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Vegetable and fruit cultivation in DPR Korea

Invited article id: 1014
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INTRODUCTION

A wide variety of vegetables and fruits are grown in DPR Korea in cooperative farms and household kitchen gardens both in field conditions and in protected environment - greenhouses and plastic tunnels. On-farm production is concentrated in the main summer season (May/June to August/September) while in protected environment vegetables are grown in both winter and summer. Common vegetable crops grown include spinach, Chinese cabbage, red pepper, tomato, cucumber, radish, onion, lettuce, eggplant, and mushroom. Among the fruit crops grown are apple, pear, peach, blueberry, apricot, persimmon, grape and plum.

Data on production of vegetables and fruits in national farm production in DPRK is not officially reported. Using field-level data on a sample of cooperative farms that received FAO emergency assistance to restore production in the wake of 2016 flood and 2017 drought, it is estimated that about 128 700 ha of cropped area are under vegetables. With an average yield of 18 tonnes/ha, vegetables production in DPRKorea is estimated at 2.3 million tonnes annually. This production is equivalent to 252 g/capita/day which is well below FAO recommended intake of vegetables at 400 g/capita/day. Average fruit harvests range from 50 to 100 tonnes/ha.[2]In order to increase supply of vegetables, the DPRK Government had undertaken measures including investment in infrastructure to expand cultivation of vegetables in greenhouses.

Greenhouse cultivation

In 2019, the DPRK Government has placed a major policy focus on "Greenhouse production of vegetables". The Pyongyang Vegetable Science Institute (PVSI) under the Academy of Agricultural Science held a symposium dubbed "Greenhouse Vegetable Farming-2019", which ran from 11 June to 26 June 2019.The presentations and deliberations at the symposium focused on breeding, introduction of new functional vegetable species and transforming vegetable cultivation into intensive production in line with the global trend. [3]

Consistent with government policy, cultivation of vegetables in greenhouses is spreading in DPRK. Hamhung vegetable farm in Hoesang district in South Hamgyong province constructed 110 greenhouses (each 100 sq.m) to grow vegetables year round. In winter the greenhouses produce thousands of tonnes of vegetable[4]s, including lettuce, crown daisy, spinach, bokchoi, red raddish, celery, chives, cucumber, pumpkin, tomato, pepper, and eggplant [5]Construction of a major infrastructure project, Jungphyong vegetable greenhouse farm and tree nursery is advancing rapidly in Kyongsong County, North Hamgyong Province of the DPRK. The project covers a total area of over one hundred thousand square meters, and is divided into a greenhouse area, a nursery area with an annual capacity of 20 million tree saplings, a government building area, and a residential area.[6]The project has built 300 semi-vaulted hydroponic greenhouses with double-walls made of plastic sheets, 50-odd blocks of dwelling houses and over 100 public buildings. Also, nearing completion are scores of

[1]Deputy FAO Representative, DPR Korea
[2]High-yielding Fruit Strains Bred in DPRK ,KCNA, 31 May 2019, 10 June 2019
[3] KCNA, 26 June 2019
[4]Pyongyang Times, 19 October 2019
[5]Korea Today, 1 July 2019
[6]Naenara news 30 June 2019

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construction projects including sapling cultivation ground covering tens of hectares, circular cutting bed, experimental district for acclimatization and seed-gathering ground.[7]

Construction of 80 blocks of modern vegetable greenhouses is progressing in South Phothae area of Samjiyon County as part of the work for turning the county into a model of modern mountainous town, an ideal socialist village.[8]

Mushroom cultivation

There are many mushroom farms in DPRK. The JongbangsanMushroon Farm located at Sariwon started mushroom production in January 2013. It became well known throughout the country for increasing annually production of mushrooms. In 2018, the farm produced 14 varieties of mushrooms by developing a multifunctional ultrafine pulverizer to ensure supply of raw materials.

[7]Construction of Jungphyong Greenhouse Farm and Tree Nursery Hastened, KCNA, 24 October 2019

[8] KCNA 16 August 2019

The Ryugyong Mushroom Farm located on the outskirts of Pyongyang has introduced new technologies that helped it exceed its production plan every year. All production processes, from moulding of mushroom substrate to inoculation of spores, cultivation in the indoor cultivation ground, and treatment of waste substrate and bottles after harvest, are controlled by an integrated production control system. As the farm is fully automated, technicians and growers are required to acquire skills. The farm introduced scores of new techniques, especially the introduction of substitute substrate, fixing the amount of spores to be inoculated into substrate, a cultivation method free from waterproof cloth, a method of extending the lifespan of filter cloth installed at the germ-free area and a method of recycling waste substrate.

Noting that growers also played their part in this effort, Ri Yong Bok, chief of the cultivation workteam, said that many employees study at the online education college of Kim Il Sung University, while others acquire advanced domestic and foreign technical knowledge related to mushroom production in the sci-tech learning space. At present, the farm turns out *Pleurotuseryngii*, *Pleurotusostreatus, Auriculariapolytricha Sacc* and *Flammulinavelutipes*.[9]. Each year the mushroom farms in every province, including the Ryugyong and the Wonsan mushroom farms, produce hundreds of tonnes of mushrooms of different species.

Major issues in greenhouse vegetable production

Among the major constraints to expansion of vegetable cultivation are farmer's access to quality seeds and the control of yield-limiting factors, principally insect pests and diseases. The main pests harming greenhouse vegetable production in DPRK include white fly, aphid, red spider mite, butterfly larva, diamond back moth and moth larva. Reliance on chemical control has lead to ever-increasing applicationof chemical pesticides causing the level of soil residual toxicity to increase. It not only endangers public health and disrupts ecosystem services, but also threatens sustainability of vegetable production. In addition, continuous use of pesticides for controlling vegetable pests has led to increasing the threshold of pest tolerance to pesticides. As a result, frequency of pesticide application has increased as also the use of new pesticide products.

FAO assistance in support of greenhouse vegetable cultivation

FAO assisted the DPRK Government in expansion of greenhouse vegetable cultivation through emergency assistance projects in the wake of 2016 floods – Emergency assistance to support food and nutrition security in flood affected areas (TCP/DRK/3605, October 2016 – September 2017); Emergency support to increase vegetable, soybean, and small livestock production to improve Nutrition Security (OSRO/DRK/701/CHA, March

[9]Pyongyang Times, 5 July 2019

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2017 – December 2017). Under these two projects, a total of 58 greenhouses were constructed for cultivation of vegetables. Under the projectTCP/DRK/3603 – Vegetable seed production *(*September 2016– August. 2018*)* eight units of greenhouses were constructed in four cooperative farms.

Fruit production

Production of fruits in DPRK in 2019 exceeded that of 2019 by 1.3 times. Despite unfavourable weather conditions, farms in South Hwanghae province have succeeded in increasing production of apples and peaches by introducing scientific farming methods. In Kwail County of South Hwanghae province, average per-hectare yield of apples was over 20 tonnes with some farms harvesting 50 tonnes/ha

Production of blueberries was also higher in Ryanggangprovince. To celebrate end of harvesting, an event of tasting apples and pears produced at fruit farms across the country took place at the Food Festival House in Ryomyong Street on 21 October 2019. Presented to the show, divided into two groups, were apples and pears of different species produced at fruit farms in Kwail and Pukchong counties, the Kosan Combined Fruit Farm, the Taedonggang Combined Fruit Farm, Onchon, Samchon and Myonggan fruit farms, Toksong Apple Farm and others fruit farms. At the event, sweet taste, sour taste and juice of fruits were appreciated at the grassroots level.

Innovations used by farms in fruit production

- Application of a new nutritive germicide; nano corrective water and carbonated nano fertilizer; hukposan fertilizer and biologically active compost in apple orchards to increase the rate of rooting of fruit trees, the rate of fructification and weight of each fruit;
- Production of high quality fruit saplingson farm and in greenhouses using tissue culture;

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- Placement of wooden beehives in apple orchards to facilitate pollination and fertilization;
- Lighting of campfires in fruit orchards to protect full-blown flowers from frost and application of potassic fertilizer to improve nutrition of trees when droughts persist;
- Use of tree shaping in early years and pruning, for example, pruning peach tree in the "Y" form to double the number of trees per hectare as compared to previously and boost the yield as well;
- Use of locally made plant-based pesticides to reduce the demand for chemical pesticide; and
- Introduction of drip irrigation system to economize the use of irrigation water.

Research achievements

The Pomology Institute of the Academy of Agricultural Science has developed more than 40 high-yielding varieties of fruits adapted to the local climatic and soil conditions. According to KyeRyong Gil, Director of the Institute, the newly-bred fruit trees include apple, pear, peach, apricot, persimmon, grape and plum. Particularly notable successes have been achieved in the breeding of peach that allow substantial savings in labour costs and increase in profitability. The new 17 varieties of peach have a shorter duration of growth and are highly resistant to diseases and cool temperatures. "Sunchon big peach" is heavy with fruit weight ranging from 500 to 700 g and of good quality. "Sunchon peach No. 3" is a medium-sized variety that can be cultivated in any parts of the country as it is highly resistant to cold and diseases and can be stored for a long time. And "early-ripening peach No. 1" is highly profitable as it bears fruits earlier than apricot. A dynamic scientific fruit farming drive has led to achievement of significant progress in increasing productivity of pomiculture with fruit harvests ranging from 50 to 100 tonnes per hectare[10].

Pyongyang Spice Plant Research Institute has come up with an innovation that reduces the amount of chemical pesticides applied on fruit trees by about 10 percent. It is a natural nano-dispersant developed through research using natural fragrance derived from the mountains of Korea as main ingredient. It has an insecticidal effect enhancing property. The dispersant is mixed with the pesticide at a ratio of 1: 1 and then dissolved in water of 5,000 to 10,000 times. It then nanoises the insecticide component and increases the insecticidal effect[11].

The Botany Institute of the State Academy of Sciences in the DPRK recently developed a reinforcing agent for pollination and fruition.The reinforcing agent consists of substance related to nucleic acid, organic matter ingredients like organic acid and plant hormone, and various macro-elements and microelements. It is applied to crops in their pollination periods unlike the existing plant growth stimulants, thus raising the ripening rate and 1000-grain weight. Many farms across the country have considerably raised the pollination rate of maize, wheat, barley and pepper by introducing this reinforcing agent.[12]

[10] High-yielding Fruit Strains Bred in DPRK, KCNA, 31 May 2019, 10 June 2019

[11] RodongSinmun, 19 June 2019

[12] New agent proves to help pollination and fruition, Pyongyang Times, 9 August 2019

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Bioponics- A new way to grow soilless vegetable cultivation

Invited article id: 1015

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With every sunrise fifty five thousand new mouths opens for food in India. The ever-increasing population pressure has reduced per capita availability of land. For producing more food more agrichemicals are used injudiciously and as a result, there is increased incidence of several fatal diseases, which affected the quality of human life. Bioponics is a way to utilize space and produce vegetables organically for the area with limited land. Bioponics was created according to the basic principle of organic and sustainable agriculture. Instead of chemical fertilizers, it uses organic fertilizers and microorganisms. Bioponics is a method of hydroponic growing coined by hydroponics veteran William Texier, the founder of General Hydroponics in Europe. It involves the use of certified-organic nutrients in a hydroponic solution along with a substrate. It provides an alternative to hydroponic growing with synthetic fertilizers. Like hydroponics, bioponics is also referred to as vertical farming, because this type of farming allows for crops to be grown in layers – in shelves or trays, one layer over another. Vegetable grows 30-50 percent faster in a bioponic system and healthier. Because the water is nutrient rich, and the pH has been balanced, the plant roots don't have to work to find minerals from the soil, which allows them to grow quicker and produce more yield without use of inorganic fertilizer.

Table 1: Vegetables suitable for growing in bioponics

Vegetables	Scientific Name (Family)	Major nutrient content
Lettuce	*Lactuca sativa* L. (Asteraceae)	Calcium, potassium, vitamin C, and folate and antioxidants
Cucumber	*Cucumis sativa* L. (Cucurbitaceae)	VitaminK, Magnesium Potassium and antioxidants
Coriander	*Coriandrum sativum* L. (Apiaceae)	Dietary fiber, manganese, iron and magnesium and antioxidants
Spinach	*Spinacia oleracea* L. (Chenopodioideae)	vitamin A, vitamin C, vitamin K, magnesium, manganese, iron and folate and antioxidants
Basil	*Ocimum basilicum* L. (Lamiaceae)	Many medicinal properties
Swiss chard	*Beta vulgaris* subsp. *Vulgaris* (Amaranthaceae)	Vitamin A, Vitamin C, Vitamin E, Vitamin K, Calcium, Copper, Magnesium, Iron and antioxidants
Peas	*Pisum sativum* L. (Leguminosae)	Protein, Fibre, Vitamin A and antioxidants

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Snow peas	*Pisum sativum var. saccharatum* (Leguminosae)	Vitamins B1, B2, B3, C and K and antioxidants
Snap peas	*Pisum sativum var. Macrocarpon* (Leguminosae)	Vitamin C and antioxidants
Green onion	*Allium fistulosum L*. (Alliaceae)	Dietary fiber, vitamin B6, iron and magnesium, folate and antioxidants
Leek	*Allium fistulosum L*. (Alliaceae)	Dietary fiber, vitamin B6, iron and magnesium and antioxidants
Chive	*Allium fistulosum L*. (Alliaceae)	Dietary fiber, vitamin B, iron and magnesium and antioxidants
Carrot (stubbies)	*Daucus carota L.* (Apiaceae)	ß-carotene, fiber, vitamin K1, potassium, and antioxidants
Radish	*Raphanus sativus* L. (Brassicaceae)	Vitamin A, C, E, B6, potassium and antioxidants

Advantages of bioponics over Field vegetable production

Bioponics is advanced version of hydroponic in which high quality vegetables can be produced. It is possible option to produce very high yields of vegetables on a small area because an optimal environment for plant growth is created. All the nutrients and water that the plants need are available at all times at balanced way. Water is used efficiently. Use of organic nutrient reduces soil and water pollution. In case of field production, good top soil is required while bioponics is a soilless culture. Bioponic vegetable required organic fertilizers formulation contain balanced nutrient content unless field vegetable production which required lab testing of soil and addition of too much and too little fertilizer. Besides this soil borne diseases are also a big problem of field vegetable production.

Bioponics and their nutrient content

Bioponics uses beneficial microbes, bacteria, and fungi normally only found in the very best farming land and combines these with pure sustainable organic nutrients (Table 1). With Bioponics, an organic environment is created by adding beneficial microbes to the growing area, which then colonize plant roots and grow media to dramatically boost the bio-availability of organic nutrients.

