practices. Advanced technologies and commercialization of mahua are needed to develop valuable food products and increase year-round availability. The underutilization of this valuable tree is due to inadequate information and processing techniques. Diverting mahua blossoms for commercial use in culinary goods and seeds could improve employment and money production.

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Innovative Insect Detection: The Rise of Sensor-Enhanced Traps

Article ID: 48933

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Introduction

Integrated pest management (IPM) in agriculture relies on understanding pest biology and environmental dynamics to develop sustainable control strategies. Accurate pest population monitoring is crucial for informed decision-making. Pheromone traps are used in the U.S. and the Netherlands to combat moth pests, but labour-intensive monitoring tasks hinder widespread adoption. An electronic trap for automated insect population monitoring aims to reduce labour and provide real-time, high-resolution data. This system reduces costs and deepens our understanding of pest behaviour, enhancing IPM efficacy. The electronic trap integrates with existing pheromone-based monitoring, enhancing efficiency and streamlining monitoring processes.

Fig 1. Delta trap with sex pheromone emitter at the top

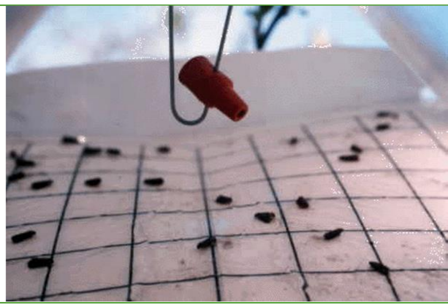

Fig 2. A delta trap in an apple orchard

Understanding the Need

Pests pose a significant threat to agriculture, public health, and ecosystems worldwide. Conventional pest control methods, including pesticides and traps, have limitations such as environmental impact, effectiveness, and labour-intensive monitoring.

Enter Sensor Traps

Electronic insect traps represent a paradigm shift in pest management. Equipped with cutting-edge technology, these traps offer a sophisticated solution to pest control challenges. From monitoring and detection to intervention, Sensor traps streamline the entire process.

How do they Work?

Sensor traps utilize various mechanisms to attract, capture, and monitor insects. Some traps employ pheromones or attractants to lure pests, while others use sensors to detect insect movement or presence. Once captured, insects can be disposed of or analysed for further study.

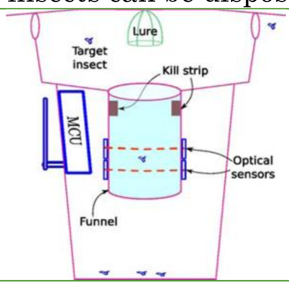

Fig 3. Schematic design of the electronic trap

Fig 4. Electronic trap deployed in an orchard

Benefits of Sensor Traps

1. Precision: Sensor traps provide accurate monitoring of pest populations, enabling targeted interventions.

2. Efficiency: Automation reduces the need for manual labour, saving time and resources.

3. Sustainability: By minimizing the use of chemical pesticides, Sensor traps promote environmentally friendly pest control practices.

4. Real-time Data: Continuous monitoring offers real-time insights into pest activity, allowing for proactive management strategies.

Case Studies

Explore real-world examples of Sensor traps in action, from agriculture to urban pest control. Discover how these devices have transformed pest management practices and yielded tangible results.

Challenges and Future Outlook

While Sensor traps offer promising solutions, challenges such as cost, scalability, and technology integration remain. However, ongoing research and innovation are paving the way for even more advanced electronic trap systems that address these hurdles.

Conclusion

Sensor traps represent a game-changing innovation in pest control. With their ability to provide precise, efficient, and sustainable solutions, these devices are reshaping the way we approach pest management. As technology continues to evolve, the future of pest control looks brighter than ever before.

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A Comprehensive Exploration of Watershed Management

Article ID: 48934

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Summary

Among the vast field of sustainable development, watershed management stands out as a ray of hope since it provides an all-encompassing strategy for the conservation of water and the preservation of the environment. With communities all over the world struggling to cope with the effects of climate change and diminishing water resources, it is more important than ever to have a solid understanding of the complexities involved in watershed management. In this article, we will go into the fundamentals of watershed management, covering everything from its description to its methods and structures.

Defining Watershed Management

To get to the heart of the matter, a watershed is the region of land that is comprised of all surface water and groundwater that flows to a single point, which could be a lake, river, or ocean. When it comes to watershed management, the methodical conservation, restoration, and sustainable utilization of natural resources within specific geographical borders are all part of the process. Its goal is to preserve the fragile equilibrium that exists between the demands of humans, the health of the environment, and economic activities.

The Concept and Importance

The notion of watershed management is based on the recognition of the interdependence of numerous factors that are contained within a watershed. These elements include soil, vegetation, water bodies, and activities carried out by watershed inhabitants. It is possible for stakeholders to handle water-related concerns in a holistic manner by adopting a watershed strategy, which takes into consideration both upstream and downstream implications. Management of watersheds is of such critical importance that it cannot be stressed. Floods, droughts, erosion, and water pollution are all examples of natural disasters that can be mitigated by the implementation of this proactive method. The conservation of biodiversity, the enhancement of ecosystem services, and the promotion of sustainable livelihoods for populations that are dependent on water resources are all additional benefits of this initiative.

Techniques for Water Conservation

1. Afforestation and Reforestation: One of the most important aspects of watershed management is the planting of trees and the restoration of natural vegetation. Trees provide the function of natural sponges, soaking up rainwater and keeping surface runoff to a minimum. Additionally, their root systems help to maintain the soil, which helps to avoid erosion and sedimentation in bodies of water. In addition, trees make a contribution to the recharge of groundwater, which in turn increases the total amount of water that is available within the watershed.

2. Soil Conservation Practices: When it comes to preserving the fertility of the soil and preventing erosion, the implementation of soil conservation strategies is absolutely necessary. By slowing the rate at which water runs off the land and increasing the amount of water that penetrates the soil, practices including contour plowing, terracing, and cover cropping serve to reduce the amount of soil erosion that occurs. These methods contribute to enhanced water quality and prolonged agricultural output by preserving the integrity of the soil, which in turn helps to preserve the integrity of the soil.

3. Rainwater Harvesting: The technique of collecting and storing rainwater is one that has been around for a long time and has recently found renewed relevance in the context of watershed management. Communities are able to harness precipitation for a variety of uses, including irrigation, domestic usage, and groundwater recharging, through the utilization of rainwater harvesting devices, which can range from straightforward rain buckets to intricate rooftop collection systems. Rainwater harvesting helps to provide water security and resilience inside the watershed by minimizing the amount of water that is derived from sources that are external to the watershed.

4. Wetland Restoration: Flood control, water purification, and the provision of habitat are just few of the ecological services that wetland ecosystems provide. Wetlands are essential ecosystems that provide these functions. As a result of human activities such as drainage, agriculture, and urbanization, wetland ecosystems all over the world are in danger of being destroyed. Rehabilitating degraded wetland regions with the goal of restoring their capacity to retain water, filter pollutants, and maintain biodiversity is the objective of wetland restoration programs. Through the restoration of wetland areas within the watershed, stakeholders have the ability to improve water quality, lower the danger of flooding, and boost the overall resilience of the ecosystem.

5. Riparian Buffer Zones: Areas of vegetation that are located in close proximity to bodies of water, such as rivers, streams, and lakes, are known as riparian buffer zones. These buffer zones are extremely important to the management of watersheds because they help to stabilize stream banks, filter pollutants, and provide habitat for organisms that live in both aquatic and terrestrial environments. Riparian buffer zones contribute to better water quality and ecosystem health by minimizing sedimentation and nutrient runoff. This is accomplished through the prevention of runoff. Furthermore, they act as pathways for the movement of wildlife, which ultimately contributes to the preservation of biodiversity within the watershed ecosystem.

Structures for Water Conservation

1. Check Dams: Small-scale structures known as check dams are constructed over ephemeral streams or gullies to reduce the rate at which water flows. Check dams are designed to slow down the flow of runoff, which has the effect of facilitating sediment deposition and promoting groundwater recharge. These buildings are useful in arid and semi-arid countries when water scarcity is a major concern. They are particularly effective in these places. It is also possible for check dams to assist lessen the effects of flash floods by lowering peak flow velocities and regulating erosion further downstream.

2. Contour Bunds: Contour bunds are low embankments that are created along the contour lines of sloped terrain to prevent soil erosion and increase water infiltration. Through the process of intercepting surface runoff, contour bunds encourage sedimentation and the retention of nutrients, so enhancing the fertility of the soil and the quality of the water. To reduce the negative effects of erosion and to preserve the moisture content of the soil, these structures are frequently utilized in agricultural settings. Furthermore, contour bunds have the capability of acting as barriers against surface runoff, so minimizing the loss of vital topsoil and ensuring that farmland continues to be productive.

3. Percolation Ponds: The purpose of percolation ponds is to recharge groundwater aquifers by capturing and infiltrating surface runoff. These ponds are artificial reservoirs designed to accomplish this. Generally speaking, these ponds are situated in regions that have high infiltration rates, such as those that have sandy or gravelly soils. Through the process of enabling water to slowly percolate into the earth, percolation ponds contribute to the sustainable management of water resources and enhance the process of groundwater recharge. In areas where groundwater depletion is a big concern, these structures are very essential because they provide a mechanism to recharge aquifers and preserve hydrological equilibrium within the watershed. However, they are also highly useful in other locations.

4. Water Spreading Structures: The purpose of water spreading structures is to redirect excess surface water to groundwater aquifers in order to recharge them and refill aquifers that have exhausted their capacity. In most cases, these structures are made up of diversion channels, check dams, and infiltration basins. Their primary function is to direct surface runoff to specific recharge regions. Through the process of boosting groundwater recharge, water spreading structures contribute to the maintenance of wetland habitats, the reinforcement of ecosystem processes, and the maintenance of base flow in rivers and streams. The utilization of these structures is especially advantageous in areas where the extraction of groundwater exceeds the rates at which it is refilled, which results in a decrease in water levels and a decline in the quality of the water.

5. Retention Ponds: Retention ponds, which are often referred to as detention basins or stormwater ponds, are developed in urban and suburban areas to capture and temporarily store various types of stormwater runoff. Attenuating peak flow rates and providing temporary storage for excess runoff are two of how these ponds contribute to the reduction of the incidence of floods. In addition, retention ponds enhance water quality by capturing sediment, nutrients, and contaminants before they reach water bodies farther downstream that are located further downstream. These buildings are crucial elements of integrated stormwater management systems, which contribute to the reduction of the negative effects that urbanization has on hydrological processes and aquatic ecosystems.

Conclusion

Management of watersheds exemplifies the philosophy of a healthy coexistence between civilization and the natural world. We can protect water resources for both the current generation and the generations to come if we adopt its principles and ensure that proper procedures and structures are utilized. While navigating the intricacies of a climate that is changing, let us not forget that the health of our watersheds is essential to the health of our world. Together, we have the potential to preserve the resilience and sustainability of our water ecosystems for future generations by taking collective action and practicing responsible management.

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Ancestral Knowledge in Mitigating Insect Pests

Article ID: 48935

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Introduction

Knowledge from our ancestors being inherited to numerous generations which cater various needs of people. In this exploration of ITK in pest management, we come to know about the importance of age-old practices, deeply rooted in culture and ecology, that have sustained indigenous communities for centuries.

Integrated Technical Knowledge (ITK)

Indigenous Technical knowledge (ITK) refers to the local or area specific practices or knowledge of the farmers which are inherited traditionally from their ancestors. This indigenous knowledge can be in the form of tools, implements, preparations, traditional cultural practices which is based on belief of local people. As the traditional practices were built upon constant observation and interaction with environment , these are eco-friendly and maintains sustainable farming environment. ITK's which aids agriculture were formulated for various purposes, one of which is mitigating the pest population in agro-ecosystem. This method of pest control maintains the ratio pest and its natural enemies.

Crop-Wise ITK Practices

1. Rice:

a. Spraying Cow-dung suspension to control thrips.
b. Erection of bamboo sticks to attract predatory birds which controls yellow stem borer and Swarming Caterpillar
c. Dragging of Kerosene dipped rope to control Rice caseworm.
d. Slices of Pummello, chopped leaves of Indian rhododendron, grounded bark of drumstick spread over the field to repel yellow stem borer.
e. Burning of bicycle tyres and fermented snail bait used to repel Rice ear head bug.

2. Pulses and stored grains:

a. Leaves of Naithulasi and chilli fruits are stored along with gunny bags to control storage pests.
b. Red earth treatment followed by Sun drying prevents bruchids.
c. Mixing of Ash before storage
d. Storing of Split grains to prevent internal feeders of grains.
e. Coconut oil mixed with black gram or green gram to control bruchids.

3. Coconut:

a. Meat trap- Abnominal part of female crab filled with poison made of *Croton tigliuum*
b. Fire flames to attract and kill moths
c. Palmyrah leaves to repel rodents in coconut field
d. *Coleus aromaticus* planted in coconut plantation to avoid.

ITK-Based Botanicals

Coriander extract: It is prepared by crushing 200 gm of coriander seeds and soaked in 1 litre of water for 10 minutes and add 2 liters of water before spraying. To control spider mites.

1. Marigold and chilli extract: It is prepared by soaking 500g of chopped marigold and 10 chilli pods in 15 litres of water overnight. Filter and dilute with water in the ratio of 1:2 ratios and add few drops of soap solution at the time of spray.

2. Turmeric extract: Soak 20 gm of shredded rhizome in 200 ml of cow urine and dilute with 2-3 litres of water and add few drops of soap solution before spray. To control aphids, caterpillars and red spider mites.

3. Chinese chaste tree Vitex: 2 kg of vitex leaves soaked overnight in 5 litres of water and boil the mixture for 30 minutes and add few drops of soap solution before spray. To control Diamond backed moth, hairy caterpillars, rice leaf folder and rice stem borer.

4. Neem decoction: It is prepared by mixing 1 to 3 gm of ground neem seed/leaf in a litre of water and soak it for 12 hrs. To repel lepidopteran pests in paddy field.

ITK-Based Traps and Baits

1. Rhinoceros beetle trap: Mud pot containing 250g of castor cake mixed with water in the ratio 1:3 is buried near to base of coconut tree in such a way a that mouth of mud pot is levelled with soil. It attracts rhinoceros' beetle. It is also added with few pineapple pieces. 2-3 pots are placed per hectare.

2. Rice Ear head bug trap: Few pieces of jackfruit and dead crabs are fixed in bamboo sticks are placed in the rice fields before milking stage, it attracts Ear head bugs.

3. Red palm weevil trap: Chopped mid rib of coconut leaf mixed with 1 litre of water, 100 gm jaggery and 10 gm tobacco powder is filled in a mud pot. 3-4 such pots with a hole at its base placed in the plantation.

ICAR's Initiative on Documenting ITKs

The Indian Council of Agricultural Research (ICAR) implemented a Mission Mode Project on 'Collection, Documentation and Validation of Indigenous Technical Knowledge' under National Agricultural Technology Project (NATP) during 2000 to 2004. This project aims to collect, document and validate the ITK's practiced and followed in different sectors of agriculture in various parts of country.

As a part of this initiative, following documents have been published.

1. 3 volumes of inventory on ITK's
2. 1 volume on validation of ITKs
3. Cross-Sectoral Validation of Indigenous Technical Knowledge in Agriculture
4. Traditional Knowledge in Agriculture.

Conclusion

In modern agriculture, traditional knowledge is still playing a vital role in pest Scientific validation of these ITKs to be done at greater extent to widen the usage of these practices as most of which are based of easily available natural resources and could be able to adopted in various parts of the country.

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Nutrient Deficiency Symptoms in Major Crops

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Nitrogen (N)

Nitrogen is mobile in plants. The mobility in soil is dependent on the chemical form of the element used. Organic N is not available to plants until it has been converted to an inorganic form by soil bacteria. Uptake inhibited by high phosphorus levels. N/K ratio is important: high N/low K favors vegetative growth; low N/high K promotes flowering and fruiting. Nitrogen is needed for vigorous vegetative leaf and stem growth and dark green leaf color (chlorophyll production). It feeds soil microorganisms as they decompose organic matter. It is part of proteins, enzymes, chlorophyll, and growth regulators.

Deficiency Symptoms General

Stunted growth and shorter internodes, small pale yellow leaves. Plant may be a light green. Older leaves affected first. Reds and purples may intensify in some plants.

Crops: Older leaves yellow, then dry, fire, or shed. Tomatoes show purpling of veins.

Broadleaf plants: Leaves are uniformly yellowish-green; this colour is more pronounced in older leaves. The leaves are small and thin, have high fall color, and drop early. Shoots are short and smaller in diameter than usual. Shoots may be reddish or reddish brown. Flowers bloom heavily, but may be delayed. Fruit set is light. Fruits may be highly colored, early to mature, and small.

Phosphorus (P): Phosphorus is very mobile in plants; relatively immobile in soil and does not leach. It is stored in seeds and fruit. It is most readily available to plants between a pH of 6 and 7.5 (unavailable in very acid or alkaline soils). Found in greatest concentration in sites of new cell growth. Phosphorus absorption is reduced at low soil temperatures. Phosphorus is necessary to stimulate early root formation and growth, hasten crop maturity, stimulate flowering and seed production, give winter hardiness to fall plantings and seedings, and promote vigorous start (cell division) to plants. Phosphorus has a role in fat, carbon, hydrogen, and oxygen metabolism, in respiration, and in photosynthesis.

Deficiency Symptoms

Red or purplish color (anthocyanin pigment) in leaves, especially undersides. Death of tissue or necrosis may follow. Root growth poor. Lower stems may be purplish. Plants may exhibit stunting and delayed maturity. Loss of lower leaves. May exhibit reduced flowering.

Crops: Corn has purplish tint, legumes bluish green and stunted, tomato has yellowing of leaves, appearance of purpling on underside of leaf, and delayed maturity.

Broadleaf plants: Leaves are green to dark green. Veins, petioles, and lower surfaces may become reddish, dull bronze, or purplish. Foliage may be sparse, slightly smaller than normal, and distorted. Leaves drop early. Shoots are normal in length unless the deficiency is severe, but they may be small in diameter.

Potassium (K): Potassium (potash - K_2O) is highly mobile in plants, and generally immobile in soil. Tends to leach. Potassium promotes vigor and disease resistance, helps development of root system, improves plant quality, and increases winter hardiness due to carbohydrate storage in roots. Increases protein production, and is essential to starch, sugar and oil formation and transfer and in water relations.

Deficiency Symptoms General

Bronzing and dying of leaf margin. Some spotting between veins; chlorotic with brown spots throughout leaf. Tendency to wilt readily. Stunted internodes and roots. Turf: Yellow-streaked leaves, followed by browning and death of tips and margins. Wilts sooner during droughts, lowered resistance to disease and cold injury, reduction in turf density.

Broadleaf plants: Leaves exhibit marginal and interveinal chlorosis (yellowing), followed by scorching that moves inward between the main veins to the entire leaf. Older leaves are affected first. Leaves may crinkle and roll

ITK-Based Traps and Baits

1. Rhinoceros beetle trap: Mud pot containing 250g of castor cake mixed with water in the ratio 1:3 is buried near to base of coconut tree in such a way a that mouth of mud pot is levelled with soil. It attracts rhinoceros' beetle. It is also added with few pineapple pieces. 2-3 pots are placed per hectare.

2. Rice Ear head bug trap: Few pieces of jackfruit and dead crabs are fixed in bamboo sticks are placed in the rice fields before milking stage, it attracts Ear head bugs.

3. Red palm weevil trap: Chopped mid rib of coconut leaf mixed with 1 litre of water, 100 gm jaggery and 10 gm tobacco powder is filled in a mud pot. 3-4 such pots with a hole at its base placed in the plantation.

Macronutrients

Calcium (Ca): Calcium is immobile in plants, and relatively immobile in soil. Moderately leachable. Sometimes difficult to differentiate between calcium deficiency and magnesium toxicity. Calcium is necessary for cell elongation and division, protein synthesis, root and leaf development, and plant vigor. It influences intake of other nutrients and increases calcium content of plants. Important in cell wall structure and as an enzyme activator.

Deficiency symptoms (relatively rare) General: Newest leaves hooked. Inhibition of bud growth; Terminal bud dies. New leaves are yellow, while older leaves dark green. Cupping of mature leaves.

Broadleaf plants: Leaves become chlorotic and/or necrotic; young leaves are small and distorted with tips hooked back. Shoots are stunted with terminal dieback. Apple fruit may have bitter pit. Roots are usually affected first, with dieback of root tips severely reducing growth.

Magnesium (Mg): Magnesium is mobile in plants, mobile in acid soils, and fairly immobile above pH 6.5. Leaches from soil. Magnesium is necessary for formation of sugars, proteins, oils, and fats, regulates the uptake of other nutrients (especially P), is a component of chlorophyll, and is a phosphorus carrier.

Deficiency symptoms General: Mottled yellowing between veins of older leaves while veins remain green. Yellow areas may turn brown and die. Yellowing may also occur on older leaves. Leaves may turn reddish purple due to low P metabolism. Decreased seed production. Deficiencies most likely on leached sandy soils and where high levels of N and K have been applied.

Broadleaf: Leaves are thin, brittle, and drop early. Older leaves may show interveinal and marginal chlorosis, reddening of older leaves, with interveinal necrosis late in the season followed by shedding of leaves. Shoot growth is not reduced until deficiency is severe. Fruit yield is reduced in severe deficiencies; apples may drop prematurely.

Sulfur (S): Sulfur is mobile in plants, somewhat immobile in soil. Organic sulfur is converted into available sulfate sulfur by soil bacteria. Leachable. It is rarely deficient. Sulfur is necessary to maintain dark green color, stimulate seed production, and promote root and general plant growth. Part of proteins, amino acids, and vitamins. Important in respiration. Deficiency, when it occurs, is most likely on sandy, low-organic matter soils.

Deficiency symptoms General: General yellowing of the whole plant, starting with the younger leaves. Plants may be light green. Plants may be stunted and exhibit delayed maturity. Deficiencies most likely on sandy soils that are low in organic matter.

Crops: Corn has striping of the upper leaves, notably on young plants.

Boron (B): Boron is extremely immobile in plants and is not translocated to new growth, but moves readily in soil. Deficiencies often occur when pH is between 6.0 and 7.5, on deep sandy soils, and when high rates of N, K, and Ca are used. Deficiency more apparent during drought stress. Boron is necessary to increase the yield and quality of fruits and vegetables and is associated with calcium utilization.

Deficiency symptoms General: Youngest leaves become light green and may be distorted. Terminal (apical) bud may die. Internal breakdown and external necrosis of stems and roots. Reduced flowering and failure to set seed.

Crops: Unrolled leave, poor pollination, and lack of tip fill in corn; black areas in the main stalk of cabbage; hollow heart of crucifers, discoloration of the curd and young leaves consisting of a corky midrib in cauliflower; cracked stem of celery; brown spots (black heart) in the interior of turnips and other root crops; yellowing and curling of tomato leaves and split fruit; and internal cork in apples. Beets: elongation and deep reddening of leaves, rosetting of leaves, roots develop black spots and split.

Broadleaf plants: Leaves are occasionally bronzed, or scorched. Young leaves are affected first. Leaves are small, thick, brittle, and sometimes distorted. Shoots exhibit rosetting, discoloration, and dieback of new growth, which becomes zigzag, short, brushy, thick, and stiff. Flowers may be few. Fruit set is light and deformed, with cracked, necrotic, spotty, corky surfaces. Fruit may drop before it is mature.

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Exploring Eco-Friendly Alternatives for Mosquito Control

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Introduction

The prevalence and impact of arthropod-borne diseases on human, animal, and environmental health are significant global concern. The rapid spread of pathogens carried by arthropod vectors pose substantial challenges to parasitology and tropical medicine. Mosquitoes, in particular, serve as vectors for various pathogens, including viruses, parasites, and bacteria, contributing to the transmission of diseases such as malaria, dengue fever, chikungunya, zika virus and lymphatic filariasis. While significant strides have been made in the prevention and treatment of malaria, with notable advancements such as the discovery of artemisinin and the development of the RTS,S/AS01 vaccine, other mosquito-borne diseases continue to pose threats to public health. The spread of invasive mosquito species, particularly *Aedes* mosquitoes, has facilitated the expansion of arthropod-borne diseases into new regions, including areas with temperate climates. The adaptability and ecological plasticity of these mosquitoes contribute to their successful establishment in diverse habitats worldwide. Control efforts historically relied on insecticides, but resistance is a growing concern, prompting the exploration of safer and more sustainable alternatives. India, with 404 identified mosquito species, faces similar challenges, emphasizing the need for greener vector control strategies.

Mosquito Control and One Health

The integration of the one health approach into mosquito control programs is essential for addressing the complex interconnectedness of human health, animal health, and the environment. By recognizing the interdependence of these components, one health promotes collaboration across multiple disciplines to achieve optimal health outcomes for all. While significant progress has been made in addressing arthropod-borne diseases, particularly those transmitted by mosquitoes, there remains a gap in applying the principles of one health. To address this many innovative control strategies have been identified. Furthermore, it is crucial to consider the potential non-target impacts of these novel mosquito control strategies, including genotoxicity and effects on the behaviour of mosquito predators. Evaluating the environmental safety and efficacy of these approaches is essential for their responsible implementation. In summary, integrating the principles of one health into mosquito control efforts can enhance the effectiveness of vector management strategies while minimizing adverse impacts on human health and the environment. Continued research and collaboration across disciplines are necessary to address the remaining challenges and advance sustainable approaches to mosquito control.

Drawbacks of Current Tools to Fight Mosquito Vector and Mosquito-Borne Diseases

1. The overreliance on chemical pesticides for mosquito control has led to adverse effects on human health and the environment. Moreover, the widespread use of pesticides has contributed to the development of resistance in mosquito populations, reducing the efficacy of control efforts.

2. The availability of chemically derived mosquito repellents has been reduced, leading to a reliance on a few compounds such as DEET and picaridin.

3. Implementing integrated mosquito control strategies that incorporate multiple approaches, including biological control methods and personal protection measures, is essential for effectively managing mosquito populations and reducing disease transmission. However, the adoption of integrated strategies remains limited in many regions, hindering comprehensive vector control efforts.

4. Despite significant advancements such as the discovery of artemisinin, the rapid development of resistance by *Plasmodium* spp. to antimalarial drugs, including artemisinin, poses a significant challenge.

5. Rural marginalized populations worldwide often lack access to expensive malaria prevention strategies, such as insecticide-treated bed nets and antimalarial medications.

6. While the RTS,S vaccine represents a milestone in malaria science, it does not provide protection against *Plasmodium vivax* malaria, which is prevalent in many countries outside of Africa.

7. Currently, there is no specific treatment available for dengue fever, highlighting a critical gap in addressing this arboviral disease.

8. The rapid spread of novel arboviruses, such as Zika virus, poses a potential pandemic risk of public health significance. The lack of effective treatment options and vaccines for these emerging threats underscores the urgency of developing innovative solutions for vector-borne disease control.

Biocontrol Agents

1. Entomopathogens: Entomopathogenic bacteria like *Bacillus thuringiensis* and *Bacillus sphaericus* have been effective against mosquito larvae. *Bacillus thuringiensis*, particularly its subspecies *israelensis*, produces proteins toxic to mosquitoes upon ingestion, leading to gut damage and eventual death. Similarly, *Bacillus sphaericus* employs binary toxins to disrupt insect cell functions. *Pseudomonas frederiksbergensis*, bacterium has shown larvicidal effects against mosquito larvae, including the common vector *Culex pipiens*, making it a promising option for biological control. Entomopathogenic fungi, such as *Beauveria* and *Metarhizium*, have also shown promise in targeting mosquito vectors. These fungi infect mosquitoes through contact, releasing toxins that cause mortality within days.

Effective microbial formulations, including water-dispersible granules and aqueous suspensions, enhance the commercial viability of these biological control agents. Viruses such as baculoviruses, densoviruses, cytoplasmic polyhedrosis viruses, and iridoviruses have been explored for their potential in reducing mosquito populations. However, their role in parasite population reduction is still under study.Certain nematodes, particularly the Mermithidae family, have been identified as potential biocontrol agents against mosquito larvae. They are host-specific, pose little environmental risk, and are being considered for mosquito control programs.

Predators: *Toxorhynchites* spp., a dipteran predator consume mosquito larvae without ingesting blood, while coleopteran families like Dytiscidae and Hydrophilidae are effective predators in ground pools and ponds. Hemipteran bugs, such as back swimmers, and odonatan larvae, like dragonfly larvae, also contribute significantly to mosquito control by feeding on larvae. Larvivorous fishes, including *Gambusia affinis, Aphanius,* guppy, and carp have been utilized for biological control. Additionally, tadpoles from various frog and toad genera actively prey on *Aedes aegypti* eggs, contributing to natural mosquito control mechanisms. Copepods, such as *Macrocyclops albidus*, are another type of water inhabitant that can prey on mosquito larvae.

Incompatible Insect Technique

The Incompatible Insect Technique (IIT) involves inducing cytoplasmic incompatibility (CI) in mosquitoes, where sperm and eggs fail to produce viable offspring due to alterations caused by Wolbachia-infected males. Wolbachia modifies sperm and disrupts parental chromosomes during mitotic divisions, affecting progeny viability.

Life-shortening Wolbachia strains, like wMelPop, reduce adult mosquito lifespan, potentially shifting the population towards younger individuals, thereby lowering pathogen transmission without eradicating the population.

Wolbachia, maternally inherited bacteria, exploit CI to spread rapidly, even at a fitness cost. Simulations suggest significant reductions in disease transmission using this method. Although life-shortening Wolbachia strains aren't naturally found in mosquitoes, their stable introduction resulted in reduced lifespan and CI-induced non-viable offspring, effectively decreasing mosquito populations.

Botanicals

Various plant species, including *Lantana camara*, *Tagetes patula*, *Catharanthus roseus*, and *Clerodendrum phlomidis*, exhibit significant activity against mosquitoes. Lantana oil and extracts repel insects due to their chemical composition, including triterpenoids and flavonoids. Marigold contains compounds like ß-karyophyllene and carotenoids, effective against *Aedes aegypti* larvae and pupae. Periwinkle's vincristine and vinblastine demonstrate larvicidal activity against *Culex* spp.

Physical Method

Changing water in birdbaths, pools, fountains, and rain barrels regularly, typically on a weekly basis, to prevent mosquito breeding. Screening doors and windows to prevent mosquitoes from entering living spaces and biting humans. Using mosquito nets, which are considered highly protective as they pose no health risks compared to coils and other repellents. Mosquito nets come in two types: medicated and non-medicated.

Mechanical Method

Mosquito traps replicate mosquito attractants like body heat and carbon dioxide. Powered by electricity, they use an impeller fan to draw mosquitoes in, where they become stuck to a sticky surface or are shocked. Electric Mosquito Zapper device emits UV light, attracting mosquitoes, which are then killed upon contact with an electric charge. Mosquito Magnet device mimics mammalian features such as heat, moisture, and carbon dioxide to attract mosquitoes. When mosquitoes approach the device, they are drawn in and subsequently killed.

Nanotechnology

Nanocomposites have emerged as a promising approach for various applications, offering advantages over nanoparticles. Nanocomposites come in different types, such as metal/polymer, metal/metal oxide, and Bio-NC, which combines metal nanoparticles with bio-compounds as a solid supporting matrix. Silver nanocomposites, synthesized using diverse solid support materials like porous carbon and silica, hold potential for developing novel, biodegradable, and environmentally friendly larvicides. A popular method involves the bio-synthesis of Ag-NCs using low-value biowaste and hydrothermal treatment for crystallization. Histological analysis confirmed significant damage to larvae exoskeletons due to silver ions released from the porous disc. This nano-technological approach holds promise for future vector control strategies, emphasizing eco-friendly and targeted solutions.