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Table 2: Some common materials used to generate Fertilizers/Compounds

Material	N	P	K	Nutrient content
Blood (dry or flour)	12-15	1.2	1	Soluble
Human urine	11	2	4	Rich in micronutrient
Bone meal	2-4	15	25	Calcium, micronutrients
Bone meal (steamed)	2-3	18-25	.2%	Carbon, micronutrients
Canola Bran	0	1.2	1.3	Iron, micronutrients
Cotton seed bran	7	2	2	Acid
Chicken Manure (dry)	3-4	2-4	1.2	Soluble, micronutrients
Compost	1-2	1	1	Micronutrients
Coffee Beans	2	.3	.7	Acid
Feathers (dry or flour)	12-15	0	0	Some micronutrients
Fish Flour	8	7	2	Soluble
Goat Manure	.5	.4	.4	Micronutrients, possible source of salmonellascoliforms, e-coli, etc
Granite Dust	0	0	4-5	Some micronutrients
Glauconite	-	1	5-7	Iron
Guano (Bats)	2-5	8-10	1-2	Soluble, micronutrients
Soft phosphate	0	18-24	0	Calcium, micronutrients
Algae (Liquid)	.5	.5	.3	Soluble, micronutrients
Algae (flour)	1	1	1	Soluble, micronutrients
Wood Ashes (hard)	0	1.5	7-10	Soluble
Wood Ashes (soft)	0	.8	5	Soluble
Earthworms	3.5	1	1	Micronutrients

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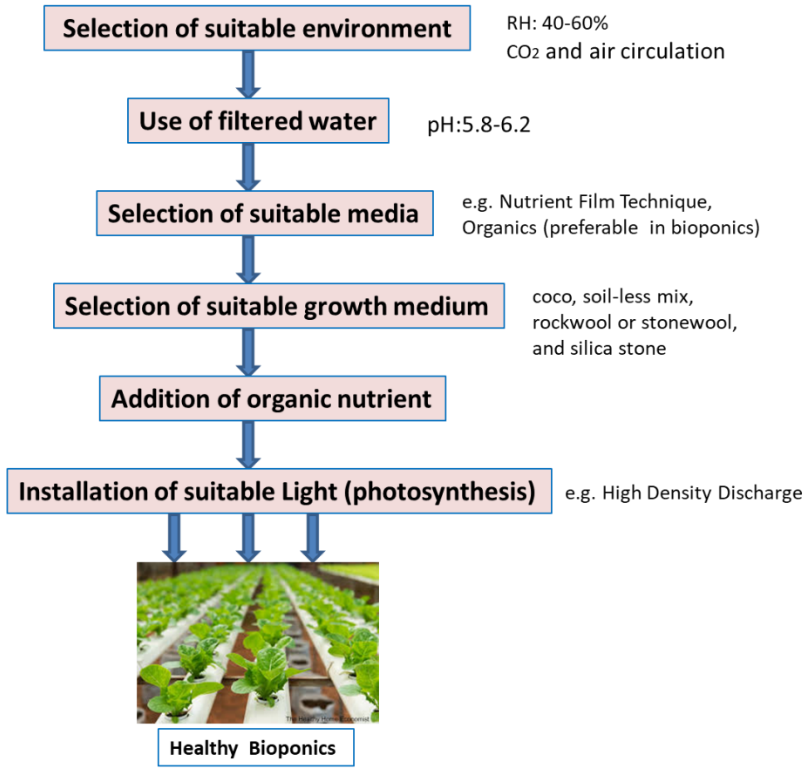

Fig 1: Steps of establishing Bioponics

Bioponics is 100% organic. No manufactured petro-chemical fertilizers, pesticides or herbicides. In this closed cycle and self-balancing system. The steps for establishing bioponics are depicted in Fig 1. There is huge potential of the bioponic system in coming future.

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Exploring the utilization potential of *Ficus* species for cultivation of lac insects (*Kerria* species) in India

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Ficus species commonly known as 'Fig', is considered as a keystone species in tropical rain forests which is distributed throughout India. Besides commercial uses for fruits (F. carica) and rubber latex (F. elastica) it is also a host plant for lac insects (Kerria spp.) known for producing a resin called 'lac' which finds application in many industrial sectors. Lac cultivation is an important source of income for livelihood of the forest and sub-forest dwellers of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha. Lac resin is a protective covering over insect body produced by ingesting phloem sap from the host plants. Recent surveys and past reports suggests that Ficus species may serve as an important host for lac cultivation thorough out India.

INTRODUCTION

Ficus L. (Moraceae), commonly known as 'Fig', is considered as a keystone species in tropical rain forests. The species are distributed throughout India from South to North up to the Himalayas at about 2,000 m elevations. North-East region has maximum diversity of the species followed by the Peninsular region and Andaman and Nicobar Islands. It is one of the largest genera in the angiosperms with ca.750 species worldwide and 115 taxa (89 species and 26 infraspecific taxa) in India. The genus is distributed throughout the world primarily in subtropical and tropical regions. The *Ficus* fruits are available throughout the year and relished by insects, birds and animals, therefore plays very fundamental role in ecosystem (Chaudhary *et. al*., 2012). Some *Ficus* species are commercially exploited for fruit (*F. carica*) and rubber latex (*F. elastica*). Besides, few *Ficus* species (*F. benghalensis, F. religiosa, F. glomerata,* and *F. rumphii*) are also served as a host plant for lac insects (*Kerria* spp.) known for producing a resin called 'lac' (Fig. 1). Lac basically consist of three natural components *viz*., resin, dye and wax which finds application in many industrial sectors like food, cosmetic and jewellary, electrical and electronics, pharmaceutical, textile, adhesive, varnish, lacquer and paints etc (Fig. 2). Lac cultivation is an important source of income for livelihood of the forest and sub-forest dwellers of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region (Mukhopadhyay and Muthana 1962; Sharma and Ramani, 2010).

Indian lac insects belong to the family Tachardiidae (=Kerridae), order Hemiptera and superfamily Coccoidea are phytosuccivorous and sessile. Only female synthesize lac resin as a protective covering over its body by ingesting phloem sap from the host plants (Fig. 3 & 4). Lac is the only resin of animal origin and is a natural polymer, exploited for its commercial purposes. Besides providing employment, it is a highly remunerative crop, paying high economic returns to the farmers and country (foreign exchange) through its export. The estimated national production of lac during 2015-16 was approximately 18,746 tons. The total export of lac and its value added products during the year 2015-16 was 7668.42 tons which was valued at 247.55 crore (Yogi *et al*., 2018). Apart from India, lac is also produced in Thailand, Indonesia, parts of China, Myanmar, Philippines, Vietnam, Cambodia etc. and India is the largest producer of lac in the world. The first account of lac insects came from James Kerr in 1781 on *Ficus religiosa* and *Ficus indica* (now *F. benghalensis*) along with *Butea monosperma and Ziziphus mauritiana* from Bihar region (Now Bihar, Jharkhand and some

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parts of West Bengal). Since then many workers reported *Ficus* species (*F. benghalensis, F. religiosa, F. glomerata, F. rumphii, F. lacor,* and *F. semicordata*) as a host plant for lac insects from different parts of the country (Sharma *et al*., 1997).

Based on the preference of host-plants by lac insect, host plants are classified into 3 categories (i) 'common' hosts or major hosts; (ii) the 'occasional' hosts; and (iii) the 'rare' hosts. Common host plants of all India importance are *Schleichera oleosa* (Lour.) Oken; *Butea monosperma* (L.) Taub. *and Ziziphus mauritiana* (Lam). Another category in common host is the host of regional importance and for specific purposes. *Ficus* species comes under the category of common host for specific purposes. Lac insect on *Ficus* species has special value being that it can be utilized successfully for tiding over the hot period for the preservation of the *Baisakhi* broodlac (the starting material for next generation) therefore called 'summer broodlac preservers'. *Rangeeni* and *kusmi* are the two strains of Indian lac insect which are classified based on preference of the insect for specific host plants. *Rangeeni* is characterized by unequal duration of bivoltine life cycle and has preference for *palas* (*Butea monosperma*) as host, whereas *kusmi* by and large has equi-durational life cycle prefer *kusum* (*Schleichera oleosa*) as host. The *rangeeni* strain also survives very well on above mentioned *Ficus* species. Moreover, in addition to *rangeeni* strain preference, *F. rumphii* also supports *kusmi* strain.

The *rangeeni* strain's *baisakhi* (summer season) life cycle spans from October to June and *katki* (summer season) life cycle spans from June to October. Till, recent past years, *rangeeni* lac resin (lac obtained from *rangeeni* strain of lac insect) had the major share in India's total lac production. But in today's scenario, it has some survival issues due to hot summer days and parasitoids threat, thereby discontinuing life cycle. Therefore, *Ficus* species may serve as life savers for this *rangeeni* lac insect strain during summer thereby ensuring continuous life cycle for lac production.

Recent surveys and past literature reports states that lac is found on Ficus species practically all over North India (Rajasthan, Punjab, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Bihar, Jharkhand, and West Bengal) and in North East region (Assam and Meghalaya). Recently lac insect was also recorded from Tamil Nadu [Vellore and Puliampatty, Erode], Rajasthan (Udaipur) on *F. religiosa,* in Uttar Pradesh and Kolkata city on few ficus species (not able to identify) (Fig. 5 & 6). Lac insects were also observed on *Ficus benghalensis*, *F. religiosa* and *F. recemosa* at Masigunda, Mahboonagar district, Telangana during 2016. Presence of lac insect species like *K. communis* (Mahadihassan), *K. chamberlini, K. ebrachiata* (Chamberlin), *K.fici fici* (Green), *K. fici jhansiensis* (Misra), *K. lacca mysorensis* (Mahadihassan) were also reported on *Ficus* species (Varshney 1992).

Past literature shows that Kusum (*Schleichera oleosa*) was considered as best host in lac cultivation also good host for summer season lac crop but its occurrence (frequency) throughout India is less. Moreover, not much importance has given to Ficus species for lac cultivation. Occurrence of lac insect species on several *Ficus* species and its distribution throughout India, makes *Ficus* host plant a versatile one and can be placed in 1st category 'common' hosts or major hosts of all India importance. Initiatives for scientific lac cultivation may be taken up at earliest to harness the benefit of lac resin.

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Fig 1: Lac Resin

Fig 2: Commercial application of lac resin in different products

Fig 3: Nymph of Lac Insects (Crawlers)

Fig 4: Female lac insect

Fig. 5: Indian lac insect (*K. lacca*) Kerr. on Pipal (*Ficus religiosa*)

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Fig. 6: Indian lac insect (*K. lacca*) Kerr. on Barh (*Ficus benghalensis*)

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Forest Certification: A mechanism for sustainable forest management

Invited article id: 1017

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Sustainable forest management is a global concern. Deforestation due to anthropogenic and nation's developmental activities, had led to environmental and ecological degradation. Meanwhile, due to the increased demand for certified forest products in the global market and the high growth of the world economy, it becomes necessary to have certified forest area. Moreover, the certification will attract more value and prices to the end products. Hence, the sustainability of the forest ecosystem is increasingly dependent upon sources of income beyond the sale of conventional products. Thus, forest certification is the new mantra to enhance the product positioning for a premium price on one hand and ensuring better forest management practices on the other hand.

INTRODUCTION

Deforestation due to anthropogenic and nation's developmental activities, had led to environmental and ecological degradation (Das *et al.,* 2016; Sarkar *et al.,* 2017a, b & c; Shinde *et al.,* 2017; Das *et al.,* 2019a & b; Sarkar *et al.,* 2019a & b; Shinde *et al.,* 2019a & b; Sarkar, 2019). Forest certification has emerged as one of the market mechanisms to give due recognition to and provide an incentive for sustainable forest management and thereby can reduce extreme pressure on forest by lowering the deforestation rate. It is a process that leads to the issuing of a certificate by an independent party, which verifies that an area of forest is managed to a defined standard. Standards are set by credible, independent organizations to ensure forest resources are managed in a way that promotes environmental, social and economic sustainability (Hughes *et al.,* 2008). Thus, it has a direct impact on trade of forest products.

Forest certification has its roots in the concern over rapid deforestation in tropical parts of the world during 1980s an 1990s. Because of this international concern, an effort was made in the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, also known as the Earth Summit, to find solution to environmental and sustainable development issues. Nearly, 86000 hectares of forest was first certified in Mexico in the year 1991 followed by USA, Costa Rica, Netherland, Sweden and UK. After a slow starting phase, the number of countries where the Forest Stewardship Council (FSC) certification is carried out, increased almost five-folds between 1995 and 1998 (Kern *et al.,* 2001).

Objectives of Forest Certification

Following are some of the objectives of forest certification:

1) To improve the environmental, social and economic quality of forest management.
2) To ensure market access for certified products, particularly in 'eco-sensitive' markets with high environmental awareness.
3) To improve control of logging operations and reduction of illegal harvesting followed by higher recovery of royalties and taxes.
4) To increase transfer of funds to forest management.
5) To internalize of environmental costs in timber prices.
6) To encourage for investment in wood processing industries; improved productivity and cost savings in the production chain from forest to end-user.

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7) To improve transparency in forest management and trade.

Benefits of Forest Certification

The benefits of forest certification have been mentioned under the following sub-headings:

a) Market benefits

(i) Certified products get the higher prices,
(ii) It become very easy to access market for the certified products, and
(iii) Branding of the products can be possible.

b) Non-markets benefits

(i) The staff morale and operational efficiency get improved,
(ii) The risk of being criticized by NGOs gets minimized, and
(iii) An organizational image and identity in terms of good forest management are developed (Baharuddin and Simula, 1997).

Steps of Forest certification

Following are the steps or the procedure of 'Forest Certification' (Fig. 1):

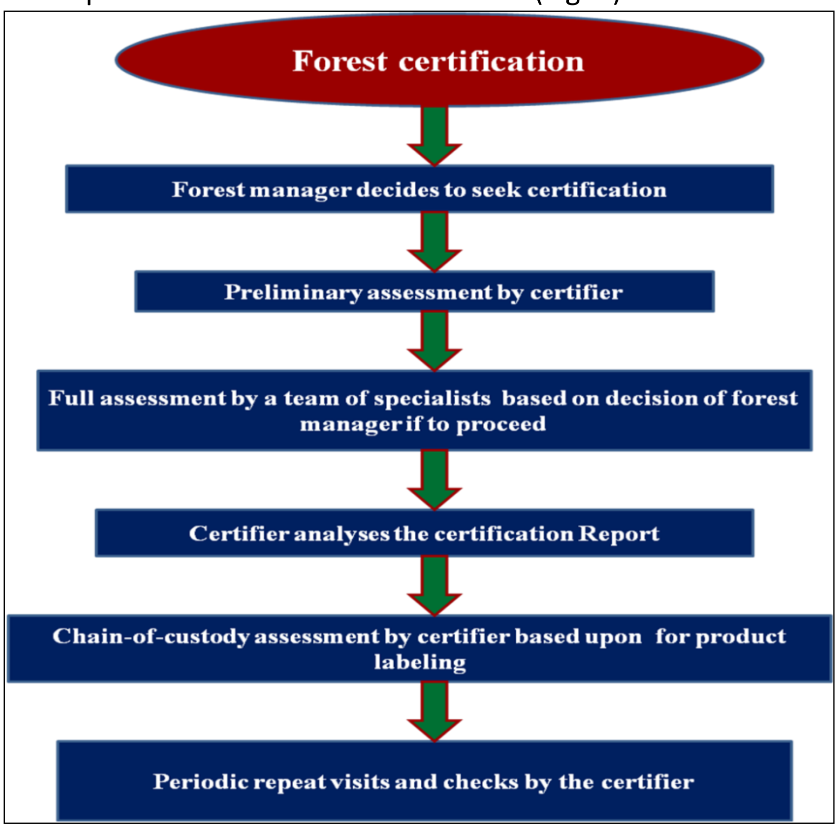

Fig. 1: Steps for certification process

Status of Forest Certification

At present majority of the certified forests are from the developed countries, mostly in Europe and North America. The area certified under FSC certification was estimated at about 11441 m ha in 82 countries having a total of 977 certificates (FSC, 2008). There was an increase in total certified forest area of the world by 30.10 m ha and estimated industrial roundwood production by 26.20 m m^3 in the year 2005-06 (Kraxner *et al.,* 2008). High success rate of forest certification has been reported where corruption and illegal logging has come down because of receiving the strong and effective support from government in Bolivia (Ebeling and Yasue, 2008). So far, India has secured only one FSC forest management Unit certificate and the only management certificate is for one private rubber plantation of 644 ha in Tamil Nadu. After realizing the need of forest certification, MoEF had constituted a national government body to frame the policy guidelines on certification of timber and NTFPs (Anon., 2010).

CONCLUSION

Sustainable forest management is a global apprehension. Due to the increased demand for certified forest products in the global market and the high growth of the world economy, it becomes necessary to have certified forest area. Thus, forest certification is the new mantra to enhance the product positioning for a premium price on one hand and ensuring better forest management practices on the other hand.

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Artificial insemination in cattle

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INTRODUCTION:

The success of a dairy farm depends upon the quality of the milk-producing animals in that farm. An animal with good merit can only be born when the female is bred with a good quality male. The breeding management of domestic animals has become more successful through the introduction of Artificial insemination (AI) technology. AI is a technique in which semen collected from male animals is deposited into the uterus of the female animal artificially. The first artificial insemination in domestic animals was performed by an Italian scientist named Lazzaro Spallanzani (1780). In India, the first successful artificial insemination was done by Sampath Kumaran in 1939 at Mysore dairy farm. In this article, we will discuss why the AI of dairy cattle is very important for achieving success in the dairy industry and how it is performed.

SIGNS AND SYMPTOMS OF ESTRUS:

Before going details about AI, we should first know when the animal should be inseminated and what are the signs and symptoms of an animal in heat. The ideal time for AI in cattle is almost 12 hours after the end of the heat or estrus phase. If the animal comes into heat in the morning it should be inseminated in the afternoon and if symptoms are visible in the afternoon, AI should be done in next day morning. The signs of estrus are described below.

- ✓ The animal will be excited and restless
- ✓ It will bellow frequently
- ✓ There will be a decrease in feed intake
- ✓ The animal in heat will try to mount other animals and will allow other cows to mount her. It is called standing heat.
- ✓ Clear and transparent mucous discharge from the vulva
- ✓ The vulva will be swollen and red
- ✓ The animals will frequently micturate
- ✓ Milk production will decrease

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The animals should be carefully observed every day to detect the signs of estrus. Many times, all the signs can't be visible. As the cyclic cow comes into estrus after every 21 days, missing one estrus will cause a delay of 21 days.

MATERIALS REQUIRED FOR AI:

The following materials are required for performing artificial insemination

- ✓ AI gun
- ✓ Long plastic gloves
- ✓ Sheaths
- ✓ Thaw unit
- ✓ Tweezer
- ✓ Thermometer
- ✓ Water thermos
- ✓ Straw cutter
- ✓ Semen tank
- ✓ Semen straw

PROCEDURE OF AI:

AI should be performed by trained personnel only. First of all the semen straw should be thawed properly. Thawing is generally performed at 35 to 38°C for 40 seconds. The animal is restrained properly and should not be in stressful conditions. The person performing AI should put on gloves in hand. The tail of the cow should be moved up and the manure in the rectum should be removed. Then the gun loaded with semen straw is inserted into the vagina (Fig 1). The cervix is felt per-rectally and the tip of AI gun should cross the cervix region. After that, the piston of the gun should be pressed gently to deposit the semen in the uterus.

ADVANTAGES OF AI:

- ✓ No need to rear a bull by the farmer
- ✓ It can help the animals to get rid of different diseases transmitted during mating
- ✓ The animal can be inseminated without direct contact of the breeding bull
- ✓ Using the semen of one bull, thousands of cows can be inseminated at a time which is impossible for natural insemination
- ✓ The semen of an animal can be used after its death also
- ✓ Artificial insemination can easily be performed in any remote areas
- ✓ Using the semen of a good quality bull can help in increasing the efficiency of the breeding program
- ✓ If the semen of an exotic bull is used for a zebu cattle the offspring will be crossbred and high milk yielder compared to its mother

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Fig 1: Artificial insemination of a cow

DISADVANTAGE OF AI:

- ✓ Special equipment and trained personals are required for performing artificial insemination.
- ✓ The instruments used in AI should be disinfected properly otherwise disease can be transmitted through them also.
- ✓ The person doing AI should have good knowledge about the female reproductive tract otherwise it can cause harm to the animal.

CONCLUSION:

Artificial insemination is an easy and economical technology. This can help to get a calf with good genetic merit. It will ultimately result in increasing milk production from the animal. As no bull is required, so the cost of bull rearing will also be saved. So, all the dairy farmers can use this technology successfully to attain good productivity in their form.

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Microbial exo-polysaccharides (EPS): role in agriculture and environment

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Varying groups of microorganisms are involved in the production of extracellular polymeric substances or exopysaccharides (EPS), which are mainly constituted of polysaccharides, proteins and DNA. These hydrated polymers are fundamental in microbial colonies and enunciate an ideal soil and environmental conditions through chemical reactions, nutrient entrapment, and protection against environmental stresses such as salinity and drought. They are also responsible for augmenting the aggregation of soil particles and beneficiate the plants by providing a cozy environment by trapping adequate moisture and nutrients. The unique characteristics of EPS, viz. biocompatibility, gelling, and thickening capabilities, further accentuate their applicability. However, despite decades of research on the potential of EPS, only a few polymers are widely used in different areas, especially in agriculture, warranting further study in this field.

INTRODUCTION:

Polysaccharides are condensation polymers of monosaccharides glycosidically linked with the elimination of water. In other words, polysaccharides are polymeric carbohydrate molecules composed of long chains of monosaccharide units bound together by glycosidic linkages, and on hydrolysis give the constituent monosaccharides or oligosaccharides.Polysaccharides are macromolecules belonging to the carbohydrate group, constituting the most important and abundant group of compounds, being synthetized by bacteria, fungi and algae (Barbosa *et al.* 2004).

Microbial polysaccharides can be classified depending on their position inside the microbial cell: (i) polysaccharides constituting the cell wall (structural polysaccharides), such as techoic acids, lipopolysaccharides (LPS) and peptidoglycans; (ii) polysaccharides which provide energy and act as carbon source for the cell, called cytosolic polysaccharides or intracellular polysaccharides (IPS); and (iii) exopolysaccharides (EPS), polysaccharides that are secreted in the form of biofilm or capsules to the extracellular medium (Kumar *et al.,* 2007; Barcellos *et al.,* 2019).

What microbial exopolysaccharides are?

Microbial exopolysaccharides (EPS) are biosynthetic polymers constituted of polysaccharides, structural proteins, enzymes, nucleic acids, lipids, and other compounds such as humic acids (Wingender *et al.*, 1999; Flemming and Wingender, 2010). The production of EPS is an energy demanding process necessitating selective advantages in the environment of the producing microorganism (Costa *et al.,* 2018).

The extracellular polysaccharides (EPS) have specific biological functions as the adhesion to surfaces, as protective barrier or as structural elements of the biofilms rendering them successful in the food industry, in medicine, pharmacy, cosmetic or oil industry, especially like xanthan gum, scleroglucan, gellan gum, curdlan, bacterial alginate, dextran, pullulan, bacterial cellulose, etc. (Ganeshan *et al.*, 2018). One of the important roles of the EPS matrix that has been explored for decades is the capacity to aggregate soil particles, a function that is important for soil structure, health, and fertility. Since EPS have a slimy texture and ionic charges, it can act like glue, getting attached to clay and ions, holding solid particles together (Shanmugam and Abirami, 2019).

Classes of EPS produced by different groups of microbes:

Bacterial EPS	D-arabinose, D-ribose, D-xylose, D-glucose, D-galactose, D-mannose, D-allose, L-rhamnose, L-fucose, D-glucosamine, D-galactosamine, D-glucuronic acids, D-galacturonic acids, D-mannuronic acid, acetate, sulphate, phosphate, etc.
Fungal EPS	β (1-3)- and β(1-6)-linked glucan, cellulose, sclerotan, isosclerotan, pachyman, lentinan, pustulan, amylose, amylopectin, glycogen, pullulan, nigeran, β (1-5)-Galactan, galactocarolose, galactose and glucuronic acid, mannan, galactomannan, xylomannan, 2-acetamido-2-deoxy-D galactose, α D (1-6) linked D-mannopyranosyl residues incorporating one D-mannofuranosyl residue, β D (1-6) linked D-galactopyranosyl backbone with 3-O-αD-mannopyranosyl-1-fructopyranosyl, fucose, uronic acid etc.
Algal EPS	L-arabinose, D-ribose, D-xylose, D-glucose, D & L-galactose, D-mannose, L-rhamnose, L-fucose, D-glucosamine, D-galactosamine, D-glucuronic acids, D-galacturonic acids, D-mannuronic acid, D & L- (3,6) anhydrogalactose, 6-O-methyl-D & L-galactose, L- guluronic acid, agar etc.

Role of microbial EPS on management of agriculture and environment:

(i) *Adhesion/Cohesion/Genetic Material Transfer*

Extracellular polymeric substances are responsible for the cohesion of microorganisms and adhesion of biofilms to surfaces, thereby influencing spatial organization and allowing interactions among microorganisms, acting as adhesives between cells. These functions are important for the establishment and biological activities of biofilms and flocs through dispersion forces, electrostatic interactions, and hydrogen bonds. The resultant formation of a gel-like tridimensional structure around the cells allows the microorganisms to be retained near each other to establish stable consortia (Flemming *et al.*, 2000). Such function is also attributed by the ex-DNA. Released by autolysis or active secretion by microorganisms, exDNA is likely an important structural component of *Staphylococcus aureus, Pseudomonas aeruginosa,* and *Ralstonia solanacearum* biofilms (Minh Tran et al., 2016).

(ii) *Symbiosis for host-microbe interactions*

Extracellular polymeric substances are responsible in playing an important role in the establishment of symbiosis between nitrogen-fixing rhizobia and plants. Rhizobial surface polysaccharides are fundamental for nodule formation by some legumes, although the underlying mechanisms are not yet fully resolved. For example, to invade alfalfa nodules and establish successful symbiosis, *Sinorhizobium meliloti* Rm1021 must produce succinoglycan (Cheng and Walker, 1998). Another interesting explanation can be attributed through the interaction between the EPS of *Mesorhizobium loti* strain R7A and *Lotus japonicas*, which produces a receptor (EPR3) that binds to and permits infection by only bacteria that produce EPS with a specific structure; mutants with truncated EPS are less successful in infection (Kawaharada *et al.*, 2015).

(iii) *Acting as agent for pathogenicity/ virulence factor:*

For some bacteria, polymers function as pathogenicity and virulence factors. For example, the high virulence of *Erwinia amylovora* is a result of the production of amylovoran and levan. Both polymers contribute to the

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pathogenesis of the bacteria, and the absence of either amylovoran or levan dramatically decreases plant colonization (Koczan *et al.*, 2009). In addition, EPS can also act as an antioxidant, although very little is known about the chemical mechanism of protection against ROS.

(iv) *Acting as a carbon reserve and nutrient trap:*

Extracellular polymeric substances produced by microorganisms might act as carbon reserves, as depicted by a few studies those investigated the role of EPS in nutrition or cross-feeding between organisms. EPS are generally complex molecules; their complete degradation requires a wide range of different enzymes (Flemming and Wingender, 2010). Rhizobium NZP 2037 uses its own poly-b-hydroxybutyrate (PHB) and EPS as sole carbon sources for survival in carbon-restriction situations (Patel and Gerson, 1974).

EPS are also responsible for trapping and making other nutrient elements available to plants. In soils, microbial EPS can sorb, bind or entrap many soluble and insoluble metal species, as well as clay minerals, colloids, and oxides, which also have metal binding properties (Gadd, 2009). In other studies, the potential of biosorption of a variety of metals by several EPS was already evaluated. Bacterial EPS are promising for the removal of toxic heavy metals from polluted water (El-Naggar *et al.*, 2008).

(v) *Protection against drought:*

High water-holding capacity was observed for EPS produced by a Pseudomonas strain isolated from soil; which can hold several times its weight in water. When added to a sandy soil, the EPS altered its moisture by allowing the amended soil to hold more water than unamended soil (Roberson and Firestone, 1992). Moreover, the EPS protect the bacteria against desiccation by acting like a protective sponge, thereby giving the bacteria time to make metabolic adjustments.

(vi) *Providing salt tolerance:*

The polymer production by NaCl-tolerant isolates can decrease Na uptake by plants by trapping and decreasing the amount of ions available (Upadhyay *et al.*, 2011). Therefore, the polymer prevents nutrient imbalance and osmotic stress, thereby having a considerable benefit towards survival of the microorganisms and benefit the plant.

(vii) Protection against Low/High Temperatures:

The production of EPS at low temperatures is an important factor in the cryoprotection of sea-ice organisms as well as a natural adaptation to low temperatures and high salinities. High concentrations of EPS have been observed in samples collected from Arctic sea ice; the EPS shields microorganisms against the severe environmental conditions during the winter season (Caruso *et al.*, 2018). Extracellular polymeric substances can be a protection factor for thermophilic bacteria by shielding microorganisms from very high temperatures.

(viii) Protection against Antimicrobials:

The matrix that surrounds microorganisms in biofilms plays an important role in decreased susceptibility to antimicrobials. In general, biofilm matrices possess a negative charge and therefore bind positively charged compounds, protecting the innermost cells from contact. In addition, electrostatic repulsion can reduce the diffusion rates of negatively charged antimicrobials through the biofilm (Everett and Rumbaugh, 2015).

(ix) Augmenting soil environment:

The production of EPS is not only an advantage to the microbes but also to the soil environment in general. The adhesiveness is important for gluing soil particles together; high water holding capacity protects microorganisms and plants against drought, as well as permits the diffusions of nutrients in the environment. EPS production also influences and is influenced by interactions between plants and microorganisms, thereby increasing the availability of nutrients as a whole, promoting plant and microbial growth (Costa *et al.,* 2018).

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Production of EPS has an important bearing on the application of sand-clay mixture as suggested by Walksman. Martin later found that bacterial slimes improved soil structure. The water-holding capacity of some polysaccharides is remarkable resulting in the ability of the producer to maintain some moisture in its immediate environment during prolonged exposure to humidity.

CONCLUSIONS:

Microorganisms have developed several approaches to survive environmental conditions, especially in soils. EPS production is an important strategy for providing a moist environment, entrapping nutrients, facilitating chemical reactions, and protecting cells against environmental conditions, antibiotics, and attack by predators. Microbial extracellular polymers are highly diverse compounds with multiple functions that depend on their composition and structure. Extracellular polymeric substances have long been of interest due to their biodegradability, biocompatibility, and thickening, gelling, and emulsion capacities. The polymers and their production can be manipulated to achieve high yields, but such manipulations are dependent on the characterization and physiological study of EPS-producing microorganisms. Improving polymer production requires an understanding of the underlying mechanisms and regulatory pathways. In contrast to the intensive work focused on improving EPS yield and altering the characteristics of well-known polymers, novel EPS and polymers produced by less studied microbial strains are still underexplored.The understanding of structure and properties of EPS is fundamental for understanding their interactions with soil. The combination of classic microbiology techniques with modern high-throughput methods and integration of different fields are fundamental for increasing knowledge on EPS composition, structure, function, and applications.

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Pest management approaches in organic farming

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The goal of Integrated Pest Management (IPM) is to control populations of pests below levels that result in economic damage. Ideally, this is achieved through the integration of all suitable control techniques in a compatible manner. The success of IPM in non-organic production systems is often due to a ready arsenal of efficacious synthetic chemical pesticides. Indeed, many of the IPM systems developed for non-organic crops are based on the pre-emptive use of pest control materials (e.g., genetically modified crops, insecticidal seed treatments) or assessment of pest populations and reaction to them with the use of "therapeutic" materials (chemical or biological) in a timely, but reactive way.Organic farming and sustainable farming systems are the best alternative approach to conventional agriculture. It is an interdisciplinary system, which aims at co-operating rather than confronting with the nature, has been hailed as the only answer to bring sustainability to agriculture.

INTRODUCTION:

Though 'Green revolution' helped us to overcome domestic food deficits and ushered in an era of food security, sole reliance on an array of chemicals hasled to several problems viz., insecticide resistance, resurgence, residual hazards, lack of bio-diversity and replacement of natural enemies created imbalance in nature and resulted in outbreak of pests and diseases(Garratt*et al.,* 2011). Historically, organic wastes of animal origin were most commonly used for nutrition and plant protection. In addition, herbs processed in liquid excreta of animals were used for plant protection. Cow dung manure and liquid manure called Kunapajala were used universally. In this direction, scientific evaluation of biodynamic pesticides, botanicals and biorationals including indigenous technologies are considered very much essential to combat noxious pests of groundnut in the transitional belt of Karnataka during rainy season. Use of botanical pesticides for protecting crops from insect pests has assumed greater importance in recent years all over the world.

Overview of IPM practices in organic farming systems:

1) Choose crops that have relatively few pests
2) Select planting time that allows crops to avoid the insect all together or at least avoid peak populations (e.g. plant early or late)
3) As much as possible, select crop varieties that are resistant to key pests
4) Practice crop rotation
5) Avoid staggered planting of the same crop with successive planting near earlier ones
6) Think about position of crops in relation to other crops
7) Sanitation – destroy old crop residue soon after final harvest
8) Know when to give up on a crop
9) Eliminate weeds before planting and control while crops are in the field; this helps to keep a number of insect pests under control including: cutworms; false chinch bugs; vegetable weevils; spider mites; slugs and crickets.

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Cultural practices:

a) The place to start:Insect pest problems are influenced by three components of a farming system. Farmers can manipulate all of these components to suppress pest species.

i) The crop species and cultivar present a set of resources, growth habits, and structure.

ii) Production practices, such as rotation, timeliness of planting and harvesting, spacing of plants, fertility and water management, tillage, mulching, sanitation, and companion planting(Feber *et al.,* 1997).

iii) Agro-ecosystem structure includes field borders, natural vegetation, and other crop production areas that resupply fields with pest insects and beneficial species when crops are replanted.

b) Protecting the crop: Sanitary measures; healthy planting material, clean seeds, clean tools etc.