Conclusion

In conclusion, there is a growing need for eco-friendly mosquito control measures to reduce reliance on long-term insecticide use, which currently dominates mosquito control strategies. Sustainable and safe approaches targeting diverse mosquito species, including bioagents, predators, insect sterile techniques, as well as physical and mechanical methods, should be developed and made accessible to the general public. Promoting the production of biocontrol formulations tailored to specific needs, such as tablets, capsules, and ice granules, can further enhance mosquito control efforts while minimizing environmental and health risks.

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Community Seed Production - Empowering Local Farmers

Article ID: 48938

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The high quality seeds ensure better yield and directly impact the food security. In India, both the public and private seed sector are well developed which play a vital role in seed supply chain. They have developed many innovative ideas in plant breeding activities for the better yield of the crops. Despite this progress, a large number of farmers rely on farm-saved seeds or farmer varieties.

Since ancient time, farmers have served as main producers and users of the seeds. But, still the large number of farmers in developing countries grow their 90% crops from the farm saved seeds/ farmer varieties. The farmers tends to maintain their own varieties that easily available for procurement and access which reduces the risk of damage by other climatic factors. In order to lower the risk, the farmers use their own seeds instead of improved varieties or other hybrids to avoid the crop failure. They often do not distinguish between the seed and grains. The surplus grains are treated as seeds for next planting season because according to them, it is an integral process. In India, farmers are predominantly small and marginal land holders. Therefore, it is necessary to ensure the availability of quality seed in affordable price to the small land holding farmers in remote villages.

One effective strategy to enhance the quality seeds supply in small and marginal lands is through **community seed production programme**. In which, a group or team of farmers work collectively to achieve a common goal with an assistance of state agricultural departments, KVK's, State Agricultural Universities. Here, the production of quality seed is a common goal in order to increase the production and productivity of crops at small and marginal farm level. Community Seed Production represents an Integrated Seed System. Because, it is a combination of formal and informal system. This system helps the local farmers to adapt new varieties, new technologies and other input / services in community manner. According to Khanel *et al.,* (2015) in community seed production, the farmers who are residing in one geographical area are engaged in seed production of food crops. Simply a group of people in a geographical location involved in production, distribution and consumption of quality seeds in a local level.

The Government of India sponsors various schemes for multiplication of seed through implementing agencies. Other than that, many private companies are also engaged in contract seed production in a specific geographical location for production of good quality seeds. The implementing agencies and their ideas may vary from place to place for developing and sustaining vibrant community seed production. Therefore, community based seed production helps to increase the availability of quality seeds at planting time for the small and marginal farm lands at their door steps with a guarantee from the farmer or village seed committee. The present paper reveals about different seed production systems, developing community seed production system and discusses the government schemes promote community seed production programme.

Formal Seed System

In formal seed production, supply chain management from seed production, distribution, to consumption is clearly defined within an organized framework. Formal seed production is carried out by both the public and private sectors. The seeds produced are focused on high-value crops within specific agro-ecosystems and areas, aimed at yielding high profitability in seed supply. During seed production they highly focused on breeding activities, with a prominent seed multiplication, processing, and testing and storage activities. A clear distinction is made between seed and grain. From the production until the consumption, they maintain the genetic, physical purity with proper sanitary quality. The constraints are they fail to address all farmers in the countries especially they do not fulfil the needs of small and marginal farmers and their varieties are not adopted to the local ecosystem and adverse environment condition with a low input facility. Moreover, they do not focus on minor crops such as millets and fodder crops.

Informal Seed System

Informal seed production is referred to as the traditional seed system or farmer local seed system. Farmers utilize seeds for sowing from saved seeds from previous harvests of farmer varieties or landraces. In this system, the supply chain of seeds is formed through one's own harvest, neighbours, relatives, and the exchange of seeds through a barter system, as well as obtaining them through the local market. The farmers use their known varieties or landraces and stay away from using other unknown varieties in order to avoid the crop failure due to cold, drought, heat, salt stress, pest & diseases. The crops involved are mostly self- and open pollinated. There is no proper distinction made between seed and grain with a single motto of multiplication. The processing and storage of seeds are often inadequate, leading to potential deterioration in seed quality due to both biotic and abiotic stresses. In informal system, the seed replacement rate tends to be low or neglected. Since, the seeds utilized for farming are confined within a geographical location, the advantage of this system is to prevent the extinction of land races and wild varieties that are exist in specific geographical location with adaptive features of drought, salt, and pest & diseases resistance which play a crucial role for agricultural sustainability in those specific regions.

Integrated Seed System

It is a collaboration or integration of both formal and informal seed system which are interdependent. Seed companies and producer groups participate in producing quality seeds. Technical and institutional levels address the diversified seed demand at the local level. Participatory varietal selection occurs at the technical level, while seed multiplication takes place at the institutional level. It is a multi-approach for utilizing the diversified seed in the framer field.

Developing Community Seed System

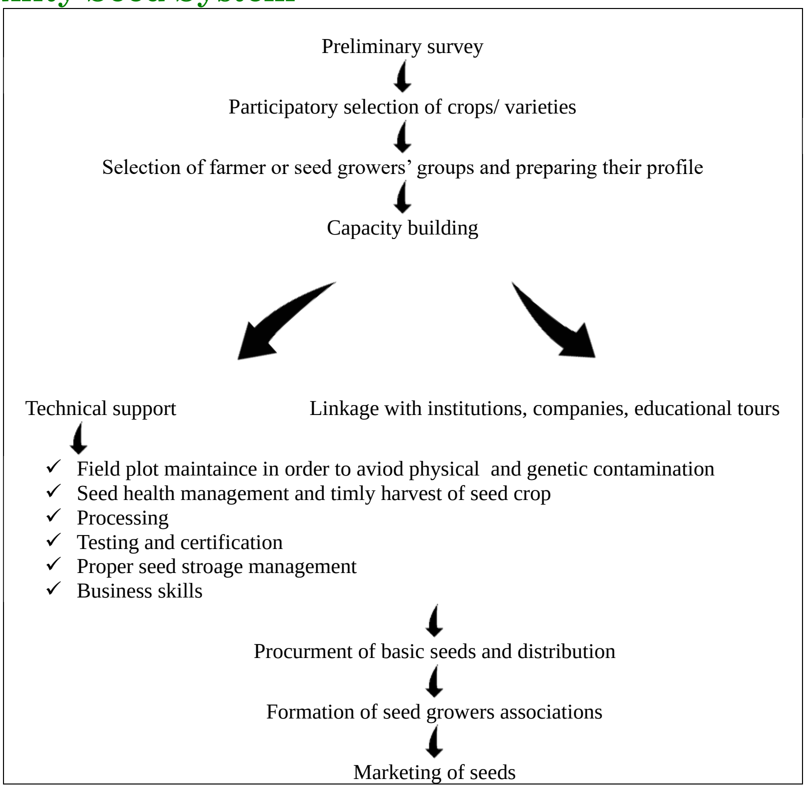

Fig. 1. Steps to develop community seed production system

Developing a community seed production system is a long-term process that requires minimum of 5 years which varied from location to location, depending on the keen interest of farmers. In the first 3 years, they focus on capacity building to understand the seed production process. The next 2 years is about the managing the community and create linkage with various institution, seed companies and small-scale seed enterprises, including visits to places such as research stations, gene banks etc. They have to be familiar with the seed certification system and know about state seed certification agencies and their role in providing certification to seeds. Educate the farmers about the rules and regulation for seed production with the marketing strategies. The developing community/ village seed bank aids in efficient supply of quality seed. It reduces the cost of seed production, processing, testing, storing, and marketing. Moreover, it empowers the farmer's economy by avoiding the poor germination at the field level. It also builds the capacity of farmers in scientific seed production and storage. The steps in developing the community seed system are emphasized in the following figure No. 1.

Community seed production system provides training and infrastructural support for seed production and empowers farm women in order to maintain genetic and physical purity from production to consumption. Through linkage of institutions, technical support, supply of foundation seeds and certified seed are made as a basic source for multiplication. This ensures additional support such as incentives for farmers for certification, maintaining quality and marketing.

Nowadays, Farmer Producer Organizations (FPO's) were involved in seed production of paddy, wheat, grams, and minor millets and they prompted the distribution of seed under their registered brand names though Farmer Producer Company Limited. This is another popular approach in Contract Seed production. The private seed companies and public institutions such as NSC and SSC involved in seed production select and empower the progressive farmers and group them to produce the seed crops under contract basis based on consumer demand, geographical locations and availability of irrigation facilities and skilled labour etc.

Schemes for the Improvement of Village Level Seed Production

The seed village scheme was implemented by government of India to produce quality seeds at village level. Because 85% of seeds are used from farm saved seeds. In order to enhance the crop production and productivity, it is essential to improve the quality of seeds at the farmer's level. Various implementing agencies including State Seed Certification agencies, Department of Seed certification, State Agricultural Universities, KVK's, State Seed Corporation (SSC), National Seeds Cooperation, State Farmers Corporation of India, and State Department Of agriculture are associated in developing community seed production system.

These agencies will identify suitable seed production areas and select suitable willing farmers using compact area approach. The group contains minimum 50 to maximum 150 members who grow similar crops. Under this scheme, farmers are assisted for 2 years by supplying 50% cost of foundation and certified seeds for the production of certified/ quality seeds.

The implementing agencies also provide three days capacity building training programme to distinguish between seed and grain production. If there is a need of storage bin, then the implementing agencies should provide sufficient storage bin at subsidy subjected to category of farmers. In Tamil Nadu, research station and more than 10 KVK's undergo quality seed production under village seed scheme. Farmers can avail 50% of subsidy to seed for the crops like paddy, oilseeds and pulses. Other related schemes such as Integrated Cereals Development programme, and Integrated Scheme for Oilseeds, Oil palm, and Maize (ISOPOM) also support community seed production system.

Under Seed Village Programme in villupuram district, Mr. Rangaraju of Kizhakku marudur village succeeded in seed production in paddy and empowered 30 farmers in the same village with SRI technology of seed production in paddy.

Similarly, in Villupuram district under Seed Hub project, Black gram VBN 8 variety were given to 24 farmers to create an awareness of potential of new Varieties. Among them, Jaya Chandiran of the same district of Mailam block recorded 735 kg, compared to the previous year yield of local variety. There are several success stories in quality seed production in village level.

Benefits of Community Seed Production

1. It ensure the local level farmer to access good quality seeds.
2. The seeds are available at the door step at an affordable price
3. Upgrade framers from grain to seed producers.
4. Local level farmers have a diversified choice of seed crops.
5. It Improves the socio- economic status of famer in remote villages
6. It enhance the capacity and infrastructural development
7. It Conserve, reproduce, and restore the traditional/ Indigenous seeds.

Conclusion

Community seed production plays a pivotal role in supplying quality seeds to local farmers. It involves a multi-approach where the seeds are adapted to local environmental conditions, guaranteed by farmers or village seed committees, and made easily accessible at the doorstep at an affordable price. Developing the economy of local farming communities through seed production is the best way to ensure sustainable food and seed security in India.

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Mulberry & Biofertilizers: A Synergistic Approach to Sustainable Cultivation

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Introduction

Biofertilizers, often referred to as microbial inoculants, play a crucial role in agriculture by mobilizing essential nutrients in the soil, making them accessible to crops through biological processes. Mulberry, the primary food source for silkworms and a perennial crop covering over 2 lakh hectares in India, has long relied on chemical inputs to ensure high-quality leaf production for optimal cocoon yield in silk production. However, the overreliance on chemicals has proven unsustainable, with detrimental effects on both the environment and human health. Recognizing this, researchers and farmers have turned to biofertilizers enriched with beneficial bacteria and fungi to enhance crop yield and quality (Baqual et al., 2005). Over the past decade, biofertilizers have emerged as a preferred eco-friendly alternative to chemical fertilizers, improving soil fertility and boosting crop production through their biological activity in the rhizosphere.

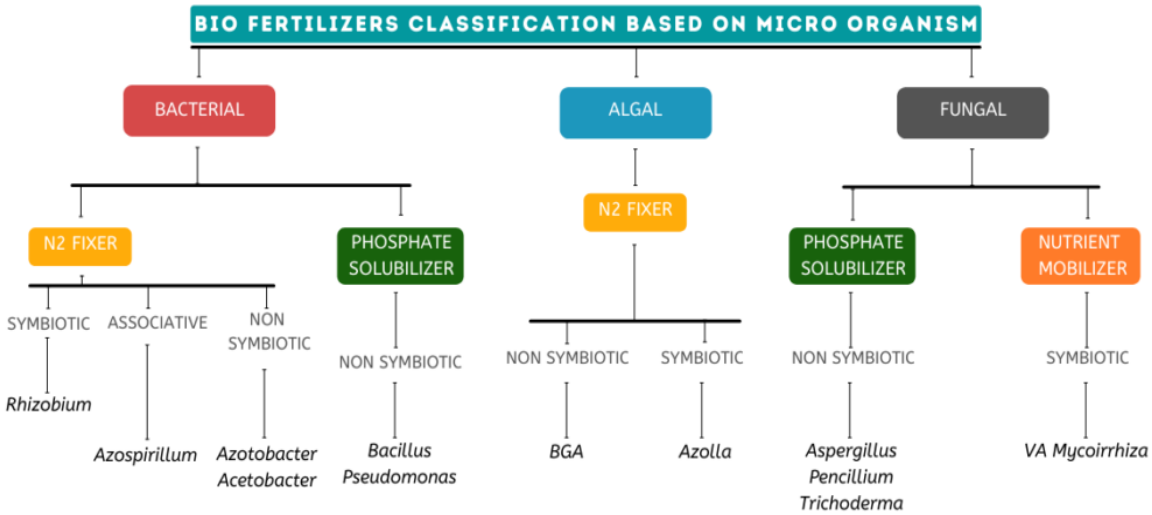
Extensive research has focused on the use of bacteria such as *Azotobacter* and *Azospirillum*, as well as Vesicular Arbuscular Mycorrhizal (VAM) fungi, to supplement nitrogen and phosphorus fertilizers in mulberry cultivation (Reddy et al., 1998). Studies have shown significant improvements in mulberry sapling growth and development with the use of these biofertilizers, particularly when dual-inoculated with both VAM fungi and bacterial strains (Sreeramulu et al., 2000 and Sumana et al., 2002). In the current agricultural landscape, biofertilizers have become indispensable alternatives to chemical fertilizers, offering sustainable solutions for enhancing soil fertility and crop productivity while minimizing environmental impact.

Biofertilizers

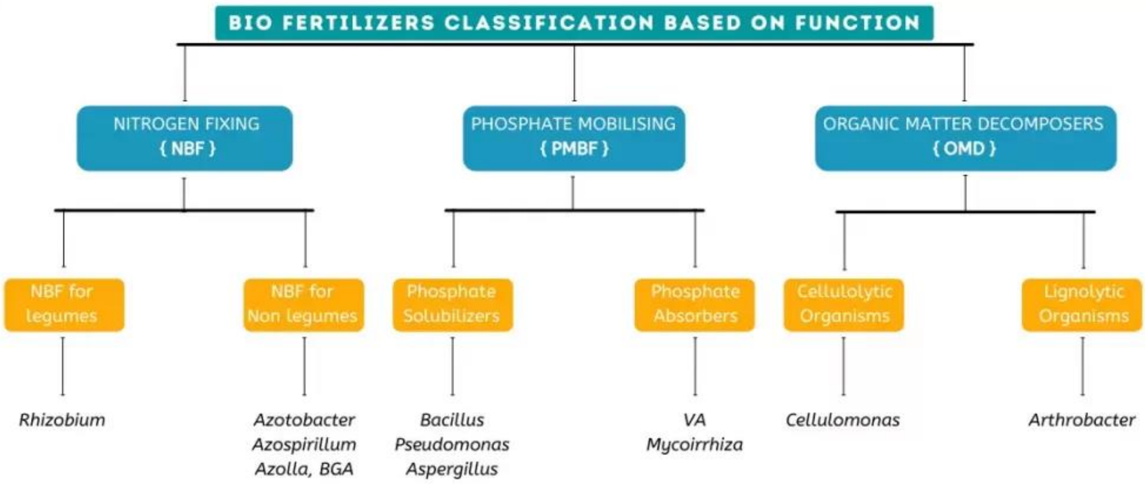
A bio-fertilizer is a substance which contains living microorganisms which, when applied to seed, plant surfaces or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the plant (Dandin and Giridhar, 2014).