Use of Resistant Varieties: Exploiting host resistance. Some of the varieties of different crops are found to be resistant or tolerant to particular disease or insect pest. Growing of such variations will help in getting good yields even if there is a pest attack e.g. DVS3 sorghum varieties resistant to earhead midge; DSV-4 sorghum varieties resistant to charcoal rot. Monsanto Boll guard–resistant to boll worms due to incorporation of Bt gene in that variety

Mechanical methods Collection and destruction of insect pests: Root grubs in adult stage can be collected during summer on the day of first rain at 7.30 to 9.00 pm with the help of petromax or fire and destroyed. The grown up caterpillars of Helicoverpa, Spodopteraetc can be collected by hand picking and subsequently destroyed. Destruction of stubbles and crop residues: Stubbles of Sorghum and Maize known to give shelter to stem borer larva which continue their next generation after summer. Hence, destruction of such stubless either by burning or by burying in the soil will kill the stem borer larvae or pupae. The egg masses and the early larval stages of Spodoptera, Bihar laity caterpillar soon after hatching can be collected easily on tobacco, soybean, groundnut and other crops and destroyed to avoid the further spread of the pest.

Pheromones and other attractants: Insects are very small creatures in a very large world. They evolved many differentways of finding each other to mate. Many insects find each other over long distances by emitting chemical signals or pheromones to attract individuals of the same species into an area so they can find each other to mate**(**Adrien*et al.,* 2010**).** Once theindividuals get close together, visual cues–such as color, shape, and behavior become more important.

Biological control using insect pathogens: Insects have many types of natural enemies. As with other organisms, insects can become infected with disease-causing organisms called pathogens. Soil serves as a natural home and reservoir for many kinds of insect pathogens, including viruses, bacteria, protozoa, fungi, and nematodes. When micro organisms or their products (toxins) are employed by man for the management of insects, animals and weed plants in a particular area it is referred to as microbial control. The microbes involved in insect control are referred to as the insect pathogens. So far over 3000 microorganisms are known to cause diseases in insects

Insect-parasitic nematodes and protozoa: Insect-parasitic nematodes show promise as biological control agents for soil pests. Nematodes are microscopic, whitish to transparent, unsegmented round worms. Nematodes in the families Steinernematidae and Heterorhabditdae have been studiedextensively as biological control agents for soil-dwelling insects. The most promising nematode involved in insect control belongs to the

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family Steinernematidae. These nematodes are characterized by their association with bacteria of the Xenorhabdus genus. The infective juveniles of the nematode carry their symbiotic bacteria in their intestines. These nematodes occur naturally in soil and possess a durable and motile infective stage that can actively seek out and infect a broad range of insects.

Protozoa: Protozoa are also employed in pest management programme. Nosema locustae is a moderately virulent protozoan that infects a wide range of grasshoppers and locusts. The organism has been registered in USA for use as a microbial insecticide against grasshoppers and is currently produced and sold commercially.

Insect-parasitic fungi: Some fungi are used successfully to protect crops from a variety of insect pests. More than 900 species of entomopathogenic fungi belonging to 100 genera are recorded and only 10 species have been commercially exploited of which Beauveriabassiana, Metarhiziumanisopliae, Nomuraearileyi, Lecanicilliumlacanii, Hirsutellathompsoni, and Paecilomycis sp. are popular in India. Most fungi can cause natural outbreaks when environmental conditions are favorable.

Insect-parasitic viruses: Insect viruses are obligate diseasecausing organisms that can only reproduce within a host insect. They can provide safe, effective, and sustainable control of a variety of insect pests, although they are most effective as part of a diverse IPM program. Some viruses are produced as commercial products, most notably for fruit pests, but many others are naturally occurring and can initiate outbreaks without additional inputs. Most virus-infected insects die attached to the plant on which they feed

Insect-pathogenic bacteria: Many insect diseases are caused by bacteria. The most commonly used bacterial product available to organic growers is Bacillus thuringiensis (Bt). This bacterium produces an insecticidal protein that provides effective control for many pest insects and has very little effect on non target insects and natural enemies.

Biologicalcontrol using insect natural enemies: One of the important components of the biological environment is natural enemies viz., predators and parasitoids that dampen pest insect populations. Organic farmers often assume that withholding conventional pesticides will have a beneficial effect on population levels of species that weaken and kill pest insects. The absence of conventional pesticides are likely to encourage the natural enemies of pest insects. But that encouragement may not be enough to provide substantive control of chronic pests without additional changes in the agro-ecosystem, which provide habitat for the pests and their natural enemies.

Predatory birds: Birds (both carnivores and omnivorous) are predators in various crop ecosystems. The capacity of the birds to locate the prey from certain distance due to their keen eyesight and modification of their beaks to catch the prey made them potential predators. Black drongo, Indian mynas, king crow, cattle egrets, sparrows etc., are efficient predatory birds. Attraction of birds to any crop ecosystem is possible by providing places (perches) for alighting/nesting providing food and water source.

Insecticides: When nonchemical practices documented in the Organic System plans are not sufficient to prevent or control populations of insect pests from rising above a level that is economically damaging, a

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biological or botanical material or a substance included on the national list of synthetic substances allowed for use in organic crop production may be applied to prevent, suppress, or control pests. The National List of Allowed and Prohibited Substances provide information on allowed and prohibited synthetic and non-synthetic substances for organic crop and livestock production. A producer must know which organic pesticides are allowed, what materials are labeled for their crops, and the efficacy of those materials against the intended target pests. Pest control materials are classified as allowed, restricted, or prohibited for use in organic systems. To avoid the risk of losing organic certification, make certain you know if and under what circumstances the material that you are planning to use is allowed.

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Insect Nutrition

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INTRODUCTION:

A thorough knowledge of insect nutrition is essential for understanding the biology of insects. The study of insect nutrition has recently undergone a metamorphosis, in that information gleaned from earlier investigations that focused principally on basic nutritional requirements and rearing technology is now being applied for understanding the feeding strategies, nutritional ecology, and evolution of insects. Nutritional physiology and biochemistry are also advancing, with the molecular arsenal available for *Drosophila* offering many new opportunities. The neurological bases for food selection and the role of biogenic amines in regulating food choice are beginning to be understood. The chemical composition of the hemolymph is now recognized as a dynamic indicator of nutritional status, affecting food selection and nutrient intake. The metabolic responses of insects to altered nutritional status and the effects of fat body metabolism on hemolymph composition are also being investigated. Future studies employing multidisciplinary approaches will continue to unravel the mysteries of insect nutrition and its consequences and significance to insect biology.

Carbohydrates:

Complex carbohydrates (polysaccharides) like starch and glycogen are broken down by digestive enzymes into simple sugars such as glucose, galactose, or fructose. These simple sugars can be processed through the Kreb's Cycle and oxidative phosphorylation to yield energy in the form of ATP. Alternatively, they can be used as building blocks for construction of chitin, a major component of the insect's exoskeleton. In some overwintering insects, a high concentration of sugar (e.g. trehalose) is sequestered in the blood and body fluids where it works like antifreeze to resist the lethal effects of cold temperatures.Insects do not have digestive enzymes that can break down structural polysaccharides like chitin and cellulose (found in woody tissues and plant cell walls). Insects that feed on wood (termites, for example) rely on digestive enzymes secreted by symbiotic bacteria and/or protozoa living inside their digestive tract. Insects that feed on plant sap (leafhoppers and aphids, for example) must process large volumes of liquid in order to extract enough protein to meet their metabolic needs. A filterchamber mechanism allows excess water and sugar to bypass most of the insect's digestive system for excretion as honeydew.

Types of Carbohydrates

Polysaccharides

Starch, Glycogen (energy storage)
Chitin, Cellulose (structural)

Oligosaccharides

Sucrose, Trehalose

Simple Sugars

Glucose, Galactose, Fructose

Proteins:

Protease enzymes in the insect's digestive system break down proteins into their constituent amino acids. Cells use these amino acids to build or replace enzymes and hormones as well as proteins needed for muscle, egg yolk, ribosomes, cuticle, and many other purposes. Amino acids can be converted to carbohydrates by removal of the amino group and processed (like sugar) to yield energy in the form of ATP. Ammonium ions ($NH4+$), produced by this deamination process, are toxic waste products that are converted to urea, collected in the malpighian tubules, and excreted from the body as uric acid.Of the twenty naturally occurring amino acids, at least ten must be present in an insect's diet. These ten, called essential amino acids, include lysine, tryptophan, histidine, phenylalanine, leucine, isoleucine, threonine, methionine, valine, and arginine. The other ten amino acids are considered "non-essential" because they can be synthesized from other amino acids or similar chemical building blocks. Insect diets and human diets require the same ten essential amino acids.

Proteins: Actin, Myosin, Resilin, Arthropodin
Peptides:Brain hormone, Bursicon
Amino Acids: Alanine, Lysine, Histidine, Glycine etc.

Lipids:

Fats (triglycerides) serve primarily as energy storage molecules. They can be broken down into glycerol and fatty acids by lipase enzymes in the midgut. The fatty acids may be further digested to acetyl by thiokinase enzymes in the mitochondria, and with the addition of co-enzyme A, processed through the Kreb's cycle to yield energy in the form of ATP. Fatty acids also serve as building blocks for cuticular waxes and the glandular synthesis of certain pheromones and defensive compounds.Most vertebrates (including humans) are able to synthesize steroids from acetyl-coA. Insects, however, appear to lack enzymes for this metabolic pathway and they must obtain steroid compounds (especially cholesterol) directly from their diet. Steroid building blocks are used to make hormones (e.g. ecdysteroids) and growth factors. Insects feeding on steroid-deficient diets generally survive as immatures but fail to molt properly into the adult stage.

Nucleicacids:

Sugars (ribose and deoxyribose), nucleotides (adenine, guanine, cytosine, uracil, and thymine), and phosphates are the major products of nucleic acid digestion. Individual cells reuse these components for synthesis of new DNA and RNA — information-storage molecules that contain the cell's genetic code for growth and reproduction. Dinucleotides such as nicotinamide adenine dinucleotide (NAD), nicotinamide adenine dinucleotide 3′-phosphate (NADP), and flavin adenine dinucleotide (FAD) are important oxidation-reduction co-enzymes that participate in the Kreb's cycle and oxidative phosphorylation reactions.Partial hydrolysis of the nucleotide adenine yields adenosine, a nucleoside that plays an important role in energy exchange within cells and tissues. Adenosine triphosphate (ATP) is the "energy currency" of the cell, and cyclic AMP (adenosine monophosphate) is a "second messenger" that transports information from the cell membrane to the cell nucleus.

Vitamins:

Vitamins include a number of complex organic molecules that animals need in very small amounts for specialized metabolic processes. (Coenzyme A, for example, is made from pantothenic acid). Humans (and most other mammals) must have a dietary source of both fat-soluble and water-soluble vitamins to ensure

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good health. Insects, however, have the ability to synthesize their own fat-soluble vitamins (A, D, E, and K) from other compounds (Sang, 1956). They still need a dietary source of most water-soluble vitamins such as thiamine (B1), riboflavin (B2), pyridoxine (B6), nicotinic acid, pantothenic acid, ascorbic acid (C), and biotin (H).Minerals are inorganic substances that animals also need in relatively small amounts. Iron and copper atoms are needed for cytochromes; nerves and muscles need calcium, sodium, and potassium ions; phosphorus is a component of cell membranes; and sulfur atoms play a significant role in both three-dimensional structure of proteins and sclerotization of the exoskeleton.

CONCLUSION:

According to Dougherty, insects are the only invertebrate Metazoa that have been raised axenically on chemically defined diets (Dougherty, 1959). The techniques used achieve such standardization of the insect as control over its environment and separation of its specific requirements from any possible hostsymbiote relationship. Sang, for example, used such techniques to determine the nutritional requirements of *D. melanogaster* and to probe metabolic capabilities. Nutritional defects can cause more or less characteristic symptoms of metabolic derangements. Thus, the study of insect nutrition, can be helpful in designing diets for insects for various lab studies.

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Clean milk production practices for dairy farmers

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INTRODUCTION

Milk is good medium for growth of micro-organisms. The purpose of milking a dairy animal is to obtain milk that is fit for human consumption. Milk from udder of a healthy cow contains very few bacteria and to keep it safe for long it should be handled hygienically. Unclean milk may be: a source of disease, rejected at the market, not good for processing and thus is a loss to farmer. The milking procedure is the first step in obtaining clean milk. Milking is an art requiring experience and skill. Milking should be conducted gently and quietly because frightening has a negative effect on milk let down due to release of adrenaline (hormone). Cows remaining comfortable yield more milk than a roughly handled cow. The act of milking should be finished within 5 to 7 minutes, so that udder can be emptied completely so long as the effect of oxytocin is available. Milking can be done either with hand or by machine.

STEPS FOR CLEAN MILK PRODUCTION

Equipment:

- Use aluminum or stainless steel cans for milking and storing milk.
- Clean utensils immediately after milking or after emptying milk: rinse with cold Water, scrub with a brush using hot water with detergent then rinse with cold water.
- Place upside down and dry in the sun and then store in clean and ventilated room.

THE MILKING ANIMAL

Animal should be fed with balanced ration. Feeding very high amounts of concentrates and low amounts of forages result in milk with low butter fat. On the other hand feeding too little concentrates leads to low milk yield. Animal should be kept healthy and clean as sick animals can transmit diseases like tuberculosis and brucellosis to milk consumers. Milk from antibiotic treated animals should not be used until withdrawal period is over. Mastitis can be controlled by observing general hygiene and proper milking procedure.

MILKING PARLOR

- A milking should be located away from any smells.
- Floor should be clean and dry; cement floor preferred for easy cleaning.
- Cleanliness results in better udder health and production of milk that remains wholesome for longer time.
- Parlor should be cleaned after each milking with clean water.

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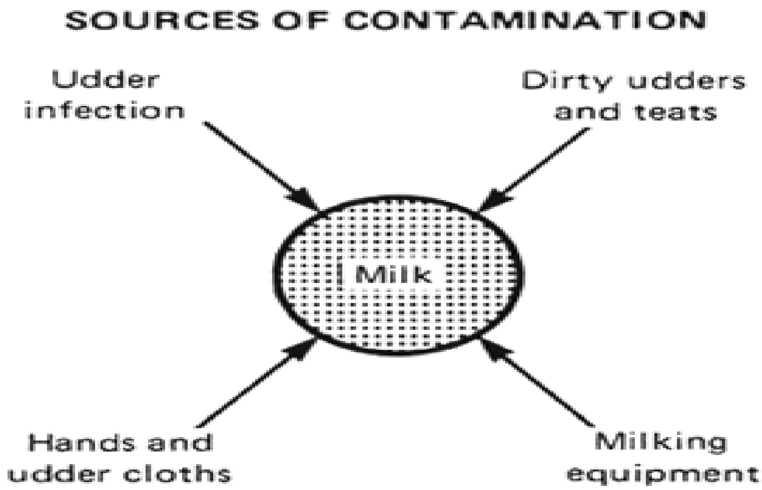

Fig. 1 Source of Contamination in Milk

Milker:
- Should be healthy and clean.
- Milk the animal quickly and completely without interruptions.
- Maintain short nails and hair and never smoke during milking time.

Animal handling and preparation:
- Offer feed to the animal according to its production level.
- Tie hind legs above hock joint in loose knot (applicable only for hand milking).
- Pre-milking sanitation can be done by dipping teats with sanitizer (0.5 % iodine).
- Wash hands with soap and clean water before milking and dry hands with towel.
- Test for mastitis with strip-cup method. If mastitis found, animal should be milked last.
- Wash udder with warm clean water with disinfectant using a clean towel. Warm water also stimulates milk let down. Dry the udder using a dry towel.
- Apply milking jelly - prevents cracking of teats and eases milking.
- Milk quickly and completely in clean container by squeezing teats, do not pull.
- After milking: Strip the teats to avoid incomplete milking (can lead to mastitis).
- After milking, dip the teats in a teat dip.

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Fig. 2 Use clean aluminum or stainless steel cans for milking

Actual Milking:

For hand milking, full hand (fisting) method is thebest as it is most kind to the teats. Aftermilking, teat has to be dipped into abactericide solution to minimize risk ofinfection. The practice of dipping offingers into the milk and then wetting theteats to soften them is not recommended.Care has to be taken that animals are notallowed to sit soon after milking, becausethe teat canal remains open for sometime.

Fig. 3 Hand Milking by Full Hand (Fisting) Method

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CLEANING OF MILK EQUIPMENT

Milk cans:

- Rinse the cans with cold water, scrub with brush and detergent. Again rinse with cold water and sterilize with boiling water or sanitizing solution e.g. hypochlorite.
- Dry cans on a drying rack. Exposure to sunlight will enhance killing of bacteria.

Milking machines and milk transportation equipments:

- Use the “cleaning-in-place” (CIP) method where detergent in hot water is circulated in the system. Then rinsed with hot water again.
- Timely replacement of worn out rubber parts should be undertaken regularly.
- Transportation requires insulated bulk tankers which require special additional equipment like pumps which should also be thoroughly cleaned. Select detergents that will not corrode the equipment material.

MILK STORAGE

Store the milk in a lockable, cool and clean place. Does not mix warm (morning) milk with cool (evening) milk, deliver to the collection centre separately or cool the warm milk before mixing. Milk is highly perishable hence it should be preserved to ensure its safety for human consumption. Milk can be preserved by cooling or heating. Chemicals can also be used to preserve milk but only on advice from the collecting centre because it is important to use the correct type and amounts. Nevertheless, if used correctly, chemicals have little effect on the physical quality of the milk.

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Bt Cotton (*Gossypium hirsutum* L.) in Northern India

Article id: 22405
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Cotton (*Gossypium* spp.) is one of the most important commercial fibre cash crops (White Gold) in spite of its tough competition with manmade synthetic fibres. It plays a prominent role in Indian economy as its production; processing and trade provide employment to large number of people in the country. India is amongst largest cotton producing countries in the world. It occupies an area of 105.0 lakh hectares, which is about 27 per cent of the world. India has emerged as the largest producer of cotton in the world with 351.0 lakh bales during 2016-17 with an average productivity of 568 kg ha^{-1}(www.cotcorp.gov.in). The cotton is a soft and staple fibre that grows around the seeds of the cotton plant, a shrub native to tropical and subtropical regions including the America, India and Africa. All the commercial cotton is Native American species *Gossypium hirsutum* and *Gossypium barbadense*. The fibre, most often, is spun into yarn or thread and used to make a soft and breathable textile, which is used as natural fibre in clothing. In northern India Punjab, Haryana and Rajasthan are the major states for cotton production. Cotton production efficiency is higher in Northern State. In Punjab cotton grown in 6.42 per cent area of India' cotton growing area and it produces 12.95 per cent of India's cotton production. South-west region of Punjab is known as cotton belt.

Best alternative to rice in Northern India

Flood-irrigated rice utilizes two or three times more water than other cereal crops. However, large amount of water input in rice culture has led to over-exploitation of groundwater as indicated by alarming fall in water table. Average fall in water table in central region of the state has been more than 0.75 m year^{-1} in the last decade (Minhas *et. al,* 2010 and Humphreys *et. al,* 2010) that threatens sustainability of rice production. This fall has resulted in increased energy requirement and cost of pumping groundwater, increased tube well installation cost and deteriorated the ground water quality (AICRP 2009, Kamra *et. al,* 2002). Thus, there is a need to explore alternate techniques that can sustain agriculture and are resource conservative. Instead of water depletion, rice residue burning becomes major problem in Northern India especially rice residue burning in Punjab, Haryana and UP creates severe air pollution problem in nearby states (Especially in Delhi). High silica content in rice residues limits its use as fodder in Northern States. Rice and cotton both are *kharif* season crops and cotton crops requires very less amount of water for their growth. So, large-scale on field burning of rice residue, intense air pollution and decreasing ground water table demands an alternate crop to rice in Punjab state of north-west India.

Bt cotton in India

In Indian Agriculture Paddy, cotton and pigeon pea is major consumer of insecticides. 45 per cent of total crop pesticide application used to be on cotton crop. Bt cotton as an alternative to cotton crop, which leads to reduction in insecticide use. Bt cotton is a genetically modified organism (GMO) cotton variety, which produces an insecticide to bollworm which is a major pest in tropical to subtropical countries of irrigated crops. Bollworms attack on bolls (hidden feeders) and American boll worm resistant to all insecticides. A strain of the bacterium *Bacillus thuringiensis* produces different Bt toxins, each harmful to different insects. Bt toxins are insecticidal to the larvae of moths and butterflies, beetles, cotton bollworms. The gene coding for Bt toxin has been inserted into cotton as a transgene, causing it to produce this natural insecticide in its tissues. In many regions, the main pests in commercial cotton are lepidopteron larvae, which are killed by the Bt protein in the genetically modified cotton they eat. This eliminates the need to use large amounts of broad-spectrum insecticides to kill lepidopteron pests. Now-a-days, genetically modified Bt cotton is getting popularity among the growers. The Bt cotton was developed with intention to reduce heavy reliance on pesticides i.e., grown throughout the world with claims of requiring up to 80 per cent less pesticide than ordinary cotton. Hence, productivity of cotton could be considerably increased by cultivation of Bt hybrids with proper spacing, suitable planting method, water and nutrient management, etc. Therefore, area under Bt cotton is increasing rapidly for its acceptability among cotton growers due to higher yield potential, shorter duration and more synchronous boll setting over the conventional varieties of cotton. The area under Bt cotton has grown exponentially in India since its introduction and the country has recently become the number one global exporter of cotton and the largest cotton producer in the world.

Issues in Bt cotton cultivation

In 26th March 2002 a joint venture between Monsanto and Mahyco introduced Bt cotton to India. In 2005, Bt cotton introduced in Northern India. Punjab and Haryana provides 15 per cent of the nations cotton output. 95 per cent of cotton grown in Punjab is Bt cotton. Nearly 12.0 acres Bt cotton area in Punjab resistant to major pest like bollworm but consistently facing the threat of white fly (sucking pest) attack. 66 per cent yield fall in cotton in 2015-16 due to pest attack (White fly infestation), replaces 15-20 per cent of area under Bt cotton with traditional varieties in *rabi* 2016-17 and use both Bt and non Bt varieties. In Haryana and Punjab, 27 per cent cotton area shrink in 2016-17 crop year, which is 7.56 lakh ha as compared to 10.3 lakh ha in 2015-16. Monoculture (growing only Bt cultivar) causes spread of diseases in plants. Growing two rows of sorghum, bajra, millets or maize as a barrier crop around cotton recommended checking spread of white fly. Punjab Agricultural University (PAU) Ludhiana, India has successfully developed the country's first Bt cotton varieties. ICAR has identified three varieties, namely PAU Bt 1, F1861 and RS 2013, for cultivation in Punjab, Haryana and Rajasthan. It is a cheaper alternative to Bt cotton hybrid seed.

In 2012, Maharashtra government ban Bt cotton cultivation due to some reasons, these are:

- Monsanto seeds are expansive, Farmers needs to purchase expansive seeds every year.
- Bt hybrid seeds lose vigour after one generation

  (Monsanto admitted that pink bollworm is resistant to first generation transgenic Bt cotton and expresses the single Bt gene)
- Loss in biodiversity
- Population of sucking pest (jassids, thrips, white fly, mealy bugs) increases after monoculturing of Bt cotton
- Unforeseen long term impact on the ecosystem

  So these are major issues of Bt cotton cultivation in India. We assume a bright future for Bt cotton farmers because of introduction of Bt cotton varieties by PAU, Ludhiana, India and also increasing Bt cotton cultivation in other parts of northern India.

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Physiology of cashew under salinity stress

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INTRODUCTION

Anacardium occidentale L. (Anacardiaceae, 2n = 42), commonly known as cashew, is precious gift of nature to the mankind and cashew kernel is considered capsule of nutritional package having combination of carbohydrate, protein, fat, mineral and vitamins. India requires about 12-13 lakh tons of raw cashew nuts to feed the large number of cashew processing units and depends on African and South East Asian countries for raw cashewnuts. Hence, there is an urgent need to increase domestic raw cashew nut production and become self-sufficient. Among the various factors associated with yield reduction in cashew, climate change associated with biotic and abiotic stresses poses challenge to crop productivity.

Climate change and cashew

Climate change pose problem for cashew cultivation since it is grown in dry farming conditions and concentrated in inter tropical regions. These areas are normally low in soil fertility with high temperatures and humidity. In India, cashew is grown in ecologically sensitive areas such as coastal belts, hilly areas and areas with high rainfall and humidity. Prolonged and unseasonal rainfall accompanied with high wind velocity during flushing and flowering result in increase in temperature and moisture stress which ultimately cause heavy yield loss. Yield loss due to moisture stress in cashew is also coupled with other environmental stresses viz., soil salinity, high temperature and irradiance.

Salinity

Soil salinity is a major environmental factor limiting agricultural productivity worldwide. About 7% of the world's land area and 20% of the irrigated land are affected by soil salinity (Yamaguchi and Blumwald, 2005). Soils are classified as saline when the electric conductivity (EC) is 4 dSm^{-1} or more, which is equivalent to approximately 40 mM NaCl, which is able to generate an osmotic pressure of approximately 0.2MPa (Munns and Tester, 2008).

Causes of salinity

Salinity in soil is caused due to excess accumulation of salts. There are two major causes of salinity viz. natural causes, and anthropogenic causes. Primary salinity is occurred due to the long-term natural accumulation of salts in the soil or surface water. The deposition of sea salt carried in wind and rain is also a reason for salinity. Salinity also causes by human activities (secondary salinization) such as land clearing, fertilization etc. which may accumulate salt up to 2.3 kg ha^{-1} $year^{-1}$. Secondary salinity occurs due to anthropogenic activities that disrupt the hydrologic balance of the soil between water applied (irrigation or rainfall) and water used by crops (transpiration) (Munns 2005).

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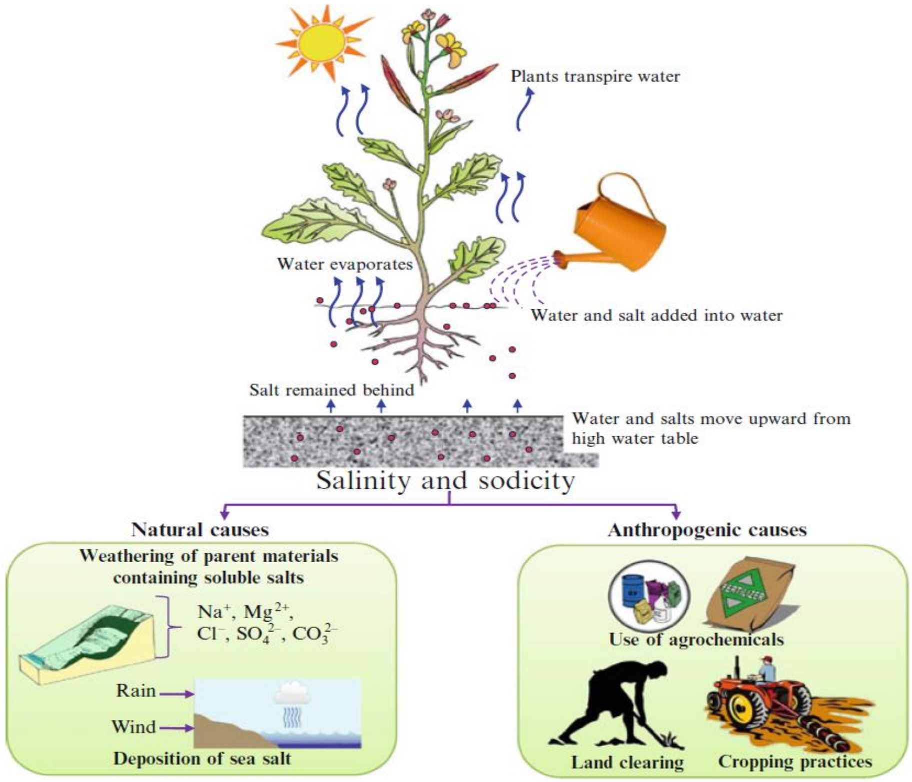

Figure1: Causes of salinity in soil and water (Source: Hasanuzzaman *et al,* 2013)

Salinity and cashew

In India, cashew is mostly grown on laterite and red soils and coastal sands. It usually prefers slightly acidic soils of pH 4.5 to 6.5 with EC <4 ds /m. Soil pH of 8.0 and poor drained soils are unsuitable for cashew cultivation. The coastal sand areas particularly part of Tamil Nadu, Andhra Pradesh and Chhattisgarh under cashew cultivation are mostly salt affected. Thus, soil fertility status of those areas is poor causing considerable yield loss.

Cashew responses to salinity

Reduction of water potential, Na^+ and Cl^- phytotoxicity and disruption of nutrient transportation process are the three main physiological disorders due to salinity stress (Munns, 2002). These disorders affect turgor, photosynthesis, enzymatic activities and generate reactive oxygen species which cause cell damage and even cell death.

Figure2: Major effects of salt stress in plants (Source: Hasanuzzaman *et al* 2013)

Seed germination and seedling establishment

Under adverse conditions such as salinity, drought and high temperature, germination and cotyledonary reserve mobilization are delayed and seedling growth is strongly affected in cashew (Voigtet al., 2009). The biochemical and physiological mechanisms involving the recovery and establishment of cashew seedlings subjected to salinity were well elucidated (Ferreira et al, 2010). The salt treatments coordinately delayed the seedling growth and the cotyledonary reserve mobilization. The mobilization of globulin fraction, important storage proteins of cashew cotyledons, was also delayed due to salinity stress.

Mineral Nutrition

Generally cashew tree grows well under semi-arid conditions, in which the problems associated with drought and salt stress in the environment are common. These two factors interfere with the acquisition of nutrients with a reduction of growth of the various plant organs including the root system. Salinity (NaCl) stress reduces the levels of K^+ in the plant and simultaneously promotes the accumulation of Na^+ and Cl^- to toxic levels in cashew seedlings (Viégas etal.2004). Salinity also appears to affect the metabolism of mineral nitrogen. In cashew, it affects activity of enzymes responsible for nitrate reduction (Viégas et al.2004).

Photosynthesis

The photosynthesis of cashew seedlings is strongly affected by salinity (Viégas et al.2004). The reduction of leaf growth appears to be a consequence of the inhibition of cellular division and expansion which in turn restricts the leaf area available for photosynthesis, limiting the productive capacity of the plants (Munns, 2005).

CONCLUSION

The challenge for cashew crop will be to improve yields in marginal lands where the harsh environment strongly limits crop growth and production. Salinity stress associated with water deficit and high temperature is the most likely environmental factors limiting production. A deep understanding of the ecophysiology of the cashew tree and its impact on crop management and development of new cultivars with superior performance is a challenge to be handled within the near future.

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Agro-Chemical Inputs and its approaches towards agrifood systems and bio-safety: Prospects & Challenges

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INTRODUCTION

Agriculture is adversely affected by numerous pests like bacteria, fungi, weeds and insects, leading to reduced yield and poor quality of the produce (Kumar, 2012). World population is projected to increase to 9 billion by 2050. By 2022 India will become the most populous country in the world surpassing China and it is going to be the 3rd largest economy in the world by 2030 accompanied by a rise in urbanization levels which will lead to a change in dietary needs. To accommodate this huge population, food production has to be increased and that too from the declining available cultivable land resource. Besides, climate change is another factor influencing the agriculture by alteration of abiotic stress, in return changes of biotic stress too. So, sustainable production and increasing productivity of existing agricultural land is an important aspect to address global food security. The Green Revolution towards the beginning of 1970s had major economic effects in terms of the production and productivity. Use of crop hybrids, agrochemicals, fertilizer and increasing irrigation facilities led India from a food deficient country to a food surplus economy. But Indian agriculture is still grappling with a number of challenges like high monsoon dependency, unpredictable weather patterns, reduction of arable land, low per hectare yield, increased pest attack, lower farmer incomes etc. Approximately 25% of the global crop output is lost due to attack by pests, weeds and diseases and thus agro-chemicals have an increasing role to play in enhancing crop productivity. But, on the contrary, issues like soil degradation, declining soil biota, residue, resurgence, resistance, eco-system disruption, health hazards etc. and above all awareness on 'safe food' is becoming relevant. Chemical control of pests is a common practice in agriculture. There are more than a thousand pesticides of both chemical and biological nature used around the world to minimize crop losses. Agriculture in developing countries suffers most because of high incidence of various pests (Subash et al, 2017). In India, estimated annual production losses due to pests are as high as US$ 42.66 million (Sushil, 2016). Since 1960s, the most common method for pest control has been the intensive use of synthetic pesticides. Such pesticide was adopted in 1940s with the use of dichloro-diphenyl-trichloroethane (DDT), followed by other organophosphate and carbamate pesticides (Nicholson 2007).