Biofertilizers can be Classified into Two Types

1. Classification based on microorganisms in biofertilizer:



2. Classification based on function of biofertilizer:



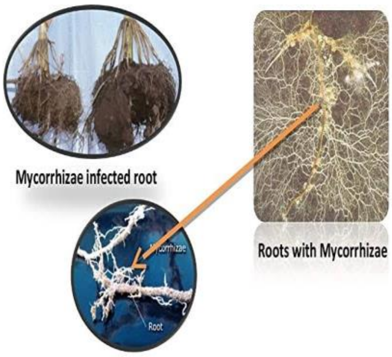
Important Biofertilizers Used in Mulberry Cultivation

Nitrogen fixing Azotobacter biofertilizer: Azotobacter biofertilizer is a bacterial preparation of live *Aztobacter chroococcum* cells blended with suitable carrier material like lignite/peat /charcoal in a powdered form capable of supplying N to the plants through biological nitrogen fixation enhancing plant growth. The material is commercially available as Seri-azo (A product of CSRTI, Mysore). 20-23 kg/ha/year (to Compensate 150 -175 kg of N) in 5 split doses @ 4 - 4.8 kg per crop after every leaf harvest/ pruning and intercultural operations is recommended. Only 50 % of the N *viz.,* 150-175 kg/ha/year needs to be applied instead of 300- 350 kg in 5 equal split doses.

Phosphate solubilizing biofertilizer: Phosphorus (P) is ihe second most important plant nutrient element next only to nitrogen. It contains live cells of *Bacillus megatherium.* It is commercially available as Seri-phos (developed by KSSRDI, Bangalore). Seriphos increases P availability to plants and increases PUE. It helps in profuse root development and also increases leaf yield by 10-15 %. It can be used along with a mixture of rock phosphate and super phosphate (1:1) or with rock phosphate alone to reduce the cost on fertilizers. Seriphos can be used along with nitrogen-fixing biofertilizer (Prakruthi, Azotobacter, Azospirullum) for synergistic effect on mulberry. 5kg/ha/ year in two to five equal split doses is recommended. For two times applications, 1st dose of Seriphos is applied during June-July immediately after pruning. 2nd dose, after two leaf harvests. For use in nurseries, the bases of prepared mulberry cuttings can be dipped in a slurry of Seriphos before planting.

Vesicular Arbuscular Mycorrhiza (VAM): VAM is a symbiotic association between plant root and certain useful fungi, which forms vesicles and arbuscules in host root cells. They colonize the root system of higher plants specially under phosphorus deficient conditions and greatly enhance the absorptive surface area of root system and nourish plants through other micro-nutrients and phosphorus in particular. There are several types of VAM fungi of which *Glomus mossea and Glomus fasciculatum* are found highly beneficial for mulberry.

VAM is available as soil-based inoculum containing mycorrhizal spores, hyphae and host root fragments. VAM can be inoculated in nursery and well established mulberry gardens as well. 200 kgs of soil-based inoculum (20 spores/ g dry soil) is required to raise requisite amount of saplings to plant one hectare of land. For inoculation of one hectare established mulberry garden, 1000 kg **o**f VAM is required. It can reduce 15 to 20 % of the recommended dose of phosphatic fertilizer without any adverse effect on leaf yield and quality. Phosphorus should be used 30-35 kg/ha/yr instead of 120-140 Kg/ha/yr. It saves approximately 563 kg of SSP/ha/year.



Advantages:

a. Using biofertilizers is an eco-friendly and sustainable way to manage soil fertility, soil health, plant growth, and the environment as these are natural products containing living microorganisms and they reduce nitrogen depletion in soils and provide sustainable farming methods.

b. Unlike chemical fertilizers, they are cheaper and simpler to use, and their preparation takes less time and energy. These are available for a wide range of crops. They have a high cost-benefit ratio without risk and enhance the effectiveness of chemical fertilizers.

c. As they excrete growth-promoting substances, vitamins and hormones, they assist in providing better nutrition to crop, maintaining soil fertility, and increasing tolerance to drought and moisture stress. They inhibit weed growth, reduce pathogen incidence and control diseases by secreting antibiotics, antibacterial and antifungal compounds.

d. Decomposition of organic matter and mineralization of soil are two benefits of bio fertilizers.

Disadvantages

1. Certain biofertilizers are less available due to shortages of microorganisms or shortage of preferred growing medium.
2. They cannot totally replace conventional fertilizers.
3. The majority of marketing sales personnel do not know how to properly inoculate.
4. The handling, transportation and storage of bio fertilizers are all critical because they are living organisms.

Tips to Use Biofertilizers

1. Adequate amounts of organic manure (as per the recommendations for each crop) and biofertilizer should be used to ensure greater survival, growth and activity of microbial inoculums in acidic soils.

2. If the soil pH is below 6.0, liming is essential. Adding lime @ 250 kg/ha along with biofertilizer treatment is recommended for moderately acidic soils. During summer months, irrigation is essential after applying biofertilizers to ensure the survival of the introduced microbes.

3. When applied to moderately acidic soils of pH around 6.5, fine powdered calcium carbonate can improve root nodulation by Rhizobium.

4. For best results, integrate biofertilizers with good agricultural practices like organic matter management and proper irrigation. This holistic approach fosters a healthy ecosystem for mulberry cultivation.

5. In phosphorus-deficient soils, it is recommended to apply P_2O_5 @ 1kg/ha once every 4 days to guarantee good growth of Azolla. Azolla develops a reddish purple colour when it is deficient in Phosphorus (Sakthivel et al., 2014).

6. Biofertilizers are applied 6 – 7 days after pruning and should be applied near to root zone, covered with soil and irrigated immediately.

Precautions

1. Biofertilizers should not be mixed with chemical fertilizers.
2. They should be kept away from heat and direct sunlight and should be used before the expiry date.
3. After application, adequate irrigation is necessary to save live bacterial cells from desiccation.
4. It should be applied 10- 15 days before/ after the application of chemical nitrogen fertilizers.
5. They should be mixed thoroughly with dry powdered FYM (4-4.8 kg bio fertiliser+200 kg FYM each time) and applied in between the rows in furrows and covering immediately.
6. The bio-fertilizers should be stored in cool place and used before expiry date.

Conclusion

Biofertilizers offer a sustainable approach to nourishing mulberry plants, promoting growth and yield while enhancing silkworm and soil health. Long-term applications of chemical inputs like inorganic fertilizers, weedicides, insecticides, fungicides etc., in bimonthly interval in mulberry gardens not only pollute the ecosystem but also cause adverse impact on the soil health and hazardous effect on human beings and beneficial organisms including silkworms. Therefore in place of chemical based sericulture, the possibilities of exploring appropriate eco-friendly alternatives of using biofertilizers are need of the hour. The sustainable production of mulberry leaf and cocoon crop is entirely dependent on the maintenance of the soil fertility of mulberry garden through the periodical application of organic manures and fertilizers in required quantity. The efforts of scientists are immense in innovating organic inputs alternate to chemicals and effective eco-friendly packages of practices in sericulture and their field implementations through sound extension system.

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Unveiling Phytopathogens: A Molecular Approach

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In the realm of agriculture, the battle against phytopathogens - microscopic assailants causing disease in plants remain a formidable challenge. Traditional methods for detection often lack precision and efficiency, leading to devastating losses in crop yield and quality. However, the advent of molecular approaches has revolutionized the field, offering unparalleled insights into the identification, characterization and management of phytopathogens. By harnessing the power of genetics, genomics and bioinformatics, researchers can now unravel the intricate interactions between plants and pathogens with unprecedented clarity. In this review, we explore the diverse molecular techniques driving the detection of phytopathogens, highlighting their significance in safeguarding global food security and sustainability

Phytopathogens especially fungi, bacteria, phytoplasma, viroid and viruses causes harmful and significant losses to the crop plants worldwide. In addition, many of the phytopathogenic bacteria and viruses may remain in latent stage in seed, propagative material and other reservoirs. Under such circumstances, it is becoming very difficult to take any disease management decision. In this view, early detection and accurate identification of plant pathogens is one of the most important strategies for controlling plant diseases to initiate preventive or curative measures. The rapid identification of a plant pathogen, allows implementation of appropriate control measures prior to the further spread of disease or its introduction. In this context, the availability of fast, sensitive and accurate methods of detection and identification of fungal pathogens is increasingly necessary to improve disease control decision making.

Rapid and accurate detection is especially required for quarantine pathogen because in this case the risk of disease and spreading of the inoculum must be reduced to zero (Lopez. *et al.,* 2003). In addition, numbers of vectors are spreading many viruses and bacteria efficiently from infected source to healthy one. Furthermore, it is necessary to improve the detection of plant pathogenic viruses, bacteria and fungi in soil, sediment, air, water, sewage or agricultural samples in view of assessment of their role of different inoculum sources on ecology, epidemiology and life cycle of the plant pathogens (Rao, 2006). Till date, researchers have developed an array of methodologies for detection of plant pathogens. Traditionally pathogens like fungi have been identified by taxonomists on the basis of spore morphology and conidiogenesis (Kendrick 1971; Barnett & Hunter 1972), bacteria by a series of biochemical and plant tests (Schaad, 1994) and Viruses are usually identified by symptoms on sensitive indicator plants, serology and/or particle size and shape examined under electron microscope (Walkey, 1985). Conventionally, cultural methods have been employed to isolate and identify potential plant pathogens but constrained by slow procedure and requirement of skilled taxonomists to reliably identify the pathogen. Moreover, these methods possess drawbacks such as ambiguities in morphological characters, or the specific nutrient requirements, growth conditions of certain pathogens grown *in vitro*, time constraints imposed by slow growing pathogens *in vitro*, difficulty of culturing *in vitro*, and inability of their accurate quantification (Goud & Termorshuizen, 2003). These limitations have led to the development of molecular approaches with improved accuracy and reliability. A variety of molecular methods have been used to detect, identify and quantify plant pathogens. In contrast to the conventional methods, these methods are much faster, more specific, more sensitive, and more accurate, and can be performed and interpreted by personnel with no specialized taxonomical expertise. However, these techniques allow detection and identification of non-culturable microorganisms and can be distinguish closely related organisms at different taxonomic levels. Molecular techniques can also help to confirm the interception of a biosecurity risk pathogen within 2-3 days. Whereas, in contrast, traditional testing for some diseases in imported plant material requires 4-5 years or longer duration (Everett *et al.,* 2006). During last 30 years, the progress in molecular detection evolved, through invention of series of molecular techniques which include ELISA, Hybridization, PCR with number of variants and Microarray based detection, coupled with increasing sensitivity, quantitation, and multiplexing in pathogen detection. Thus, information regarding current state of art and the recent development in molecular detection of plant pathogen is addressed herewith.

1. Serology: This is the most commonly used method of detection of plant viruses. Many of the serological techniques have been employed for identification of plant viruses. Polyclonal antibodies being used in flocculation techniques (precipitin tube and precipitin-ring tests), diffusion tests in gels (Ouchterlony double-diffusion tests, radial diffusion), agglutination tests and electron microscope serology.

2. ELISA (Enzyme-linked immunosorbent assay): The application of serology was revolutionized following the development of the ELISA (Enzyme-linked immunosorbent assay) technique (Voller *et al.*, 1976; Voller & Bidwell 1977) and subsequent modification to the double-antibody sandwich technique (Clark & Adams 1977). This method allowed the use of small amounts of reagents and test tissue, and was easily applicable to processing large numbers of samples. The technique involves coating of 96-well polystyrene micro-titre plate with antibodies, then adding the plant tissue containing virus. Enzyme-conjugated antibodies then added and allowed to bind with any viral antigens that are present. After a washing step, enzyme substrate is added to the wells and the intensity of the colorimetric response measured using spectrophotometer (micro-titre plate reader). Comparison of spectrophotometric readings of samples infected with known virus and healthy controls allow the identification of virus-infected samples. The DAC-ELISA method is also developed an alternative to the double-antibody sandwich method (Fox, 1993).

3. Dip-sticks and dot-blot assays: Serological techniques have been exploited for field use in the dip-stick and dot-blot assays. It consist of nitrocellulose dip-sticks coated with antibodies which are dipped into the test specimen, or nitrocellulose sheets coated with 'dots' (small discrete aliquots) of antibodies to which 'dots' of macerated test specimens (infected twig) can be added. This is also called as Twig Imprint Blot. Further step of washing with enzyme-labeled antibodies and enzyme substrate produces a colorimetric response which can designate the test sample as either positive (colored) or negative (clear) (Mitchell *et al.,* 1988).

4. DNA based Methods of Detection: Based on nucleic acid of pathogen (DNA/RNA) and techniques of molecular biology, recently, more numbers of rapid techniques for pathogen detection have been developed.

PCR-Based Methods

In the advancement of molecular biology, variants of PCR have been exploited and developed number of PCR methods for detection of plant pathogens by several researchers at this juncture.

1. Conventional PCR: The polymerase chain reaction (PCR) is the most important and sensitive techniquepresently available for the detection of plant pathogens. PCR allows the amplification of millions of copies of specific DNA sequences by repeated cycles of denaturation, annealing and extension at different temperatures using specific oligonucleotides (primers), deoxyribonucleotide triphosphates (dNTPs) and a thermo stable *Taq* DNA polymerase in the adequate buffer. The PCR products can be visualized following gel electrophoresis, staining with ethidium bromide and then examined using a UV transilluminator. The presence of a specific DNA band of the expected size is an indicative of the presence of the target pathogen in the sample. Conventional PCR helps to identify pathogens at different taxonomic levels (genus, species or strain) depending on the specificity of the primers.

2. Nested-PCR and Cooperational-PCR (Co-PCR): This method comprises in two consecutive rounds of amplification in which two external primers amplify a large amplicon which is then used as a target for a second round amplification using two internal primers. Some improvements in the relative concentrations of the external and internal primers have permitted to perform the two reactions in a single closed tube supporting high throughput. This method has been widely used for detection and/or further characterization of numerous fungal pathogens (Hong *et al.,* 2010; Wu *et al.,* 2011; Qin *et al.,* 2011). Whereas, in Co-PCR single reaction containing the four primers, one pair internal to other, enhances the production of the longest fragment by the co-operational action of all amplicons (Olmos *et* *al.,* 2002). In both of the nested and Co-PCR methods, an external primer is being used for generic amplification and the internal primers for further and more specific characterization of the amplified product at species or strain level.

3. Multiplex PCR: This method comprises use of several PCR primers in the same reaction allowing the simultaneous and sensitive detection of different DNA targets with reduction in time and cost. This method is important in plant pathology where plants are usually infected by more number of pathogens. During this method different amplicon specific to the each of target pathogen were simultaneously amplified and identified on the basis of their molecular sizes on agarose gels. Multiplex PCR technique has been used for the simultaneous detection and differentiation of *Podosphaera xanthii* and *Golovinomyces cichoracearum* in sunflower (Chen *et al.,* 2008); for detecting *Phytophthora lateralis* in cedar trees and water samples (Winton & Hansen, 2001); for determining the mating type of the pathogens *Tapesia yallundae* and *T. acuformis* (Dyer *et al.,* 2001).

4. Magnetic Capture-Hybridization (MCH) PCR: This method used by Langrell & Barbara, (2001) for detection of *Nectria galligena* in apple and pear trees. The severe problems of PCR inhibitors frequent occurring during amplification process have been tackled in this technique. This method relies on coating of Magnetic beads with a biotinilated oligonucleotide which is specific of a DNA region of the fungus of interest followed by hybridization between the fungal DNA and magnetic beads-oligomer. Further this conjugate is separated from inhibitory compounds in the extract. After the magnetic capture-hybridisation, PCR amplification was carried out using species-specific primers.