Fig. 1 : Trend in consumption of pesticides (technical grade) in India

Source: Based on data from Ministry of Chemicals and Fertilizers.

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Pesticide Use in Agriculture

Insecticides, fungicides and herbicides are commonly used for pest control in agriculture. However, insecticides form the highest share in total pesticide use in India. Both total as well as per hectare consumption of pesticides in India show significant increase after the year 2009-10 (Fig. 1). In the year 2014-15, pesticide consumption was 0.29 kg/ha (GCA), which is roughly 50 per cent higher than the use in 2009-10. The recent increase in pesticide use is because of higher use of herbicides as cost of manual weed control has risen due to increase in agricultural wages (FICCI, 2015). However, per hectare use of pesticide in India is much lower as compared to other countries like China (13.06 kg/ha), Japan (11.85 kg/ha), Brazil (4.57 kg/ha) and other Latin American countries (FAOSTAT, 2017).

The Production Scenario

Pesticide production in India is dominated by insecticides and fungicides followed by herbicides and rodenticides (Fig. 2). The share of insecticides has come down from more than 70 per cent in 2003-04 to 39 per cent in 2016-17. The shares of fungicides, herbicides and rodenticides are growing over the period. The growth in the use of fungicides is high mainly because of their application in fruit and vegetable crops. Major pesticides produced in India are Mancozeb, 2-4-D, Acephate and Profenofos

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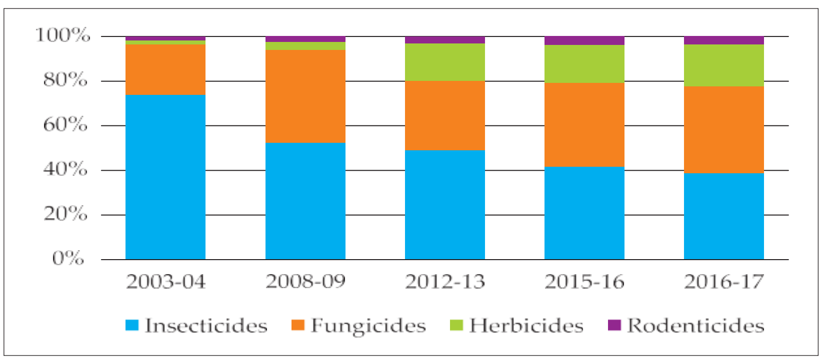

Fig. 2 : Share of pesticide groups in total pesticide production (technical grade)

Table 1 : State-wise consumption of Chemical pesticides (technical grade)

States/UTs	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	CAGR
Andhra Pradesh	8869	9289	2803	4253	4050	2713	1884	-0.22755
Bihar	675	655	687	765	787	831	840	0.037121
Chhattisgarh	570	600	812	1016	1589	1625	1495	0.174341
Goa	9	8	9	9	12	48	22	0.160638
Gujarat	2600	2190	1210	2330	1730	1980	1713	-0.06718
Haryana	4060	4050	4050	4080	4070		4050	-0.00041
Himachal Pradesh	328	310	325	344	379	450	341	0.006499
Jammu &	1818	1711	1789	1723	1921	2251	2188	0.031357

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Kashmir								
Jharkhand	84	151	151	430	650	493	541	0.364017
Karnataka	1858	1412	1615	1735	1793	1434	1279	-0.06034
Kerala	657	807	712	1276	910	1123	1070	0.084684
Madhya Pradesh	633	850	846	987	696	732	694	0.015452
Maharashtra	8317	6723	6618	10969	8663	11665	13496	0.084026
Orissa	871	555	606	1219	1075	723	770	-0.02033
Punjab	5730	5625	5730	5723	5689	5743	5843	0.00326
Rajasthan	3623	2802	2559	2736	2694	2475	1252	-0.1623
Tamil Nadu	2361	1968	1766	2142	2096	2096	2000	-0.02728
Telangana				3812	2862	2950	3840	0.002442
Uttar Pradesh	8460	8839	9057	10164	9736	10457	10142	0.030684
Uttarakhand	199	206	247	174	172	217	131	-0.06731
West Bengal	3515	3670	3465	3190	3060	3712	2624	-0.04756
	55236	52421	45057	59077	54633	53719	56215	0.002932

Source: Ministry of Chemicals and Fertilizers, Govt. of India.

Pesticide consumption is the highest in Maharashtra, followed by Uttar Pradesh, Punjab and Haryana (Table 1). During the last decade, the total consumption increased in Maharashtra and Uttar Pradesh, while it slightly declined in Punjab and Haryana. States like West Bengal, Gujarat and Karnataka have seen a steep decline in the total consumption. On the other hand, Chhattisgarh and Kerala showed a steep increase in total pesticide consumption.

Handling, storage, transportation

The importance of proper care in the handling of pesticides hardly requires an emphasis. Realizing this, the guidelines to handle them at different stages have been prescribed and are available. Proper enforcement of these guidelines is essential.

- Compliance to the prescribed schedules and guidelines for handling, storage, packaging, transportation, etc. of the technicals and the formulations may be enforced from the time of manufacture till impact assessment, with effective deterrents against casual approach.
- Innovative and effective handling equipments and devices (convenient protective clothing, shoes, eye glasses, masks, weight lifting pads etc.) that are readily adoptable under the harsh tropical weather conditions of the country may be developed.

Environmental interactions

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Introduction of the man-made chemicals into the environment is only a part of the problem. Besides, there is continuous introduction of a number of natural emissions from various flora and fauna. The natural chemicals interact not only amongst themselves but also with those introduced from the extraneous sources. These interactions need an investigation for a proper understanding.

Bio-pesticides have the potential to control crop losses and reduce negative environmental externalities. Bio-pesticides constitute around 3 per cent of pesticide market in the country. So far 14 bio-pesticides have been registered under the Insecticide Act 1968 in India. Consumption of biopesticides has increased from 219 tonnes in 1996-97 to 683 tonnes in 2000-01, and further to around 3000 tonnes in 2015-16 (Sinha and Biswas,2008; DAC&FW, 2017).

- Information on the interaction amongst chemicals introduced naturally in the environment through various plant and animal emissions and their impact on plant or mammalian systems (ex. allergenic effects) needs to be generated.
- Joint action / toxicity of natural chemicals (constituents of plant or animal products) with those introduced extraneously into the environment and their impact on plant or animal systems (ex. synergistic toxic effects of special concern) may be investigated and areas of concern identified.

Consumer awareness and care

- Consumer awareness on the different aspects of chemicals such as product quality, use, activity spectrum etc. through various government, non-government and private agencies needs to be created.
- An effective consumer care system must be put in place.
- Deterrents for preventing customer cheating may be enforced.
- Devise mechanisms and deterrents for preventing the foul play by any of the industry, consumer or the government.
- Symbolic labels may be designed and prescribed for illiterate masses. In printed matter, use of vernacular language and readability of the font size ought to be ensured.
- Training on handling of the chemical accidents may be imparted at basic level along with an easy and assured access to first aid and antidotes.

CONCLUSIONS:

There are some issues which need immediate attention to strengthen domestic pesticide production industry and safe application of pesticides. Firstly, to encourage the use of cost-effective and environmentally safe pesticides especially bio pesticides. The uniformity in testing procedures (parameters, labs, actors, etc.) and removal of banned and hazardous pesticides are necessary for avoiding the adverse impacts. The point-of-sale quality assurance and farmers protection mechanisms in case of spurious products must be strengthened. Another consideration is the promotion of safe use and application practices through awareness program among farmers. Lastly, there are certain gaps in data on pesticide production and use. In particular, data on use of biocontrol agents are scanty. For chemical pesticides, the production, consumption and trade data from different sources are difficult to reconcile, which must be addressed.

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Insect pests of bamboo

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INTRODUCTION

Bamboo is a stout and hardy plant and is more likely to die from lack or too much water. The most common pests are likely biological and come in forms of insects such as aphids, scales, mealybugs and mites.

Insect species: *Pyrausta coclesalis*
Order: Lepidoptera
Family: Pyralidae
Hosts:*Dendrocalamus strictus, D. giganteus, Bambusa nutans, B. vulgaris, Cephalostachym pergracile.*

Life history:

It is one of the most important pests in bamboo nurseries. There are 7-8 larvae instars. The light green larvae feed in groups for the first two instars and individually after the third instar. After consuming about half of the leaf tissues, they give up the old leaf cases and make new ones. From the sixth instar onwards, they change cases almost every day. Feeding begins in the upper crown and move downwards. Larval stage varies from 18 to 36 days. When fully grown, the larvae pupate in cocoons made between the rolled leaves

Damage & Symptoms:

The damage is caused by larvae, which tie leaves together as leaf cases and feed on the upper tissues of the leaves. The over wintering larvae undergo hibernation from the end of the September to beginning of May and pupate for 10 to 15 days.

Control measures:

Application of 0.2% Fenitrothion or 1 % Carbaryl in water is effective for the control of this pest. Entomopathogenic fungi namely, *M. anisopliae* and *B. bassiana* spore suspension at the concentration of 1x107 spores/ml should be drenched if population is 20 individuals of I-VII instar larvae.

***Pyrausta coclesalis* infected leaf**

***Pyrausta coclesalis* Adult**

Insect species: *Algedonia bambucivora*
Order: Lepidoptera
Family: Pyralidae

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Hosts:*Dendrocalamus strictus, D.giganteus, Bambusa nutans, B. vulgaris.*

Life history:

It is one of the most important pests in bamboo nurseries. The species is distributed throughout the Indian sub-continent and South – East- Asia.

Damage & Symptoms:

The lesser leaf roller. It is also a pest of bamboos. Larvae are injurious leaf roller of *B.nutans*, *D.giganteus, D.strictus,* and *B.vulgaris* particularly during July to October. The naked smooth pinkish larvae feed inside the rolled leaves of the host and finally they pupate inside the leaf roll. There are four generations in a year.

Control measures:

Applying of 0.2% Fenitrothion or 1 % Carbaryl in water gives effective control.

***Algedonia bambucivora* Pupae on host leaves**

***Algedonia bambucivora* Adult**

Insect species :*Massepha absolutalis*.

Order: Lepidoptera

Family: Notodontidae

Hosts:*Dendrocalamus strictus*

Life history:

The pest is fairly abundant in the monsoon and passes the winter in the larval stage inside a boat-shaped case made of leaves. Moths emerge only in the succeeding spring

Damage & Symptoms:

This insect feeds on *D. strictus* in association with *P. coclesalis* and *Algedoniabambucivora.*

Control measures:

The larvae is parasitized by some species of *Brachymeria, Chelomus* and *Tetrastichus*

***Massepha absolutalis* Larva**

Insect species:*Hieroglyphus banian*

Order: Orthoptera

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Family: Acrididae
Hosts: *Dendrocalamus strictus*

Life history:

The adult is 35-52 mm long and light green in colour. There are five bulbous sulci on the protergum of the adult. There is one generation per year, and eggs overwinter in capsule in the soil from August to April. Nymphs hatch in April and May, and there are six or seven instars. Nymphs are not very vigorous and feed in groups on small bamboo plants and some grass at the first instar and then, move on to bigger plants. Adults emerge during June-August.

Damage & Symptoms:

They frequently affect *D.strictus.* They are green and brown in colour. The adults of *H. banian* lay eggs in the soil in November and hatch during June and July. They are serious defoliator of bamboos.

Control measures:

Dusting hoppers and adults with 5% Carbaryl gives effective control. In addition, light trap collection gives good number of reduction in population of grasshoppers.

***Hieroglyphus banian* on host leaf**

Insect species:*Eucyrtus concinus*
Order: Orthoptera
Family: Gryllidae
Hosts:*Dendrocalamus strictus, Bambusa nutans*
Life history:

Small green gryllids lay eggs in leaf sheaths of bamboo leaves in series of rows. Eggs hatch within a week. There are four to five nymphal instars. Life cycle completes within a month.

Damage & Symptoms:

They frequently affect *D.strictus.* They are green and brown in colour. The adults of *H. banian* lay eggs in the soil in November and hatch during June and July. They are serious defoliator of bamboos.

Control measures:

Dusting hoppers and adults with 5% Carbaryl gives effective control. In addition, light trap collection gives good number of reduction in population of grasshoppers.

***Eucyrtus concinus* on bamboo leaf**

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Insect species: *Oregma bambusae*
Order: Homoptera
Family: Aphidae
Hosts:*Dendrocalamus strictus, D. giganteus, Bambusa nutans, B. tulda, B. vulgaris.*

Life history:

It is one the serious pests of bamboos. The aphids have been detailed from 16 species of bamboos.

Damage & Symptoms:

Nymphs and adults feed on bamboo shoots by sucking sap. The dispersed adults settle down on new shoots by piercing the tissues. In heavy outbreaks, aphids usually cover the entire shoots. A large population of aphids caused the plants to be smothered with a black fungus which grows on grows on the honeydew secreted by the aphid. Infestation by this aphids caused yellowing of leaves.

Control measures:

Kerosene oil in soap emulsion can be used to control. Foliar spray of 0.04 % Demacron or Rogor and 0.02% Fenetrothion is effective to control the pest. *Scymmus sp* predator on bamboo aphids can be used to control.

***Oregma bambusae* infection on bamboo leaf**

Insect species:*Notobiyus meleagris*
Order: Hemiptera
Family: Coreidae
Hosts:*Dendrocalamus spp*.

Life history:

It prefers sympodia bamboos and prefers *Dendrocalamus* spp. There are five generations per year. Adults will undergo diapause during winter season. Eggs are deposited on shoot sheath and arranged in rows.

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Damage & Symptoms:

Adults and nymphs feed mostly on shoots at 1-2 m high and emit strong repellent odour when disturbed. Some birds, spiders and wasps are found preying on nymphs and adults.

Control measures:

Application of 0.2% Fenitrothion or 1 % Carbaryl in water is effective for the control of this pest. For controlling this pest Entomopathogenic fungus, *B.bassiana* spore suspension at the concentration of 1x107 spores/ml should be sprayed.

***Notobiyus meleagris* Adult**

Insect species:*Oligia vulgaris*
Order: Lepidoptera
Family: Noctuidae

Hosts:*Dendrocalamus strictus, D. giganteus, Bambusa nutans, B. vulgari.*
Life history:

There are six larval instars and pupate inside the shoot or dropped into the soil and pupate. Pupal period lasts for about 3-4 weeks. At night, adult moths are active with strong phototaxis.

Damage & Symptoms:

This is shooting boring Noctuid. Larvae are light purple in colour. There is one generation per year. When bamboo shoots are available, the larvae mine into the shoots and feed inside and make tunnels running in different directions. It can be identified by feeding holes on sheaths.

Control measures:

Light trapping and removal of damaged shoots.

***Oligia vulgaris* Moth**

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Insect species: *Holotrichia consanguinea*
Order: Coleoptera
Family: Scarabaeidae
Hosts: *Bambusa nutans, B. bamboos*

Life history:

The beetle lays egg in soil. Freshly hatched larvae are creamy white. Pupation occurs in soil adult beetles emerge during pre-monsoon rains.

Damage & Symptoms:

It has been reported as minor pest attacking rhizomes of *Bambusa bambos*, *B. nutans* etc.
The beetle lays egg in soil. Freshly hatched larvae feed on the roots and rhizomes of bamboo.

Control measures:

Mechanical control measure was suggested. Spray host trees with *Carbaryl* 0.2 % or *Chlorpyriphos 0.2%* with the onset of monsoon and the spraying within 2-3 days after receipt of first showers

***Holotrichia consanguinea* beetle**

Insect species: *Odontotermes microdentatus* and *O. obesus*
Order: Isoptera
Family: Termitidae
Hosts : *Dendrocalamus strictus, D. giganteus, Bambusa nutans, B. vulgaris.*

Damage & Symptoms:

Only a very few species of termites are known to attack on the root system bamboo in nurseries. Of these *Odontotermesmicrodentatus* and *O.obesus* are two mound building important pests. They attack on the roots of germinating seedlings and rhizomes of bamboos. The damaged occurred below the ground level.