5. PCR-ELISA: This is serological-based PCR method wherein both the forward and reverse primers 5' end labeled with biotin and an antigenic group (e.g. fluorescein), respectively (Landgraf *et al.,* 1991). PCR amplified DNA can be immobilized on avidin or streptavidin-coated microtiter plates via the biotin moiety of the forward primer and during colorimetric reaction of anti-fluorescein antibody to the antigenic group of the reverse primer can be quantified by an ELISA. This method is as sensitive as nested PCR and does not require electrophoretic separation and/or hybridization, and easily automated. This method was utilized in detection of several species of *Phytophtora* and *Pythium* (Bailey *et al.,* 2002).

6. Reverse Transcription (RT)-PCR: This method is enabled to differentiate living as well as non-living fungal pathogens. The method comprises reverse transcription of RNA by the enzyme *reverse transcriptase*. The resulting cDNA is then amplified using conventional or any other PCR-based method. Also this method is being used in monitoring of disease reaction under different developmental stages of plants.

7. *In situ* PCR: This method involves combination of techniques of PCR and in-situ hybridization. This technique comprises, initially PCR amplification of specific gene or target sequence from compact cell followed by confirmation through specific probe during hybridization process. The drawback of this method is non-specific DNA synthesis occurs during *in situ* PCR on tissue sections thus creates high background noise. Also, methodology of this technique is time-consuming and laborious.

8. Real-time PCR: This method is being considered as gold standard method of detection of plant pathogens. It is very sensitivity and specific method and beside detection, it allows accurate quantification of the target pathogen. It is a high throughput method used for the analysis of a large number of samples i.e 96 or 384 samples at the same time. However, with use of portable real-time PCR machines, it allows on site detection of pathogen under field condition. The principle of this method is based on the use of doubled-stranded DNA binding dyes (specific and non-specific) and probes mainly, SYBR Green, TaqMan, Molecular Beacons, Scorpions, or dye-primer based systems, such as hairpin primers or Plexor system. Recently, this technique has been utilized for detection of *Alternaria helianthi* causing blight disease of sunflower (Chavhan *et al.,* 2015).

9. Loop-mediated Isothermal amplification (LAMP): This method requires only a simple platform such as heating blocks or water bath instead of normal thermal cycler to produce rapid temperature changes. This method is also called as loop-mediated isothermal amplification (LAMP). LAMP is a powerful and novel nucleic acid amplification method that amplifies a few copies of target DNA with high specificity, efficiency, and rapidity through exploiting a set of four specially designed primers. This method was first described and initially used for detection of hepatitis B virus by Notomi *et al.* (2000). LAMP relies on auto-cycling strand displacement DNA synthesis in the presence of *Bst* DNA polymerase, specific primers and the target DNA template. However, the mechanism of the LAMP amplification reaction includes three steps viz., production of starting material, cycling amplification, and recycling. LAMP assays is being mostly used for the detection of bacteria (Chen *et al.* 2011), virus (Wang *et al.* 2011), and parasites (Iseki *et al.* 2007). It is also being used for rapid detection of pathogenic or allergenic fungi.

10. Fingerprinting: This DNA based method utilizes many of the target genomic regions including conserved as well as unique sequence regions of the pathogens. In general, this technique is being used to study the phylogenetic structure of plant pathogens. However, these techniques also useful for identification of specific sequences and their use for the detection of pathogen at very low taxonomic level, and even for differentiation of pathogen at strain level withdifferent host range, virulence, compatibility group or mating type. This method comprises utilization of nucleic acid of target pathogen,Primers pairs,*Taq* DNA polymerase and various restriction enzymes. Fingerprinting comprises several techniques mainly, Restriction fragment length polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified fragment length polymorphism (AFLP) and Microsatellites etc. These techniques being utilized for identification and differentiation of several fungal and bacterial plant pathogens..

DNA Hybridization Technology

1. DNA microarray: DNA microarray is a collection of species-specific oligonucleotides or cDNAs (probes) immobilized on a solid platform and subjected to hybridize with a labeled target DNA. These are membrane-based arrays contains spotted samples of 300 µm in diameter or more. It is represented in the form of higher density chips such as glass or silicon, or microscopic beads wherein thousands of sample spots (less than 200 µm in diameter) are immobilized. This method comprises labeling of PCR amplified target DNA followed by hybridization and quantification through generated fluorophore, silver, or chemiluminescence-labeled targets. It is generally being used for gene expression profiling but also exploited for identification and differentiation of plant pathogens (Anderson *et al.,* 2006). The detection and quantification of multiple pathogens present in a sample (tissue, soil and water) in a single assay is possible through this technique. This method was applied for identification of oomycete, nematode, bacterial and fungal DNA from pure cultures (Fessahaie *et al.*, 2003; Levesque *et al.,* 1998; Lievens, *et al.,* 2003 & Uehara *et al.,* 1999) in plant pathology research.

2. Reverse Dot-blot Hybridization (RDBH): The dot-blot is a simple and sensitive technology which is the nucleic acid equivalent of the ELISA test. Test samples are macerated and small aliquots ('dots') placed onto nitrocellulose or nylon membranes. Nucleic acid is baked (fixed) onto the membrane, which is then placed in a labeled 'probe' DNA solution. There are a number of labeling systems available including radioactivity, chemiluminescence or fluorescence. Following binding of the probe DNA to any template DNA on the membrane, excess probe is removed through washing. The membrane is then dried and exposed to X-ray film or the fluorescence is photographed. Positive reactions will be visible as dark dots on the developed film. This method is becoming more sensitive and more specific than equivalent serological techniques under only optimized conditions.

Sequencing

Most of the time morphological approaches are not potent to identify the pathogen. In this case sequencing based method may help in precise and accurate identification of plant pathogen. This method comprises PCR amplification of a target gene with universal primers, followed by sequencing and comparison with the sequence databases available at public domain. This method includes following sequencing platforms.

1. Massive sequencing techniques: Massive sequencing technologies are cost effective, throughputsequencing, having a tremendous impact on genomic research. They have been used for genome sequencing and quantification of sequence variation. The next-generation sequencing (NGS) technologies commercially available today include the 454 GS20 pyrosequencing-based instruments (Roche Applied Science), the Solexa 1G analyzer (Illumina, Inc.), and the SOLiD instrument (Applied Biosystems) etc (Capote *et al.,* 2012).

2. DNA barcoding: DNA barcoding is a taxonomic method that utilizes a short genetic marker in the DNA to identify an organism as belonging to a particular species. It has facilitated the description of numerous new species and the characterization of species complexes. Based upon different loci or gene sequences especially ITS region; nuclear genes encoding 60S ribosomal protein L10, ß-tubulin, enolase, heat shock protein 90, TigA fusion protein, and TEF1, mitochondrial gene *cox* II and spacer region between *cox* I and *cox* II genes sequences (Park *et al.,* 2008) have been utilized in database development and generation of DNA barcoding platform. Recently, the Consortium for the Barcode of Life (CBOL) is taking an international collaborative effort to generate a unique genetic barcode for every species of life on earth.

Till date numerous molecular detection techniques are now available and being utilized, but regardless of the approach, important questions viz., sensitivity, accuracy, robustness, frequency of testing and cost need to be clarified prior their inclusion into research. However, challenges yet remain to identify and detect unculturable fungi, cryptic species and characterization of diversity of fungal flora in different environments without bias wherein no one knows how many fungal species exist. There is necessity of development of speies-specific sequence database through NGS and pyrosequencing approaches in the order of improvement in the accuracy of current molecular detection.

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Epidemiology, Diagnosis and Integrated Management of Diseases of Pomegranate

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Introduction

Pomegranate (*Punica granatum* L.) belongs to family *Punicaceae* is an ancient fruit crop of India. It is native to Iran but extensively cultivated in Mediterranean regions specially in Spain, Morocco, Egypt and Afghanistan. It is also grown in Burma, China, Japan, USA, USSR, Bulgaria and Southern Italy. It is regarded as "vital cash crop" of an Indian farmer andis grown in an area of 1.3 lakh ha with a production of 11.0 lakh tones (Jadhav and Sharma, 2009). Among the different states growing pomegranate, Maharashtra is the largest producer occupying 2/3 of total area in the country followed by Karnataka, Andhra Pradesh, Gujarat and Rajasthan. The most popular varieties suitable for processing and table use are Ganesh, Mridula, Arakta, Bhagwa, Kesar, G-137 and Khandar. Pomegranate thrives well in dry tropics and sub-tropics and comes up very well in soils of low fertility status, adding to that it is salt tolerant too. The fruit has a wide consumer preference for its attractive, juicy, sweet, acidic and refreshing arils. There is a growing demand for good quality fruits both for fresh use and processing into juice, syrup and wine. Seeds with fleshy portions of sour pomegranates are dried and marketed as "Anardana", which is being used as a condiment for curries. Fruits are the important raw materials for wine industry because of easy fermentation. Other value added products are juice, jelly, anarub and rind powder. Pomegranate is good source of carbohydrates and minerals such as calcium, iron and sulphur. It is rich in vitamin C and citric acid is the predominant organic acid in pomegranate (Malhotra *et al.*, 1983). Glucose (5.46%) and fructose (6.14%) are the main sugars with no sucrose in fruits. The fruits of pomegranate are known to possess pharmaceutical and therapeutic properties. Sweet varieties are mildly laxative, sour types are good against inflammation of stomach and heartache. Flower buds are very useful in Ayurveda for managing bronchitis. The bark (stem) and rind (fruit) portion is used to treat diarrhea and indigestion (Anon., 1969). The bark of the stem and root contains number of alkaloids belonging to pyridine group. The bark is also used in tanning industry (Patil and Karle, 1990).

Area under pomegranate is increasing worldwide because of its hardy nature, wider adaptability, drought tolerance, higher yield levels, excellent keeping quality and remunerative prices in domestic as well as export markets. Pomegranate production is also associated with many problems like other crops. Inherent constraints are long dry spells, non-availability of suitable varieties, environmental vagaries, nutritional deficiencies, physiological disorders, post-harvest glut, post-harvest losses, improper storage and lack of marketing facilities, price fluctuation. Biotic constraints are pest and disease problems. Among these several constraints, losses due to pests and diseases are very high. Although, 25 to 30 per cent of total cost of production is being spent on plant protection especially pesticides, the biotic constraints could not be managed effectively.

Cultivation of high yielding varieties of pomegranate with intensive care and management in the recent past under irrigated condition with early stage exploitation of plant leads to certain severs pest and disease problems. Among the major diseases leaf spot, fruit spot and wilt results in reduction of pomegranate fruit yield and put the growers in to hardship. Pomegranate is susceptible to many diseases which affect the fruit quality and yield. The major fungal pathogens responsible for various diseases in Pomegranate are *Cercospora punicae, Colletotrichum gloeosporioides, Ceratocystis fimbriata, Fusarium fusarioides, Drechslera rostrata, F. oxysporium*, *F. moniliformae, Aspergillus niger*, *Alternaria alternate* ; and the bacterial pathogen *Xanthomonas axonopodis* pv. *punicae* (Madhukar and Reddy, 1989).

1. *Cercospora* leaf spot (*Cercospora punicae*):

Symptoms: The pathogen induce light brown zonate spots appears on the leaves and fruits; whereas, on twigs black and elliptic spots are formed. The affected areas in the twigs become flattened and depressed with raised edge, such infected twigs gradually dry up and in severe infection, whole plant may die.

The pathogen produces olivaceaus brown, short, fasciculate, sparingly septate and 20 to 40 x 3 µm conidiophores. Conidia are hyaline to pale olivaceaus cylindrical, sub-fusiod to sub-clavate and 40 to 50 x 3 µm in size.

Survival and spread: The pathogen spreads through wind borne conidia. The disease is serious during September to November.

Management: The disease can be effectively controlled by pruning and destruction of diseased twigs, followed by spraying with thiophanate methyl @ 0.1 per cent or chlorothalonil @ 0.2 per cent or mancozeb @ 0.2 per cent.

2. Anthracnose (*Colletotrichum gloeosporioides*):

Symptoms: The disease appears as small, regular to irregular dull violet or black spots surrounded by yellow margins on the leaves. The infected leaves turn yellow and drop off.

Survival and spread: The pathogen spreads through wind borne conidia. The disease is severe during Aug.-Sept. when there is high humidity and temperature between 20 to 27ºC.

Management: The disease is controlled by spraying with Carbendazim @ 0.1% or Thiophanate methyl @ 0.1% or Mancozeb@ 0.2% at fortnight interval.

3. Other Minor Leaf Spots :

a. *Sphaceloma punicae:* The disease attacks leaves, shoots, calyx and fruits. Rusty spots appear on leaves. Infected leaves turn yellow and die. Rusty coloured pustules appear on fruits. Drizzling rains and abundant dew favour disease development and spread. Spraying with Thiophanate methyl @ 0.1 per cent or Carbendazim @ 0.1 per cent controls the disease.

b. *Fusarium fusarioides:* The disease appears as minute specks towards the leaf margin. The spots are brown, circular to irregular in shape, which later coalesce forming a big dark, brown, necrotic blotch.

c. *Drechslera rostrata:* The disease is characterized by the appearance of numerous, small black spots scattered all over the fruit and the margin of spots varies from dark green to orange in colour. In advanced stages, few spots gradually enlarge and coalesce to form big dark spot of various sizes. Mild infection is confined to rind of the fruit, but severe infection extends to the inner tissues and even to the seeds, showing ashy discoloration. The fungus produces conidia which are pale to dark olivaceaus brown, cylindrical to rostrate, somewhat less curved, measuring 43.1 to 124.9 x 9.2 to 17.4 µm in size with 5 to 13 transverse septa and a minute hilum protruding from the based. The other end is bluntly tapered. The septa from basal and apical cells are prominent being thicker and darker than the intermediate septa (Arjunan *et al*., 2005).

4. Wilt (*Ceratocystis fimbriata*): *Ceratocystis* wilt is one of the major threats to pomegranate cultivation. Presently, majority of the pomegranate orchards are severely affected by this disease and its severity is increasing at alarming rate. The disease is prevalent in parts of a Maharashtra, Karnataka, Andra Pradesh, Gujarat and Tamil Nadu states (Jadhav and Sharma, 2009). Despite many factors conductive for the high severity of disease, seedlings selection for planting, soil borne nature of pathogen, association with shot hole borer and plant parasitic nematodes are major factors.

Symptoms: All the leaves in the plant turns to yellowing / light green colour, yellowing of leaves in the single branch, sudden wilting of leaves, complete wilting of the plant and pin holes with brown discoloration in the stem. Roots of diseased appeared brown to black with irregularly shaped lesions. Drooping of foliage of one or more branches of the plant and plants may take few days to 2-3 months to reveal complete wilting. Some plants reveal sudden drooping of all leaves of the plant resulting in complete wilting within one or two days of symptom initiation. The vascular wilt caused by *C. fimbriata* is characterized by grayish discolouration of bundles and adjoining tissues.

Survival and spread: *C. fimbriata* is soil borne and survive in soil through their thick walled conidia, alleurio conidia and chlamydospores, respectively. Scolytide beetles (*Xyleborus fornicatus*) act as a vector of this pathogen. Infected seedlings, irrigation water, root contact, implements, rain water, budding knife, secateurs and wind are the major sources for the spread of disease and pathogen enters through wounds.

Management: Drenching of diseased plants and also adjacent healthy plants with carbendazim (0.2%) or propiconazole (0.2%) + chlorpyriphos (0.2%) is effective for control of this disease. Soil application of *Trichoderma viride* @ 2 kg + 20 kg well decomposed compost or vermicompost per acre is also effective to control this disease.