Control measures:

Application of soil insecticides such as 50 ml Aldrin 30EC or 75ml of Chlorpyrifos 20EC@ 5 litres / square metre on to the surface of the nursery bed area, gives suitable protection to nursery seedlings. Commercially available neem seed kernel extract (Neemazal – F) should be prepared at the concentration of 0.007% and sprayed in the field for 50% mortality.

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***Odontotermes microdentatus* and *O. obesus* infestation on bamboo**

CONCLUSION

In general, standing bamboos, particularly natural stands in India are free from major pest problems. When bamboos are grown as plantations under intensive management practices, there can be pest outbreaks which need monitoring. Bamboos during storage and as finished products are liable to serious damage by borers, mainly the *Dinoderus spp*. This is a serious problem in bamboo industry and preventive or remedial measures of control will have to be implemented depending on the severity of borer infestation. The traditional knowledge available with the forest dwellers on bamboo preservation are to be collected and the same desires to be scientifically tested and evaluated.

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High density planting and Ultra high density planting system in Cashew: A boon for doubling the farmers' income

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INTRODUCTION

Cashew (*Anacardium occidentale* L.) is an export-oriented crop grown for its nuts, a true drupe, often referred as 'wonder nut'. It is one of the most valuable processed nut traded on the global commodity markets and is also an important cash crop. It has the potential to provide source of livelihood for the cashew growers, empower rural women in the processing sector, create employment opportunities and generate foreign exchange through exports. The term 'Cashew' has originated from the Brazilian name 'acajaiba' and the Tupi name 'acaju', which the Portuguese converted into 'caju' and is commonly known as 'kaju' in India. It is known as 'Paragi Andi' in Kerala meaning foreign nut, 'Lanka Beeja' in Orissa assuming its introduction from Sri Lanka, and 'Mundiri' indicating the shape of the nut in Tamil Nadu. High density planting enhances productivity of cashew considerably through better utilization of environmental resources.

High density planting system in cashew

High-density planting system in cashew doubled nut yield during the first 10 years of planting (Yadukumar *et al.*, 2002). Selection of right variety and its planting density are prerequisites. This involves initial planting of more number of grafts per unit area and thinning out at later stages (after 8-10 years) depending upon the canopy expansion rate. Instead of 177 plants/ha (7.5 m x 7.5 m), 312-625 plants/ha are planted (8 m x 8 m, 4 m x 4 m). In Tamil Nadu, high density planting technology at 5 x 4 m to accommodate 500 plants per hectare was standardized and released for adoption during 2011 (Anon., 2011). An yield of 3000 kg nuts/ha could be harvested at the age of six years. High density planting technology is recommended to the farmers of Tamil Nadu by organizing seminars, workshops, field days, campaigns, training programmes and exposure visits every year. This technique has been promoted by conducting frontline demonstration programs through TANHODA of Govt. of Tamil Nadu. Under this, Hi-tech HDP programme, 1000 ha was brought under HDP during 2010-14. All the new area expansion programmes were recommended under HDP system.

The initial plant population is to be decided carefully considering soil fertility status, climate and management practices for every agro-climatic condition. If soil is fertile, 5 x 5 m spacing (400 plants/ha) can be maintained to get the highest yield and income. In poor fertility areas, 4 x 4 m (625 plants/ha) is recommended (Yadukumar *et al*., 2003).

Further, optimum tree population (625 trees /ha at 4m x 4m spacing) for high density plantations in cashew was suggested based on the physiological responses (Balasimha and Yadukumar, 1993). This was considered as threshold level for maximizing canopy area, photosynthetic capacity and yield in cashew on an unit basis, although, net photosynthesis and transpiration values were significantly higher in wider spaced trees that received higher irradiance on an individual basis. Tree competition for irradiance was observed to be an important factor and hence high density cropping system should aim at optimizing this limiting factor as reported earlier.

High density planting is more suitable for soils with low fertility. Further, high density planting reduces weed growth due to early ground coverage by the crop canopy and also reduction in soil temperature thereby

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increase in soil moisture content especially during peak summer season and also through mulching effect. Regular pruning is needed to contain the canopy. In later years for instance, eleventh year after planting, it is necessary to thin out the tree population to 50 per cent by removing every alternate tree in each row. Cashew yield can be increased by 2 to 3 folds by high density planting as compared to the normal density planting. During later years, plant population is to be regulated by selective felling to minimize competition. This technique is more useful in poor soils where rate of expansion is slow.

When plants attain full growth, spacing between plants can be regulated to 8 m x 8 m. During early years, though per tree nut yield is more or less same with all trees, irrespective of density of planting, per hectare yield is more from high density planting. Large quantities of firewood can be obtained while cutting excess trees, which fetch additional revenue. Weed growth in such plantation can also be checked effectively. Relatively short-statured and compact varieties such as Anakkayam -1 and Dhana are more suitable for high density planting, since thinning operation can be delayed to more than 10 years. Salam (1999) reported that the varieties M 44/3, Anakkayam-1 and H-1608 were suitable for high density planting. A dwarf hybrid HC 6 was evolved at Regional Research Station, Vridhachalam, which is highly suitable for high density planting system. It is due to dwarf hybrid with a smaller round compact canopy, 3.0 m tall, less spreading, intensive branching, smaller trunk girth, smaller leaves, lower number of internodes, reduced intermodal length and higher stomatal density (Aneesarani *et al.,* 2011).

VRI-3, which is very popular among Tamil Nadu farmers due to its export grade kernels, is highly amenable for pruning and hence suitable for HDP system. The hybrid VRI (cw) H1 produces enormous number of current season's shoot, flowering shoots after pruning and as a result high nut yield. The high density planting with a spacing of 5 x 4 m was released as technology for the benefit of farmers in Tamil Nadu.

High density planting (5m x 4m) field at Regional Research Station, Vridhachalam

High density planting demonstration plot at farmers field in Cuddalore district

Ultra-high density planting system in cashew

With the shrinking land area for cultivation of fruits and vegetables, the availability of land for a drought tolerant and hardy crop is reducing greatly at a faster rate. Planting cashew trees at a closer spacing would accommodate more number of plants per unit area, more photosynthetic area for bearing and thus higher yield per unit area on available land. With the current practice of growing cashew seedlings in a haphazard manner to accommodate hardly 60 plants per hectare, farmers are unable to achieve the national highest average yield of 1500 kg/ha. The present recommendation of 7x7 m would accommodate 200 plants per hectare yielding higher to the tune of 1000 kg/ha wherever farmers adopted apt management technologies in right time. Ultra high density planting system in cashew with 4x2 m and 3x2 m would be a new venture and if

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managed along with proper drip and fertigation system for high soil fertility, it would be the most precise and state of the art technology to increase the productivity of cashew in Tamil Nadu and on the whole in India.

Scope

High density planting is a modern method of fruit cultivation involving planting of fruit trees densely, using varieties which are modified for canopy for better light interception, precocious cropping and regular high yields of good quality fruits. As the value of land is increasing, the available land for cultivation is decreasing; high density plantation is a very important and effective venture as great amount of fruit bearing volume per hectare would be attained at early years. Higher planting density produces higher level of photosynthetic active radiation with high leaf area index and better utilization of the available solar radiation.

The technology “Ultra high density planting system in cashew” consisted of planting 1200 to 1666 plants per hectare combined with canopy management, foliar spray and drip fertigation to double/triple the nut yield. A novel technology has been standardized in cashew by planting grafts at 4 x 2 m or 3 x 2 m to accommodate 1200 plants and 1666 plants per hectare respectively. Training of plants up to six months after planting to contain in the provided space was essential. Training consisted of removal of sprouts in the grafts up to 75 cm from the ground level, followed by formative pruning to develop 2-3 primary branches, 4-5 secondary branches and 5-6 tertiary branches/secondary branch. The plants put forth flowering at 12 months after planting (Aneesarani and Keisar Lourdusamy, 2016).

A nut yield of 250 kg/ha recorded from one year old plants. The plants were pruned during second week of July (tertiary branch pruning) to induce current season’s shoot production. Drip irrigation was given daily @ 8 l/day for first one month, 16 l/day at alternate days from 6-8 months, 32 l/day once in 4 days from 8-12 months (except rainy days). Liquid fertilizers given in two splits (July and November) to supplement the recommended dose of 225:75:75 kg/ha. Foliar spray schedule was given as per recommendation and treatments. Increase in number of current season’s shoots and number of flower panicles has doubled the yield. Actual yield per unit area recorded from two year old plants was 170 kg/0.35 acre in 3x2 m and 200 kg/0.35 acre in 4x2 m (compared to 81.2 kg/0.35 acre in 7x7 m and 112.5 kg/0.35 acre in 5x4 m). Estimated yield was 1275 kg/ha in 3 x 2 m and 1500 kg/ha in 4 x 2 m (compared to 609 kg/ha in 7 x 7 m).

New findings from the experiment

Canopy management started from one month after planting. Basic framework of the plants was done within six months after planting with defined number of primary, secondary and tertiary branches. The spacing 4 x 2 m was the best for canopy management, light interception, more number of current season’s shoots, flowering panicles, fruit set and yield. Due to proper canopy management, the trees were brought to flowering and yield from first year after planting itself. A yield of 1520 kg nuts per hectare recorded in 4 x 2 m spacing at 2nd year after planting itself. The technology would be a great boon to the cashew farmers in the country for high remuneration from first year itself (Aneesarani and Keisar Lourdusamy, 2016)

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Ultra High Density Planting at Regional Research Station, Vridhachalam


UHDP planting (4mx2m spacing)

Two year old plants

Flowering in 5 year old VRI-3 trees

CONCLUSION

Though there were many attempts made to standardize high density and ultra high density planting system in cashew with variable success, however commercial adoption by the farmers across the state is still lacking. Further, canopy management through pruning is not well understood properly and in addition, use of machinery for pruning is negligible or absolutely not available in India. Therefore, this can be achieved by developing dwarf rootstocks and scion cultivars in cashew. Modern and successful training systems adopted in temperate fruit crops may be tried and adopted in cashew after long term evaluation.

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Evolution of herbivory in insects

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The evolution of herbivory is a relation between the plant characteristics and insect behavior. The basic interaction between the plant and insects is in the form of host plant interaction. This form of host plant interaction includes both biophysical and biochemical characteristics of the host plant. The deciding factor for herbivory is the diverse traits of the plant including both physical and chemical characteristics and the internal and external adaptations to those characters. Basically the herbivory is an ageold process which is a result of coevolution between the two trophic levels. To cater the herbivory, some plants have evolved some chemical compounds which are otherwise known as secondary plant metabolites. Based on the chemistry of these plant metabolites the preference of insects towards their host plants have taken diverse direction. Chapman has classified the herbivory further into monophagous, oligophagous and polyphagous.

INTRODUCTION

With the advancement of time, the insects have evolved dynamically in divergent niche which leads to different feeding habits, thus the intraplant (feeding on green leaf tissue, nectar or pollen) and interplant (feeding on plants of different species and family) diversification in feeding in insects lead to development of monophagy, oligophagy and polyphagy. The predominance of oligophagous species among insect herbivores does not necessarily indicate that oligophagy is in most cases the best strategy regarding the balance between costs and benefits, but may simply reflect the irreversibility of specialization. In a provocative contribution, Jermy (1993) questioned the often implicitly made assumption that insect-plant relationships are the result of unconstrained selection. Furthermore, the tritrophic interactions such as the diversity in plants, their chemistry and natural enemies of the herbivores is also reported to be responsible for the evolution of herbivory such as some insects are generalist feeders that is they can overcome the adverse effects of the toxic secondary metabolites produced by plants whereas some insects are specialist feeders that is they can metabolise the more toxic compounds that can't be metabolizing the toxic isothiocyanates.

Plants are regarded as suboptimal food source because they contain dilute nutrients in indigestible structural compounds such as cellulose and lignin. The deficiency in adequate nutrients leads to diverse morphological specialization in insects, which may be categorized as

1. External morphology such as diverse structure of mandibles

The typical insect mandible comprises of 2 different types of regions such as molar area for grinding of food and incisor area for cutting the hard food into small particles. In case of
grass feeders such as grasshoppers the molar and incisor area are well developed, whereas in leaf feeding caterpillars the the true molar area is absent.

2. Internal morphology such as filter chamber and gastric caeca

Leaf feeding beetles and bugs have thinner cuticles than the carnivorous ones , thus the phytophagous insects has a well developed adaptive mechanism for the conservation of Nitrogenous compounds (Rees, 1986). The cuticular reabsorption by insects is an evolutionary adaptation by insects for conservation of

Nitrogenous compounds as the plants are not adequate source of proteins for few insects . In grass hoppers the posterior arms are reported to be absent whereas, in forb-feeders both the anterior and posterior arms are more developed than the herbivores. This is an evolutionary adaptation to the diverse characteristic of plants .

Biophysical basis

The morphological and anatomical characteristics of a plant like colour, shape, size, thick cuticle, trichomes, surface waxes, silica deposits, glandular hairs, tight leaf sheath, compact panicle and tightness of husk influence insects' preference. The resistance mechanisms related to morphological or structural plant features all together called 'Phenetic resistance'. Phenetic resistance causes reduced or impaired feeding or oviposition and contribute to the action of other mortality factors.

A. Tightly wrapped leaf sheath, closely packed vascular bundles and high silica content- rice stem borer.
B. Red pericarp and surface wax- Brown plant hopper
C. Pubescent varieties of soybean variety, cotton and bhendi - Leaf hopper
D. Frego bract cotton varieties - Boll weevil

Biochemical basis

Chemicals in plants impart resistance to a wide variety of insect pests. E.g
Eg. Nutirents : Asparagine in Mudgo rice variety - Brown plant hopper
Low carbohydrates- Mexican bean beetle *Epilachna varivestis*

Basically the evolutionary ecology of herbivores is closely related to the chemical ecology of the host plant species. The info-chemicals emanating from the host plants acts as a source of token stimuli which acts as a source of plant information for identification of proper host plants. according to resource concentration hypothesis and enemies hypothesis, in the diverse background of plants a herbivore can identify the apparent host which is the prime cause of herbivory in insects.

If the defense system provided by plants to insects is taken into consideration, it can be divided into 2 ways (Gols, 2014) such as

1. Direct defense (defense produced by the plant itself i.e. the first trophic level regulates the second trophic level)
2. Indirect defense (defense is provided to the plants by the natural enemies such as parasitoids and predators i.e. third trophic level imparts defense to the first trophic level through regulating the activity of second trophic level i.e. insect pests) (Alzbory and Chen, 2018)
3. Thus the host plants and its herbivores have been cospeciated and the evolution of new species not definitely the dead end which further continued from polyphagy, oligophagy and monophagy.

CONCLUSION

The herbivory in insects is a result of coevolution or parallel evolution . As the new host plant evolves in response to diverse climatic conditions as the paleological record suggests, the herbivore species evolves in a pair- wise pattern. The particular herbivore influences the inclusive fitness of the host plant, which further lead to the development of a chemical defense i.e. secondary metabolites, otherwise known as chemical coevolution (Bernays and Graham,1988). Thus this alternation in plant chemistry ultimately influences the specialized herbivore population , thus resulting in diverse range of herbivory in insects.

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Usage of aromatic and medicinal plants for for feeding animals

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India is home to about 20 percent of the world's livestock population and the human population with only 2.3 percent of the global geographical area. India is a livestock leader in cattle (16 percent) and the buffalo (55 percent). Food and feed deficiency has been identified as one of the main limitations of the livestock industry to achieve the desired level of animal production (Bikas *et al*. 2013). Dependence on livestock for their livelihood is the mandatory nature of the rural indian population. In the early days, usually, farm animals were taken to pastures and forest areas nearby grass. During grazing, they also take wild aromatic and medicinal plants that grow naturally i.e. Fennel, Mint, Cloves and Tomb, Karela, Shankhpuspi, Dronpuspi, Ashwagandha, Neem, Ak, Marva Tulsi, etc., this pasture in important aromatic medicinal plants that keeps the cattle animals free from common diseases. Today, Grasslands and forest areas are not left for open grazing. As a result, forage crops have been used as a source of food for domestic and farm animals to produce high returns, which are also rich in nutrients adapted to the needs of animals. Moreover, green fodder production is insufficient in the country and generally, the animals feed on dry straw which causes the health problems in animals. Therefore, you feel the need to feed our pets in aromatic and medicinal plants to keep they are in good health and without common diseases. Plants (whole plants, leaves or seeds, mainly used as animal feed) and its extracts (considered as additives) are increasingly used in animal nutrition as snacks, digestive and physiological stimulants, dyes and antioxidants, and for the prevention and treatment of certain pathological conditions.