5. Bacterial Blight / Oily spot (*Xanthomonas axonopodis* pv. *punicae*): Among the diseases infecting pomegranate, the bacterial disease popularly known as 'bacterial blight or oily spot' caused by *Xanthomonas axonopodis* pv. *punicae* (Hingorani and Singh) Vauterin *et al.* is one of the major production constraints. Chand and Kishun (1991) reported that the epidemics of bacterial blight caused 60 to 80 per cent losses in pomegranate. They isolated the causal organism and identified it as *Xanthomonas campestris* pv. *punicae* based on its pathological, cultural, biochemical and physiological features. Later on during 1995, Vauterin *et al.* re-named the causal organism as *Xanthomonas axonopodis* pv. *punicae,* on the basis of presence or absence of metabolic activity on different carbon substrates. Pomegranate cultivation in Maharashtra, now has been threatened due to incidence of bacterial blight (oily spot) disease (*Xanthomonas axonopodis* pv. *punicae*). The disease has been resulted in enormous losses to pomegranate orchards, as it renders the fruits unfit for consumption and market. Since 2002, the pomegranate growers are in dire straits due to the severe outbreak of bacterial blight. The disease, which was of minor importance earlier appeared as a serious threat in all the pomegranate growing regions of Maharashtra, Karnataka and Andhra Pradesh resulting in both qualitative and quantitative losses. The disease has spread like wildfire in the pomegranate plantation in the Maharashtra, particularly in the districts of Solapur, Sangali, Satara, Osmanabad and Latur (Suryawanshi *et.al*, 2010 and Ambadkar *et.al*, 2015). The disease continued to damage the crop, although farmers have adopted all possible and available protection measures. The disease could not be mitigated effectively due to rapid buildup of inoculums and its widespread occurrence. Pomegranate "the boon commercial fruit crop" to the farmer turned as a big bane after the severe outbreak of bacterial blight. Many growers finding no options to mitigate the disease effectively have uprooted their crop owing to unbearable losses. For the successful management of any disease under normal conditions, clean sanitation, eradiation of primary source and chemical protection at initial stages are some of the measures recommended. However, these measures are not enough, whenever the outbreak of disease occurred. Hence, thorough understanding of the disease epidemiology and concrete package is necessary to address the menace effectively, so as to save the crop at large. Now, it is learnt that, bacterial blight of pomegranate is wide spread and is a major production constraint. The disease prevailed in all the seasons with varying degree of severity. Now, it is the established fact that, weather factors play an important role in the inhibition and spread of the disease. In recent days, lot of emphasis is being given on weather based forecasting models for prediction of disease outbreak. There is ample information available on the source of survival of the pathogenic bacterium in the infected plant residues. The vital role of infected fallen leaves in the survival of pathogenic bacterium causing leaf spot of various crops is well established. Similarly, the infected plant residues of pomegranate, such as leaf, stem and fruit, which are left out in the field after the harvest of the crop serve as a primary source of inoculum for subsequent season to initiate the disease. But, the information on period of survival of the pathogen is still in question. The continuous presence of the pathogen in the garden throughout the season has led to many fold speculations on possible survival of the pathogen on some alternate hosts grown in and around the garden. There is little information available on chemical management of bacterial blight of pomegranate, but there is large number of chemicals available in the market as bactericides and their bioefficacy and suitability needs to be verified by in vitro and field studies, so as to incorporate the effective ones in the management package. In recent years, there has been a major thrust on residue free organic pomegranate production. Taking the task into consideration, efficient botanicals and bioagents need to be explored to fit into the management schedule. Many a times, plant nutrients also play an important role in susceptibility or resistant mechanism of the host to different pathogens. Research on this aspect needs to be triggered to find out actual role of plant nutrients in bacterial blight development/suppression.

Considering all these facts National Horticulture Mission, Govt. of India has launched a Network Project on Mitigating Bacterial Blight Disease of Pomegranate in Maharashtra, Karnataka and Andhra Pradesh under the supervision of National Research Centre on Pomegranate, Solapur.The results of this project indicated the possibility of management of Bacterial Blight Disease. The scientist of NRC Pomegranate, Solapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Mahatma Phule Krishi Vidyapeeth, Rahuri, University of Agriculture Sciences, Dharwad and IIHR, Banglore have developed a schedule of spraying for management of major and minor diseases as well as pest of pomegranate which is found beneficial in integrated disease management of bacterial blight and other problems of pomegranate.

Symptoms: Small irregular, water-soaked spots appear on the leaves. Spots vary from 2 to 5 mm in diameter with necrotic centre of pin – head size. Spots are translucent, later turn light brown to dark brown and are surrounded by prominent water-soaked margins. Spots coalesce to form large patches. Severely infected leaves fall off.

The bacterium attacks stem, branches and fruits also. On the stem the diseases starts as brown to black spots around the nodes. It leads to girdling and cracking of nodes. Finally the branches break down. Brown to black spots appears on pericarp with L, V and Y shaped cracks. The spots on the fruit are raised and oily in appearance.

Survival and spread: The bacterium survives on the tree. The pathogen survives for 120-180 days on the fallen leaves during off season. Primary infection occurs through infected cuttings, whereas secondary infection occurs through wind and rain splashes.

It is a gram negative, rod shaped, aerobic, non spore forming bacteria motile with single flagellum. The size of bacterium is 1.0-3.0 µm x 0.4-0.75 µm.

Key Phenotypic Characters of *X. axonopodis* pv. *punicae*

1. No Growth >37°C
2. Growth slow which takes ≥ 72 hours
3. No growth at or above 2 % salt concentration
4. No growth at or below pH 6 and at or above pH 8.0
5. All virulent Xap produces Fuscan pigment in media.

Factors Favourable for Blight Development

1. Relative humidity – Rh > 30.0% (Rapid >50%)
2. Rainfall: 0.1 mm rain sufficient
3. Wind speed
4. Temperatures between 25.0°c to 35.0°c

Management

Sanitation Measures:

a. Drenching with bleaching powder (a.i. 33% Cl) every 3 months @ 25 Kg / 1000 lit. water / ha on ground below the canopy.
b. Disinfection of pruning tools such as secateurs, pruning knife etc. after handling each plant with sodium hypochlorite (2.5%).
c. Sanitation of orchard.

Chemical control:

a. Spraying with Streptocycline (5g / 10 lit. water) + 2 Bromo, 2 Nitro Propnae, 1,3 Diol (Bronopol / Bacterinashak / Black Out) (5g / 10 lit. water) + Copper Hydroxide (Kocide) (20g /10 lit. water) + Spreader / sticker (5ml / 10 lit. water). OR
b. Streptocycline (5g / 10 lit. water) + 2 Bromo, 2 Nitro Propnae, 1, 3 Diol (5g / 10 lit. water) + Carbendazim (10g / 10 lit. water) + Spreader/sticker (5ml / 10 lit. water). OR
c. Streptocycline (5g/10 lit. water) + 2 Bromo, 2 Nitro Propnae, 1,3 Diol (5g /10 lit. water) + Copper oxychloride (20g / 10 lit. water) + Spreader / sticker (5ml/10 lit. water). OR
d. Streptocycline (5g/10 lit. water) + 2 Bromo, 2 Nitro Propnae, 1,3 Diol (5g/10 lit. water)+ Mancozeb (20g / 10 lit. water)/ + Spreader / Sticker (5ml / 10 lit. water).

Precautions to be Taken

1. Production of disease free planting materials.
2. Shift to *hasta bahar* crop.
3. Sanitation of orchard.
4. Proper rest to the crop.
5. Adopt uniform *bahar* and management schedule.
6. Unattended orchards should be removed.
7. Use of recommended fertilizers.
8. Follow recommended spray schedules of plant protection.

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Assessment of Newly Developed High Yielding & High Oil Content Yellow Mustard Variety (Pitambari) through On-Farm Trials (OFTs): Case Study

Article ID: 48942

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Details of On-Farm Trials (OFT's)

An On-Farm Trial was conducted on Yellow Sarson variety Pitambari for Assessment of yield performance & oil quality. Different yield contributing traits such as 1000-seed wt (g), Yield (q/ha.), Oil content (%), cost of cultivation, B : C ratio, etc. were observed for farmers acceptance and adaptation of Yellow Sarson variety.

Table-1: Details of On-Farm Trials conducted during Rabi, 2022-23:

Particulars	Contents
Crop	Yellow Mustard
Title	Assessment of newly developed high yielding & high oil content yellow mustard varieties.
Problem diagnosed	Low performance of normal mustard variety.
Farming situation	Irrigated
Details of technology identified for solution	T1- Farmers practice (B-09) T2- New high yielding yellow sarson variety (Pitambari)
No. of farmers	12 (Plot size-666 m2/treatment), area= 0.8 ha.
Replications	12
Critical inputs	Seeds of Pitambari yellow sarson variety.
Production system	Rice-Wheat/Mustard
Source of technology	CSAUA&T, Kanpur.
Observation to be recorded	(i) 1000-seed wt (g), (ii) Yield (q/ha.), (iii) Oil content (%), (iv) Cost of cultivation, (v) B: C ratio, (vi) Quality acceptance
Reaction of the farmers	Acceptance

Technology Assessed or Refined (as the Case may be)

Assessment of suitable variety of Yellow Sarson (Pitambari). K.V.K. Amroha conducted on-farm trial to assess the high yielding variety of Yellow Sarson under timely sown Condition (**Pitambari**). The Yellow Sarson variety sown in November 2022 with full package and practices. The problem assessed on the basis of suitable and high yielding & high oil content yellow sarson (Var. Pitambari) under irrigated condition.

Table-2: Effect of Yellow sarson (Pitambari) over to Control:

Technology Option	No. of trials	Yield (kg/ha)	% Increase in yield	Net Return (Rs./ha.)	B.C. Ratio
T1– Farmers Practice (B-09)	10	12.50	-	43550	2.73
T2 – Pitambari		15.45	19.09	59475	3.37

Recommendations: The data showed in table that T_2 (**Pitambari*)*** is more suitable in relation to yield as compared to T_1. Farmers practice (B-09) recommend to the farmers of Amroha district to use Pitambari for irrigated condition good yield (19.09% more) and hgh oil recovery.

Farmers reactions: Use of Pitambari variety is good for yield and high oil recovery.

Assessment of New High Yielding Wheat Variety (DBW-173) & their Characterization Under Late Sown Condition through On-Farm Trials (OFT): Case Study

Article ID: 48943
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Details of On-Farm Trials (OFT's)

An On-Farm Trial was conducted on late sown Wheat variety DBW-173 for Assessment of yield performance & quality of Wheat variety. Different yield contributing traits such as Number of tillers/plant, 1000-grain weight (g), Yield (q/ha), cost of cultivation, B : C ratio, etc. were observed for farmers acceptance and adoration of Wheat variety.

Table-1: Details of On-Farm Trials conducted during Rabi, 2022-23:

Particulars	Contents
Crop	Wheat (Rabi 2022-23)
Title	Assessment of new high yielding wheat varieties & their characterization under late sown condition.
Problem diagnosed	Low yield & poor quality of wheat varieties
Farming situation	Irrigated
Details of technology identified for solution	T1- Farmers practices T2- New high yielding wheat variety (DBW-173/HD-3298)
No. of farmers	12 (Plot size 666 m2/treatment), area= 0.8 ha.
Replications	12
Critical inputs	Seeds of new high yielding variety
Production system	Rice-Wheat system
Source of technology	University/Private
Observation to be recorded	(i) No. of tillers/plant, (ii) 1000-grain wt., (iii) Yield (q/ha.), (iv) Cost of cultivation, (v) B: C ratio, (vi) Protein content (vii) Acceptance
Reaction of the farmers	-

Technology Assessed or Refined (as the Case may be)

Assessment of suitable variety of late sown Wheat. K.V.K. Amroha conducted on-farm trial to assess the high yielding varieties of wheat under late sown Condition (**DBW-173**). The wheat variety sown in November 2022 with full package and practices. The problem assessed on the basis of suitable and high yielding wheat variety under late sown condition.

Table-3: Effect of Wheat variety DBW-173 over to Control

Technology Option	No. of trials	Yield (kg/ha)	% Increase in yield	Net Return (Rs./ha.)	B.C. Ratio
T_1– Farmers Practice (DBW-373)	10	36.00	-	517500.00	2.25
T_2 – DBW-173		46.50	22.58	77125.00	2.81

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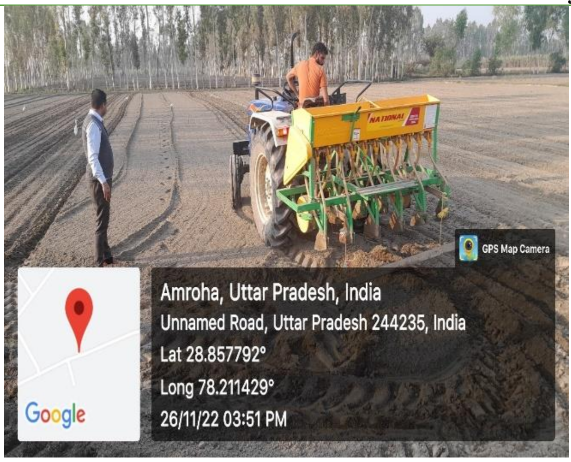
Recommendations: The data showed in table that T_2 (**DBW -173)** is more suitable in relation to yield as compared to T_1. Farmers practice (DBW 373) recommend to the farmers of Amroha district to use DBW –173 for late sown condition good yield (22.58% more) and against pest & diseases.

Farmers reactions: Use of DBW – 173 variety is good for late sown condition.

	
Sowing of DBW-173 Wheat variety	**Performance of DBW-173 at farmers field**

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Organized On & Off-Campus Farmers Training Program

Article ID: 48944

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Off-Campus Farmers Training Detail

An off-campus farmers training was organized under Plant Breeding in Kumrala village, Gajraula block, Amroha on 18/08/2022. Total 20 farmers attended the training programme. During the training programme scientists were discussed about varietal diversification of rapeseed & mustard varieties. Farmers were highly satisfied from the training prograame and also implicated the technology and seed/ variety for mustard sowing in rabi-2022.

Off-Campus Farmers Training Detail

An off-campus farmers training was organized under Plant Breeding in Neelakheri vilulage, Dhanora block, Amroha on 20/08/2022. Total 20 farmers were attended the training programme. During the training programme scientists were discussed about varietal diversification of Sugarcane varieties. Farmers were highly satisfied from the training prograame and also implicated the technology and seed/ variety for Sugarcane transplanting.

On-Campus Farmers Training Detail

An on-campus farmers training was organized under Plant Breeding Discipline at Krishi Vigyan Kendra (KVK), Amroha on 30/08/2022. Total 20 farmers/farm Women were attended the training programme. During the training programme scientists were discussed about Roughing techniques and its importance in paddy seed production programme. Farmers were highly satisfied from the training programme and also implicated the technology in paddy seed production programme.

Off-Campus Farmers Training Detail

An off-campus farmers training was organized under Plant Breeding Discipline in Village-Khayalipur, Amroha on 27/09/2022. Total 20 farmers/farm Women attended the training programme. During the training programme scientists were discussed about New varieties of mustard & their production techniques. Farmers were highly satisfied from the training programme and also adopted the newly released mustard varieties in their cultivation practices.

Off-Campus Farmers & Farm Women Training Detail

An off-campus farmer & farm women training was organized under Plant Breeding Discipline at Pal village, Gajruala, Amroha on 18/01/2023. Total 20 farmers/farm Women attended the training programme. During the training programme scientists were discussed about “Roughing techniques in wheat crop”. Farmers were highly satisfied from the training programme and also adopted the practices for quality seed production of wheat crop.

Off-Campus Farmers & Farm Women Training Detail

An off-campus farmer & farm women training was organized under Plant Breeding Discipline at Majhola village, Gajruala, Amroha on 18/01/2023. Total 20 farmers/farm Women attended the training programme. During the training programme scientists were discussed about “Roughing techniques in Mustard crop”. Farmers were highly satisfied from the training programme and also adopted the practices for quality seed production of wheat crop.

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Some important good quality photographs of farmers training program

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Technology Demonstrated in the Technology Park/Crop Cafeteria

Article ID: 48945

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New High Yielding Basmati Rice Variety Pusa Basmati-1718

Basmati Rice variety Pusa Basmati-1718 is a high yielding, scented, strong aroma, extra-long slender grains, very good kernel length after cooking, intermediate amylose content, having high protein content & resistant to bacterial blight diseases. This variety are recommended for cultivation in Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Haryana, Punjab & Rajasthan.

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Monitoring the sowing of field crops in the Technology Park/Crop Cafeteria

Monitoring the sowing of other field crops like pulses, oilseeds, cereals & millets in the Technology Park/Crop Cafeteria. The high yielding varieties of different crops were sowing in the Technology Park/Crop Cafeteria for showing demonstrations to the farmers. On the basis of demonstration performance technology will be recommended for large scale adaptation.


Monitoring the Germination, Roughing & Weeding in the Varietal Demonstration Trial

Monitoring the germination of different varietal trial for calculating the germination percentage. Roughing were done for proper maintenance of plant population, physical purity as well as genetic purity in the varietal trial through removal of off-types, weed plants & other crop plants. For proper growth weeding were done for removal of weeds & other unwanted crop plant competitors.

Technology Park/Crop Cafeteria Visited by Dignitaries

Director Extension & other official staff visited the varietal demonstration trial in the Technology Park/Crop Cafeteria at Krishi Vigyan Kendra, Gajraula, Amroha.

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Flying Foes: Decoding the Whitefly Invasion in Coconut Groves

Article ID: 48946

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Introduction

Whiteflies are the small insects of the Aleyrodidae family which ranges from 1-3mm. In life cycle of whitefly there are, four primary phases(egg, nymph, pupa and adult). Basically the female whiteflies lays egg on the underside of leaves, then the egg develop into small, wingless nymphs that are " crawlers". nymphs uses its piercing and sucking mouth parts to feed on the plant sap. They undergo multiple moults during their growth before reaching the pupal stage. They are motionless and covered in a protective layer while they are pupae. When the adult whiteflies eventually emerge from the pupal case, they start feeding on the sap. These whiteflies can pose a serious threat to both agricultural and horticultural crops. Among the horticultural crops, coconut ecosystem is majorly affected by these whiteflies. Effective management strategies often involve a combination of cultural, biological, and chemical control methods.

List of whitefly species attacking coconut ecosystem:

S.No.	Whitefly species	Scientific name
1	Spiralling whitefly	*Alyerodicus dispersus*
2	Rugose spiralling whitefly	*Alyerodicus rugioperculatus*
3	Bondar's nesting whitefly	*Paralyerodes bondari*
4	Nesting whitefly	*Paralyrodes minei*
5	Palm infesting whitefly	*Alyrotrachelus atratus*

Origin of Invasive Whitefly

1. **Spiralling whitefly** was first identified in Hawaii (1987) on *Terminalia catappa*(Indian almond tree), In India it was first identified in Trivandrum in Tapioca.

2. **Rugose spiralling whitefly** was first identified in Florida (2009) and in India it was identified in Pollachi in coconut tree in 2016.

3. **Bondar's nesting whitefly** was first identified form Brazil in citrus, in India it was identified in Kerala in 2018 in coconut.

4. **Palm infesting whitefly** was identified in Brazil, in India, Mandhya District of Karnataka in coconut.

Species Differentiation

Normally, whitefly pupa is used for species differentiation based on morphological characters. It has 6 pairs of abdominal / compound pores and it has vasiform orifice , operculum and lingula. Based on the number of abdominal pores and shape of lingula species differentiation is done.

Whitefly species	Egg	Pupa	Adult
Rugose spiraling whitefly (RSW)	Yellowish, elliptical and laid singly	8 pairs of compound pores; acute/ triangular shape of lingula..	Adult having greyish eyes; wings having dark spots on forewing
Bondar's nesting whitefly (BNW)	Eggs laid in nest which is construct by wax, nest is highly compact and rigid	6 pairs of compound pores, it is flower petal like; lingual is short	Adults having 'x' shaped oblique greyish bands on forewing
Nesting whitefly	Eggs laid in loosely	Same as bondar's	It resembles BNW; but

	woven woolly wax nests	nesting whitefly	devoid of 'x' shaped greyish band on forewing.
Palm infesting whitefly	Eggs are stalked and laid in semicircular pattern groups, initially creamy white in color, turn to black before hatching.	Margin has serrations, rounded lingula is present.	Same as rugose spiraling whitefly but it is smaller than RSW.

Management Practices

Cultural Control:

a. Remove alternate weed hosts
b. Field sanitation
c. Prune Infested Plant.

Mechanical control:

a. Use yellow sticky traps
b. High-pressure water spray
c. Uses of reflective mulches in vegetable garden.

Biological control:

a. Parasitoid - *Encarsia guadeloupae*, *E. haitiensis, E. formosa* @ 100 parasitoids /ac (10 leaf bits/ac) & reintroduce parasitized pupae.
b. Predators - *Jauravia sp, Nephaspis oculata* against RSW, *Clitostethus arcuatus, Harmonia axiyridis, Chrysoperla zastrowi sillemi* eggs @ 400/ac;
c. Mould scavenger beetle, *Leiochrinus nilgirianus*.

Chemical control:

a. Neem oil 3%(teepol or sandovit @ 1ml/l), NSKE 5%.
b. Boiled maida paste @25g/lit of water 1% starch solution against sooty mould
c. Fish oil rosin soap @ 25g/l
d. Insect growth regulators
e. Azatin/Ornazin/AzaDirect (azadirachtin), Enstar II (kinoprene), Pedestal (novaluron), and Talus (buprofezin).

IPM Packages

1. Continuous monitoring on pest population using yellow sticky traps
2. Avoid transportation from infested areas
3. Release of *Dichochrysa sp*. @ 1000eggs/ha at 15 days interval
4. Field insectary technique: Field collected parasitized pupae was placed in or on the other whitefly infested areas
5. Pesticide holiday: Application of insecticide may be avoided to enhance natural parasitism
6. Planting reservoir / banker plant (Banana, *Canna indica*) to attract natural enemies
7. EPF *Isaria fumosorosea* @2x108 spores/ml(5g/l of water) at 15days interval
8. Absence of natural parasitism, neem oil 1% may applied
9. Awareness program for buildup of *Encarsia guadeloupae* is to conducted in all epidemic zone.

Conclusion

In summary, invasive whitefly species are a major threat to agricultural and horticultural crops, especially coconut ecosystems. Knowledge of the life cycle and characteristics of different whitefly species is essential for effective management. Cultural, mechanical, biological, and chemical control methods provide a multimodal approach to combat these pests. Options include eliminating alternative weed hosts, using biological control agents, and implementing integrated pest management strategies. The use of natural enemies, continuous monitoring, and avoiding transportation from infested areas are essential components of integrated pest management packages.

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How Nature's Tiny Heroes Battle: Exploring the Cassava Mealybug and its Parasitoid?

Article ID: 48947

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Introduction

In the complex network of agricultural ecosystems, few opponents are as challenging as the cassava mealybug (*Phenacoccus manihoti*). Originating from South America, this insect's insatiable hunger and rapid breeding capabilities have resulted in considerable harm, endangering both food security and the economic well-being of communities where cassava is a predominant crop. Conventional approaches to pest management have frequently proven ineffective, either because of environmental issues or the mealybug's capacity to build up a resistance to synthetic insecticides. However, a ray of hope emerges from nature in the shape of a diminutive yet powerful comrade: The parasitoid. The mutualistic bond between the cassava mealybug and its parasitoid presents a captivating insight into the intricate equilibrium of ecological relationships. By utilizing a variety of complex mechanisms, the parasitoid plays a crucial role in controlling mealybug populations, presenting a viable and enduring remedy to the difficulties presented by this stubborn pest.

Biology and Symptoms of Cassava Mealybug

The cassava mealy bug *P. manihoti* is an Oligophagus insect that reproduce by parthenogenesis and goes through 4 instars. Adults are pink, body covered with waxy bloom and the size may vary from 1.10-2.6mm long & may lay upto 500 eggs on underside of the leaves. Optimum temperature for population is between 20°C- 30°C. The cassava mealybug has a poor survivability during rainy season because it may washed off. The mealybug sucks nutrients from the plants, leading to leaf distortion, shedding, and stem decline causes dieback. During feeding, mealybugs excrete honeydew, which lands on leaves and attracts colonization by sooty mould fungi, hindering gas exchange and photosynthesis, ultimately leading to death of the plant.

***Apoanagyrus lopezi*:** One of the frequently utilized natural enemies for managing the spread of cassava mealybugs is the wasp species *Apoanagyrus lopezi* (De Santis) (Hymenoptera: Encyrtidae). In 1980, these wasp were used to control mealy bug in cassava fields of west Africa and reduces pest population by 80–90%. The introduction of *A. lopezi* wasps to Thailand in 2009 to manage the mealybugs outbreak in affected cassava fields due to their specific predation on this pest. Guidelines exist regarding the appropriate method of releasing *A. lopezi* wasps in response to a cassava mealybugs infestation. The release of the parasitic wasp *A. Lopezi*, at a ceremony organised and hosted by the Thai Department of Agriculture in the country's Northeastern Khon Kaen province. Large-scale deployment of this parasitoid was done in Africa and was successfully achieved in Thailand and several other Southeast Asian countries in 2010. In 2010, huge number (lakhs) of wasp were air dropped in Thailand to control mealy bug and the results were amazing.

In India the pest was first reported in Thrissur, kerala in 2020. Even though a lot of native natural enemies were there but none found successful. The *A. lopezi* was imported from IITA (International Institute of Tropical Agriculture) subcenter Benin during 13 Aug 2021 for management on cassava mealybug in India. First field release programme after the mandatory quarantine studies was hosted by TCRS (Tapioca & Castor Research Station) on 7 March 2022 at Yethapur, Salem.

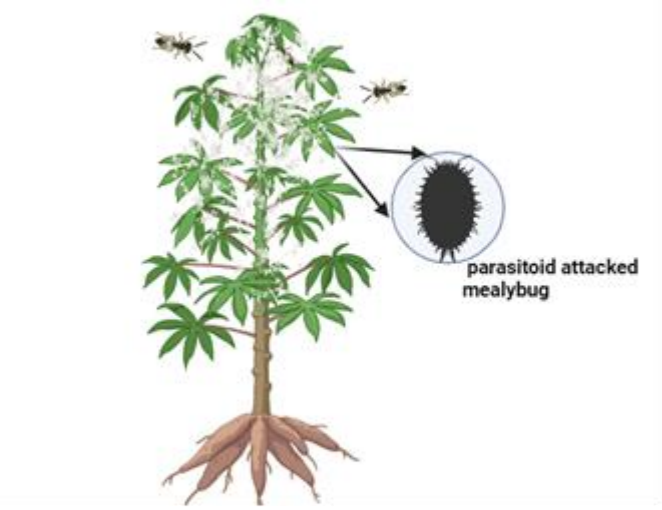
Field Release of Parasitoid

It is recommended to release these wasps either once or thrice every three weeks upon the initial detection of cassava mealybugs in an infested cassava field. The suggested quantity of *A. lopezi* wasps to be released in a cassava field, such as 200 pairs per rai (0.16 ha) is ideal.

Release should be either in morning or in evening. Release from multiple points in the field for the uniform distribution of these parasitoid.

Avoid application of pesticides in the field after release if it is inevitable leave a small space in the released field.

Diagram Represents the Host Parasitic Activity



Conclusion

In conclusion, exploring cassava mealybug and its parasitoid dynamic relationship, we gain insight into the delicate balance of ecosystems and the vital role played by these tiny heroes in maintaining agricultural sustainability. As we continue to study and understand these interactions, we unlock valuable knowledge that can inform innovative solutions for pest management, ensuring the resilience of our food systems for generations to come.

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Secret of Indian Herbs

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Introduction

India is one of the twelve mega biodiversity centers having about ten per cent of the world's biodiversity wealth, which is distributed across sixteen agro-climatic zones. Out of 17,000 species of higher plants reported to occur within India, 7500 are known to have medicinal uses which are being used by several ethnic communities in India. Non timber forest products account for seventy percent of India's forest product exports and the demand for photochemical is expected to increase in future as a new frontier for trade. India has probably the oldest, richest and most diverse cultural traditions in the use of medicinal plants. According to estimations the Trans Himalayas possess 700, Himalayan regions 2500, Desert areas 500, Semi-Arid areas 1000, Western Ghats 2000, Deccan Peninsula 3000, Gangetic Plain 1000, North-East India 2000, Islands 1000 and Coasts 500 medicinal plants. These plants are the secret of Indian health from more than 3000 years

Ayurveda, the oldest medical system in the Indian subcontinent, has alone reported approximately 2000 medicinal plant species, followed by the Siddha and Unani medical systems. The Charaka Samhita, an age-old written document on herbal therapy, reports on the production of 340 herbal drugs for curing various diseases. Currently, approximately 25% of drugs are derived from plants, and many others are synthetic analogues built on prototype compounds isolated from plant species in modern pharmacopoeia. More than 7, 00,000 practitioners of Ayurveda, Siddha, Unani, Yoga, Naturopathy and Homeopathy are registered in the Indian Systems of Medicine and also a sizeable number of practitioners are not registered. There are 9493 manufacturing units, 22,635 dispensaries and 1355 hospitals of the Indian Systems of Medicine. Approximately 800 species of medicinal plants are in active trade and still there is a gap of 40,000 metric tons in the demand and supply of medicinal plants. The major source of medicinal plants is the forest area and about ninety per cent medicinal plants are collected from the wild, which generates about 40 million man-days of employment (Ved and Goraya, 2007).

Exploration Medicinal Plants

Exploration for forest-based plant products for new pharmaceuticals and the demand for medicinal plants are increasing in both developing and developed countries especially among the youth. Surprisingly, the bulk of the traded material is still from the wild and a very small number of species are cultivated. According to the data compiled by the International Trade Centre, Geneva, India is ranked second amongst the exporting countries, after China. Recent trends have indicated further increase in this trade with the herbal cosmetic industry playing a major role in fuelling the demand for herbals worldwide. With the Indian Skin Lightening Market valued at $191 million with an annual growth rate of 16 per cent, fairness is the largest and most important segment in skin care category standing at Rs. 434 crores as of 2008 and growing at a phenomenal 18 per cent. A recently conducted survey reports that there is a huge potential market for whitening products among the age group 25-40. There would be around 100 per cent increase in demand for these products (Anon., 2009). In addition to the international trade, there is a substantial volume of internal trade in medicinal plants in India.

As per the estimation by National Medicinal Plants Board, New Delhi and Foundation for Revitalisation of Local Health Traditions, Bangalore the Annual Demand for Botanical Raw Drugs (Dry Wt.) during 2005-06 for Herbal Industry 1, 77,000 metric tons, Rural Households 86,000 metric tons, Exports 56,500 metric tons which is summing up to 3, 19,500 metric tons, which possess a Annual Trade Value 627.90, 86.00, 354.80 and 1068.70 crores, respectively (Ved and Goraya, 2008). The expanding trade in medicinal plants has serious implications on the survival of several plant species, many of which are under threat of

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becoming extinct. Today this rich biodiversity of medicinal plants is facing a serious threat because of the rapid loss of natural habitats and overexploitation of plants from the wild resources. To meet the demands of the Indian herbal industry, medicinal plants are being harvested every year from some of 165 000 ha of forests.

Endangered and Threaten Medicinal Plants

The following species of medicinal plants from India have been considered to be endangered and threatened for over a decade: *Acorus calamus, Alpinia galanga, Commiphora wightii, Dendrobium nobile, Dendrobium pauciflorum, Dioscorea deltoidea, Diplomeris hirsuta, Gentiana kurroo, Nelumbo nucifera, Paphiopedilum druryi, Podophyllum hexandrum, Rauvolfia serpentina, Santalum album*, *Saussurea lappa*, *Saraca asoca, Picrorrhiza kurroa, Costus speciosus, Berberis aristata*, *Gloriosa superba*, etc.

The Medicinal Plant Specialist Group met in September 1996 in Nairobi and resolved to identify the 'Top 50' medicinal plant species for conservation. The Group listed five steps to identify both global and regional priority species. The Indian Subcontinent Plant Specialist Group that met in January 1998 identified the following species of medicinal plants for detailed study and protection: *Abrus precatorius, Adhatoda vasica, Centella asiatica, Costus speciosus, Gloriosa superba, Rauvolfia serpentina, Saraca asoca, Streblus asper, Tribulus terrestris* and *Withania somnifera*.

State Forest Departments (SFDs) of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Maharashtra, in consultation with the Foundation for Revitalisation of Local Health Traditions (FRLHT) and with the support of DANIDA and UNDP have established 54 forest gene bank sites called Medicinal Plant Conservation Areas (MPCA). The network of 54 MPCAs, measuring 200 ha to 500 ha each, has been established gradually since 1993 and represents all forest types with large bio-climatic and soil regime variation. These gene banks harbour 45% of recorded populations of flowering and medicinal plants of Peninsular India, including 70% of the red-listed. The MPCAs provide the authentic plant material for propagation and research.

Since the beginning of this century, more than half of the world's tropical forest area has been destroyed. Experts estimate that only 5-10% of all plants in the world have been systematically investigated for their pharmacological activity. Many of them are threatened in the tropical forest. A strong strategy in terms of conservation through biotechnology and legal matters has to be developed. To address the need for conservation of native medicinal plant species of India, the country needs to establish a network of forest sites across the bio geographic regions of the country. However, a network of in situ gene banks, in the forest habitats is the most cost-effective way to manage the intra- and interspecific diversity. Various institutes are working on specific species for the conservation of germplasm.

Some of the Endangered and Threaten Medicinal Plants

			
Acorus calamus	***Dendrobium nobile***	***Alpinia galanga***	***Commiphora wightii***
			
Gloriosa superba	***Berberis aristata***	***Costus speciosus***	***Rauvolfia serpentina***

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Entomopathogens

Article ID: 48949

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Introduction

Biological control of insect pests includes parasitoids, predators, and entomopathogenic microbial agents involves to reduce pest populations. An increasing number of recent studies demonstrate that entomopathogens play a vital role to control the pests, including endophytism, plant disease antagonism, plant growth promotion, and rhizosphere colonization. Several types of naturally occurring, viz. fungus, bacteria, viruses, and nematodes are present. Viruses, bacteria are host-specific, while fungi have a greater host range, and they may infect both soil-dwelling and aboveground pests.

Entomopathogenic Fungi

The term entomopathogenic fungi refer to a fungus which induce disease symptoms in host insect but does not diminish host's life span. Out of 700 species of fungi, about 90 genera are entomopathogenic because of their wide range activity against a variety of sap sucking as well as chewing insect pests. Entomopathogenic fungi such as *Verticillium lecanii, Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi, Isaria, Lecanicillium, and Hirsutella.* Hence are most commonly used mycobiocontrol agent or green pesticides. *Beauveria bassiana* and *Metarhizium anisopliae* are two of the most important and widely used entomopathogenic fungi (EPFs) to control insect pests. *B. bassiana* and *M. anisopliae* can colonize a variety of plants, including but not limited to wheat, soybean, rice, bean, onion, tomato, palm, grape, potato and cotton.

Table 1: Recent studies investigating the effect of entomopathogenic fungi against insect pests:

Entomopathogenic fungi	Insect orders
Metarhizium anisopliae sensu lato	Acari, Blattoidea, Diptera, Coleoptera, Hemiptera, Isoptera, Lepidoptera, Orthoptera
Aschersonia aleyrodis	Hemiptera (Aleyrodidae)
Aspergillus sp.	Orthoptera
Beauveria bassiana sensu lato	Acari, Coleoptera, Diplopoda, Diptera, Lepidoptera, Orthoptera, Siphonoptera
Hirsutella thompsonii	Acari
Metarhizium acridum	Orthoptera
Nomuraea rileyi	Lepidoptera

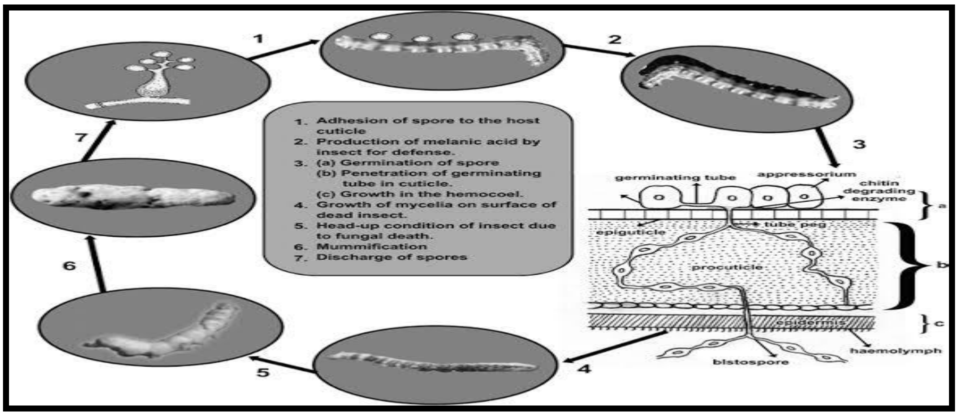

Figure 1: Mode of action - *Metarhizium anisopliae*

Entomopathogenic Bacteria

Entomopathogenic bacteria can be utilized as a stand-alone pest management tool, they are best employed in rotation or in combination with insecticides to provide maximum efficacy and environmental sustainability. *Bacillus popillae* causes milky illness in scarabaeids, while *Bacillus sphaericus* is a mosquito-borne infection. *Bacillus thuringiensis* is a common entomopathogenic agent that is used to control caterpillars and beetles. *Bt* is a bacterium that produces spores. Crystals ingested disintegrate in the stomach and are broken by host proteases to generate an active toxin known as endotoxin. This bacterium produces parasporal bodies (crystals) that contain unique insecticidal endotoxins (Cry proteins) that act through ingestions via a pore-forming mechanism that is harmful to the insect gut epithelium. The Cry toxins (-endotoxins), are now commercially available for use against a wide range of insect pests, including Lepidoptera, coleoptera, and diptera species.

The strain HD-1, belonging to *subsp. kurstaki* became the main commercial focus for the management of lepidopteron pests in agriculture and forestry. Subsequently, the discovery of a Bt strain belonging to the *subsp. israelensis (Bti)* was followed by its commercialization for the management of mosquitoes and simulids. Then, a particularly active strain of the subsp. *tenebrionis* was discovered and employed against coleoptera.

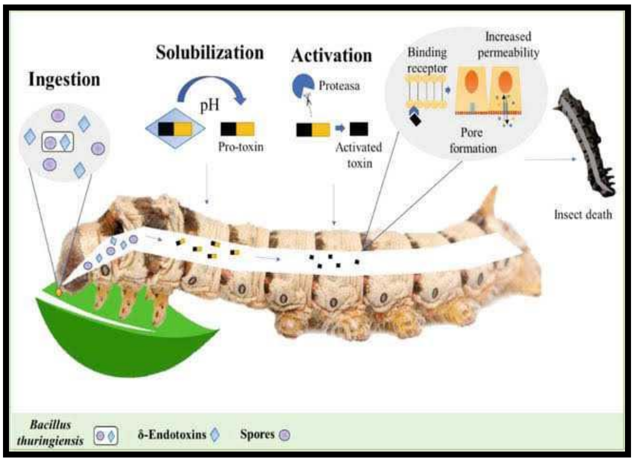

Figure 2: Mode of action - *Bacillus thuringiensis*

Entomopathogenic Nematodes

Entomopathogenic nematodes (EPNs) represent soil-inhabiting nematodes capable of infecting a wide range of insects. Their free-living infective juveniles (IJs) penetrate insect hosts through natural openings or through the cuticle and release their symbiotic bacteria into the hemocoel. The two families Heterorhabditidae and Steinernematidae are widely used, for two reasons: firstly, they both show great potential as inundative biological agents against numerous insect pests, in additione to or in replacement of chemical pesticides, and secondly, due to their short life span and ease of lab culture.

Table 2: Recent studies investigating the effect of entomopathogenic nematodes against insect pests:

Entomopathogenic nematodes	Insect pests
S. riobrave, S. feltiae, S. carpocapsae	*Plodia interpunctella* (Indian meal moth)
H. bacteriophora, S. feltiae, S. jeffreyense, S. yirgalemense	*Cydia pomonella* (codling moth)
S. carpocapsae	*Plutella xylostella* (diamondblack moth)
H. bacteriophora, S. glaseri	*Spodoptera litura* (tobacco cutworm)
H.bacteriophora, , S. carpocapsae	*Anomala graueri* (white grub)
H. bacteriophora, H. megidis, S. carpocapsae, S. feltiae, S. glaseri, S. kraussei	*Eriosoma lanigerum* (wooly apple aphid)

Benefits of Entomopathogens

They are specific for particular insect species and do not infect other animals or plants. They have considerable epizootic potential and can spread quickly through an insect population and cause their collapse. They penetrate the insect body and infect sucking insects such as aphids and whiteflies that are not susceptible to bacteria and viruses.

Conclusion

Chemical pesticides are often employed to protect plants. This has the reason of increasing insect resistance to numerous chemicals included in plant protection products. EM are microorganisms that kill insect pests. This might open new possibilities for controlling insect infestations. Entomopathogens are being developed for use in agriculture crops as ecologically favorable alternatives. They can be used to manage insect pests as biological control agents and increase agro-sustainability and ecologically recognized methods. In the realm of pesticides, the field of microbial pesticides provides a unique opportunity to conduct prospective and predictive research.

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Illuminating the Dark Side: Effects of Artificial Light at Night (ALAN) on Insect Life

Article ID: 48950

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Abstract

At the present alarming rate of insect decline, it is imperative that we seek out to identify the multitude of threats faced by the insects and to develop effective strategies to mitigate them. One of the most prevalent but least noticed anthropogenic changes that impact insects is light pollution in the form of artificial light at night (ALAN). It impacts insects through effects on movement, attraction, feeding, mating, reproduction and development. Moreover, ALAN along with other factors like habitat loss, pesticide pollution, invasive alien species, and climate change, is capable of contributing to the decline of insect populations. Hence, the contribution of light pollution to insect decline needs to be better understood and acknowledged to reduce its adverse effects and help the conservation of insect fauna.

Keywords: Artificial light, insect decline, light pollution, attraction, predation.

Introduction

In the last few decades, scientists have uncovered steep reductions in insect population across the globe (Sanchez-Bayo & Wyckhuys, 2019). This alleged ‘insect decline’ has sparked significant public concern as insects are crucial components of all terrestrial and aquatic food webs and render important ecosystem services. Several well-documented factors have been implicated in insect decline *viz*., habitat fragmentation, pollution, urbanization, invasive species, climate change, etc (Owens et al., 2020). However, one of the most prevalent but least noticed anthropogenic changes that impact insects is light pollution in the form of artificial light at night (ALAN).

Artificial lighting has become an integral part of the modern world, exposing organisms and ecosystems to ALAN worldwide and raising concerns regarding potential adverse effects on insect life. Most urban areas are ablaze with light from streetlamps, illuminated buildings and billboards, floodlights, highway lighting and vehicle headlamps during night. Night time lighting is responsible for changes in natural rhythms, such as diel, lunar, and seasonal rhythms and has negative consequences for insects at all biological organization levels, from molecular to community and ecosystem levels.

Effects of ALAN on Insects

ALAN has the potential to disrupt visual perception and biological rhythms and impact insects through its effects on movement, attraction, feeding, mating, reproduction and development.

1. Attraction: The most obvious and well documented effect of ALAN on insects is attraction of nocturnal insects to artificial light. It can be of two types- attraction to emitted light (ecological light pollution) or attraction to polarised light (polarised light pollution).

a. Attraction to emitted light- Positively phototactic insects like moths and beetles exhibit a fatal attraction to ALAN by virtue of their ‘flight to light’ behavior. In many cases, ALAN causes flying insects to circle the lights to the point of exhaustion leading to injury or death as they collide with hot lamps. Most of the insects drawn towards stationary artificial light sources perish before morning through disorientation, exhaustion or predation. Insects that evade immediate mortality may still get trapped in a ‘light sink’, unable to carry out normal behaviors crucial for their fitness. Sex-biased phototaxis skews the effective sex ratio in insect populations some moths.

b. Attraction to polarised light- Polarised light pollution occurs when light undergoes linear polarisation by reflecting off smooth surfaces, dark buildings, asphalt surfaces, solar panels, agricultural black plastic sheets, glass surfaces, paintworks of dark-coloured cars, etc. All such artificially polarising surfaces can attract positively polarotactic aquatic insects *i.e.*, insects which are lured to polarized light. Artificial lights may not inherently constitute this form of light pollution, but they can exacerbate the situation. It can cause mortality and reproductive failure in positively polarotactic insects like aquatic beetles, water bugs, dragonflies, mayflies, caddisflies, stoneflies, etc. that follows polarotactic water detection.

2. Predation: Insects that congregate around artificial lights can be readily preyed upon by insectivores like bats, rats, shorebirds, lizards, spiders and toads. Predators benefit both from the aggregation of insect prey under artificial lights and the augmented visibility which benefits visually oriented insectivores. Moreover, anti-predator adaptations like camouflages, aposematic and cryptic colorations may lose their effectiveness under artificial illumination, as these warning signals are most visible within specific natural light conditions._ALAN can also interfere with the moths' evasive flight behaviour which is known as the light interference hypothesis.

3. Mating and Reproduction: ALAN obscures the visual signals that insects use to find and court potential mates. It also delays or eliminates of the time window during which nocturnal insects engage in courtship and mating. Some moths like *Helicoverpa zea* do not mate when ambient light levels exceed the illumination produced by a quarter moon (Agee, 1969). ALAN also exerts differential impacts on behavior of males and females by disruption of sex pheromone production in noctuid moths like cabbage moth (Van Geffen et al., 2015).

Further, light pollution may disrupt flash communication systems and courtship of fireflies that requires exchange of bioluminescent signals, which are masked or subdued by artificial illumination. Female fireflies often have to compete with streetlights to attract males and the efficiency with which males detect female bioluminescence is reduced when the background environment is highly illuminated because of the masking of signaling. Receptive females of *Lampyris noctiluca* perched beneath streetlights are often not visited by male conspecifics s (Ineichen & Rüttimann, 2012). Hence, due to its disruption of flash communication systems and cascading effects on mating success and population, ALAN is postulated to be a major cause of current global decline of fireflies.

4. Development: Two types of physiological responses may be disrupted by ALAN:

a. Disruption of perception of day-length and its implicit seasonality- Alteration in day length predicts much about future seasonal environmental conditions as particular physiological stimuli are required to trigger initiation and termination of pupation, eclosion, diapause, etc. ALAN interferes with diapause where length of photoperiod act as cue for its initiation in some of the insects like cabbage moth, *Mamestra brassicae* (Van Geffen et al., 2014).

b. Disruption of the hormonal systems around vital processes- Exposure to ALAN may disrupt hormone levels related to appetite, satiety and growth rate (like insulin-like growth factor (IGF), growth hormone, melatonin, etc). For instance, the presence of light at night diminishes the production of melatonin, a potent regulator of circadian rhythms. Also, ALAN can strongly reduce the total amount of sex pheromone produced by female *M. brassicae*, (Van Geffen et al. 2015), possibly due to the light inhibition of PBAN (Pheromone Biosynthesis Activating Neuropeptide) that regulates sex pheromone production.

Conclusion

Despite strong evidence that artificial lighting disrupts a range of insect behaviors, there is a dearth of research into its ecological impacts. Unlike the other kinds of pollution, light pollution goes largely unnoticed; and compared to other factors contributing to insect declines, ALAN is relatively simple to reverse and could significantly mitigate insect population decline. Hence, the role of light pollution in insect decline needs to be better understood and acknowledged, urging policymakers to integrate the known impacts of ALAN into current insect conservation initiatives. Further, more research is required to develop more insect friendly lighting technologies.

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