The digestive effects of herbs and spices have been proven mainly in humans and laboratory animals, and little trials have been carried out on farm animals (Zotto et al. al., 2016). In view of the previous discussion, some aromatic and medicinal plants containing food, feed and fodder value are discussed here:

1. **Shatavari (*Asparagus racemosus*):** is a popular complement that people and animals use to treat a wide range of symptoms. Antioxidants protect the body of the damage caused by free radicals, which can damage the cells and lead to the development of diseases, including cancer (Zotte *et al*. 2016).
2. **Tumba (*Citrullus colocynthis*):** it is a medicinal plant, usually grows wild in sandy soils in the rainy season. It belongs to the family Cucurbitaceae. In general, it is used to feed livestock, camels, and goat and corrects gastric abnormalities in-home animals (Dusyant and Deen, 2010)
3. **Senna (*Cassia senna*):** It is mainly used as a laxative. Its leaves and pods contain sinus chemicals. The leaves are mainly used to heal stomach alterations in animals. The laxative properties of *Cassia senna* make it an excellent green feed for feeding animals in semi-arid regions.
4. **Ashwagandha (*Withania somnifera*):** Ashawangadha is usually lush green and can be used to feed the animals. In humans, it is used in the headache cure, the development of the cure of the nervous system, the heart anesthesia, blood pressure and reduces cholesterol levels (Tyagi, 2008).
5. **Methi/fenugreek (*Trigonella foenum-graecum* L):** The effect of feeding fenugreek seeds to 20 percent of the diet dry matter in the performance of dairy cows and milk. It is also recommended as an alternative to forages of alfalfa crop, as it can prevent swelling of cattle. It is also reported to provide

similar rumen conditions, digestibility and weight gain in cattle in comparison to alfalfa (Kumar *et al.,* 2013).

6. **Tulsi (*Ocimum tunuiflorum*):** The leaves of *Ocimum tunuiflorum* suppressed benzo pyrine induced chromosomal aberrations in the bone marrow and elevated glutathione (GSH) and glutathione-S-transferase (GST) actives in the liver of mice. The suppressing effect of *Ocimum* on chemically induced hepatomas in rats and tumors in the forestomach of mice was reported by Samresh *et al*. (2003).
7. **Neem (*Azadirachta Indica*):** Neem leaves acts as a growth promoter by killing parasites that prevent growth. The ingredients of neem act as a repellent and interrupt the appetite of insects and decrease their need to reproduce (Tipu et al., 2006).
8. **Bakin (*Melia azedarach*):** Green leaves of bakin are used to feed goats and sheep in rural areas. Hayat et al. (1996) studied the prophylactic effects of indigenous preparation of salinomycin bakin against coccidiosis in broiler chickens.

Aromatic plants, their extracts and essential oils contain a variety of functional bioactive compounds, which have possible applications in the food and feed for livestock animals.

Table – Use of aromatic plants as animal feeds

Aromatic plant	Animal	References
Oregano	Chickens broilers	Giannenas *et al*. 2005
Sage	Rabbits	Pogany *et al.* 2010
Garlic	Turkeys	Suriya *et al*. 2012
Saffron	Laying hens	Botsoglou *et al*.2005
Anise	Laying quail	Christaki *et al.* 2011

Conclusion- The feeding of domestic animals in such crop in addition to other forage crops improve the performance and health status of animals and keep them free of serious diseases. In addition to this, feed the animals with drug plants also improves the quality of animal products like milk, meat, and eggs, but further research is needed recommended to optimize effects on animals.

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Nutrient Management in Cashew

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Majority of the cashew growing soils in India are lateritic, red and coastal sands which are acidic in nature with poor soil fertility. Limited nutrients or no use of fertilizers and organic manures is responsible for low productivity in cashew. Most deficient nutrients in cashew growing soils are nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), zinc (Zn), boron (B) and molybdenum (Mo). It has been estimated that for every one kg of cashew nut produced, the plant depletes the soil by 64.1 g N, 2.05 g P, 24.7 g K, 4.19 g calcium (Ca), 1.57 g sulphur (S), 525.7 mg iron (Fe), 63.6 mg manganese (Mn), 87.8 mg Zn and 26.5 mg copper (Cu) nutrients. Cashew requires regular fertilizer application to ensure early and high yields in new / young plantations, and regular high yields from mature plantations. Hence, nutrient management is useful venture in cashew.

The availability of soil nutrients to cashew plants depends on several factors. It may be due to low amounts in the parent material from which the soil is derived, fixation and immobilization of nutrients, or leaching losses of nutrients under high rainfall conditions, nutrient imbalances in the soil and continuous cultivation due to removal of nutrients by cashew plants without subsequent replenishment.

Nutrient dose and response

The major nutrients viz., nitrogen (N), potassium (K) and potassium (P) are required most for cashew growth and development. Nitrogen has more influence on tree growth, production and quality of cashew. Urea is the most commonly used nitrogenous fertilizer in India. Potassium is the second major nutrient next to N required by cashew. Among different sources of K fertilizers, Muriate of potash (potassium chloride) is most commonly used fertilizer in cashew. The recommended dose of K varies from 125 to 750 g/tree/annum as basal depends upon the nature of soil, spacing and age of the cashew plant. Phosphorus is the second most limiting nutrient after N and K in the nutrition of cashew. Phosphorus deficiency is common in cashew growing acid soils in which the mineral fraction is dominated by kaolinite and sesquioxides. Phosphate fixation of water soluble P is greater in cashew growing acidic soils dominated by kaolinitic type of clay mineral but allows the use of rock phosphate as a good source of P to cashew crop. Of phosphatic fertilizers for use on acid soils in India, the slow-release and more efficient ground Mussoorie (rock) phosphate is popular.

The recommended dose of fertilizers varies with the age of plants, plant density and fertility of the soil. About 10 to 15 kg farmyard manure (FYM)/plant/year is recommended in addition to primary nutrients (N, P and K). Recommended fertilizer dose by ICAR-Directorate of Cashew Research (DCR), Puttur are as follows: 500 g N and 125 g each of P and K and 10 kg poultry manure per tree per year under normal density planting system (10 m x 5 m; 200 plants/ha); 250 g N and 50 g each of P and K and 10 kg poultry manure per tree per year under high density planting system (4 m x 4 m; 625 plants/ha). After certain stage of the crop, reduction in recommended doses of fertilizers per plant may be necessary due to the nutrient build up in soil due to the deposit of cashew biomass fall out. It has been estimated that by systematically recycling all the waste biomass produced by cashew, it is possible to get back 20.7 kg N, 10.5 kg P_2O5 and 30.8 kg K_2O /ha/year.

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Time and method of fertilizer application

The key to enhance fertilizer use efficiency is to synchronize the time of fertilizer application with the growth need of the crop and period of high root activity. Flushing and early flowering phase (September to December) is the most appropriate time for fertilizer application in a cashew orchard. Fertilizers are applied in two split doses in Cashew, the first at the onset of the monsoon period and the second during the post-monsoon period.

Cashew trees are surface feeders with 72 per cent of root activity found within a 2 m radius from the tree trunk. Hence, fertilizer application within 2 m radius from the main stem results in efficient utilization of the applied nutrients. In Cashew the best suited methods of fertilizer application are viz., application of fertilizers in two circular trenches (1.5 and 3.0 m from the trunk) for sandy soils; a single trench method (25 cm wide and 15 cm deep circular trench at 3 m from the trunk) for sloping ground, and the band method (in a circular band 1.5-3.0 m from the trunk + soil incorporation) for flat ground. Flushing and early flowering phase (September to December) is the most appropriate time for fertilizer application in cashew orchard.

Foliar feeding

Deficiency or toxicity of essential micronutrients *viz.,* Fe, Mn, Zn, Cu, B, Mo, chlorine (Cl) and nickel (Ni) in soil adversely affects the growth and development of cashew plants. Among micronutrients, deficiencies of Zn, B and Mo are more common in cashew growing acid soils. Iron and Al toxicity is a distinct problem. Micronutrient deficiencies in soil not only limit the cashew production but it also has negative effects on human health. Foliar feeding is often the most effective and economical way to correct micronutrient deficiencies in horticultural crops. Foliar application of nutrients normally reduces the loss through adsorption, leaching and other processes associated with soil application. Deficiencies of micronutrients can be corrected by foliar sprays of ferrous sulphate (0.5-1%), manganese sulphate (0.5-1%), zinc sulphate (0.5%), copper sulphate (0.1%), solubor (0.1%) and Mo (0.1%) salts to cashew at the emergence of the flush, panicle initiation and fruit set stages.

Integrated Nutrient Management

Application of chemical fertilizers, organic manures / green manuring and biofertilizers constitute an efficient nutrient management strategy in cashew to enhance the soil quality and also for sustainable production. Green leaf manuring with *glyricidia* and sesbania in cashew resulted in higher nut yield and improvement in soil nutrient content. The *glyricidia* contributed 186 kg N, 23.6 kg P_2O_5 and126.2 kg K_2O/ha and sesbania contributed 141 kg N, 17.9 kg P_2O_5 and 162.3 kg K_2O/ha. Application of *Azospirillum*, *Azotobacter* and Vesicular Arbuscular Mycorrhizae increased the germination percentage of nuts and plant growth, and reduced the incidence of fungal diseases in the Cashew nursery.

About 15.5–37.7% of tree total requirements of macronutrients are recycled from canopy biomass fallout of leaves. Studies conducted at ICAR-DCR, Puttur on nutrient budgeting and nutrient balance in a six year old cashew plantation of 'Bhaskara' variety under high density planting system (625 trees/ha) showed a negative N, P and K balance of 113, 38 and 92 kg/ha in control plot where no fertilizer was applied. A strong positive N, P and K balance ranged from 128 to 253, 18 to 54 and 34 to 128 kg/ha were recorded in plots with 2/3rd and full dose of recommended fertilizers (750 g N and 150 g each of P_2O5 and K_2O per tree/year).

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Organic production of cashew offers immense potential. The availability of cashew leaf litter from different age group plantations (10 to 40 years) ranged from 1.38 to 5.20 t/ha. Studies have shown that about 5.5 tonnes of available cashew biomass waste per ha can be converted into 3.5 tonnes of compost which can meet nutrient requirement to cashew by 50 per cent.

The application of fertilizers through the irrigation water (fertigation) has the advantages of increasing the efficiency of the fertilizers and reducing the costs of labour and machinery for its application. In Cashew, water soluble fertilizers like urea, diammonium phosphate and muriate of potash are used for fertigation through drip lines from December to March and application of 2 kg castor cake to soil during August. With fertigation, quantity of nutrients (through fertilizers and organic manures) to be applied can be reduced to half of the quantity of recommended nutrients. An increase of 100 per cent and 226 per cent in yield was observed in the treatment received half of recommended dose of NPK in inorganic form (Recommended dose: 500 g N, 125 g each of P_2O5 and K_2O/tree/year) of nutrients through fertigation indicating better nutrient use efficiency.

CONCLUSION:

Cashew requires regular fertilizer application to ensure early and high yields in new or young plantations and regular high yields from mature plantations. Application of chemical fertilizers, organic manures / green manuring and biofertilizers constitute an efficient nutrient management strategy in cashew to enhance the soil quality and also for sustainable production.

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Newer molecules with novel mode of action in insect pest management

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Several decades'chemical insecticides as a principal method of control of number of economically important pests of crops, livestock and human beings. Many of the synthetic insecticides are nerve active and their usage for the management of pests almost started way back in 1940's with the introduction of organochlorines (OC) like DDT, followed by organo--phosphates (OPs) in the 1950s, carbamates in the 1960s, synthetic pyrethroids in the 1970s and neonicotinoids in the 1990s (Cassida and Durkin, 2013). Due to indiscriminate usage of the above mentioned group's leads to the development of insecticide resistance in insect became global phenomena in the last decades, environmental pollution and destruction of natural enemies and resurgence of insect pests especially sucking pests. Moreover, the above groups are mainly nerve target insecticides targeting acetylcholinesterase, nicotinic acetylcholine receptor, the aminobutyric acid receptor/chloride channel and the voltage-gated sodium channel (Cassida and Durkin, 2013).Therefore, insect pest management depends on the development and frequent introduction of novel insecticide molecules with different mode of action in order to sustain their longevity in insect pest management programme.

More than 550 pest species have developed resistance to one or more existing insecticides and it has been lead to the importance of Insecticide Resistance Management (IRM) programs. In the current scenario of pest management programme (Whalon *et al*, 2008 and APRD data base, 2012), there is a need to search for the alternate molecules with different mode of action. This led to the discovery and development of natural hormones and synthetic hormone mimics capable of interfering with the processes of growth, development and metamorphosis of the target insects. These chemicals have been called insect growth regulators (IGR) or third-generation insecticides. Presently, IGRs account for only 5% of the global market and considering their comparatively slow action can be looked as a major limitation in Insect Pest Management (IPM) programme. Discovery of other classes of insecticides with different mode of action targeting various sites in insects, i.e. spinosyns (spinosad, spinetoram), sodium channels blockers (indoxacarb, metaflumizone) and the diamides (chlorantraniliprole and flubendiamide) provide notable examples of excellent mammalian selectivity coupled with excellent utility and efficacy against broad range of insect pests and theses types on newer molecules account for about 12% of the global market pest management programme (Sparks, 2013).

The brief details of the newer molecules with different mode of action are discussed as follows:

The growth and development of insects are regulated by various hormones namely neurohormones (neuropeptides), ecdysteroids (the moulting hormone, ecdysone) and the sesquiterpenoid juvenile hormones (JHs). Exogenous application of analogues (agonist or antagonist) of these different hormones on the pests can be affect the development and reproduction of the target insect pests.

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Insect Growth Regulators (IGRs)

Insect Growth Regulators (IGRs) are one of the new avenues for the discovery and development of novel compounds with different mode of action that interferes with the developmental and reproduction process of insects. This leads to the development of commercial IGRs which is environmental-friendly molecules and well fitted in the IPM programmes. In 1960s, the development of IGRs was initiated but slow progress for the development of IGRs related molecules was noticed. IGRs related molecules are interferes with the regulation of metamorphosis and in reproduction in insects. IGRs can be grouped according to their mode of action, as follows: substances that interfere with the action of insect hormones and chitin synthesis inhibitors.

Juvenile hormones mimics (Dhadialla *et al*, 1987)

Several juvenile hormones are known to present in insects (i.e. JH I-III, JH 0, and iso-JH 0) that are synthesized and secreted from the corpora allata. Any disturbance in the normal hormone balance may cause a crucial disorder in the growth and development of insects.Based on various experiments, in 1967 Williams first recognized the use of juvenile hormone (JH) analogs have potential as control agents for insects.Discovery of new molecules over the last two decades has resulted in the discovery of chemically novel insecticides that mimic the action of the two insect growth and developmental hormones, the steroidal 20-hydroxyecdysone (20E) and the sesquiterpenoid juvenile hormone (JH). Bisacylhydrazines are non-steroidal agonists of 20E and exhibit their insecticidal activity via interaction with the ecdysteroid receptor proteins. Aromatic non-terpenoidal insecticides mimic the action of JHs. The first compound introduced into the market was methoprene. This is a terpenoid compound used primarily against household pests because of its low activity against agricultural pests. Several JH analogues are presented in Table 2 and are commercially available as insect growth regulators.

The aromatic non-terpenoidal insecticides (fenoxycarb and pyriproxyfen) mimics the action of JHs. These compounds showed reasonable field stability and high potency on agricultural insect pests. First commercial compound, Fenoxycarb was developed and marketed for the control of agricultural pests. Pyriproxyfenis a phenoxycarb derivative is a JH mimic affecting the hormonal balance in insects, resulting in strong suppression of embryogenesis, metamorphosis, and adult formation. It is specifically effective for controlling of Hemipterans especially whiteflies and scale insects (Ghanim and Ishaaya, 2010).

Moulting hormones mimics (Dhadialla *et al*, 1987)

The prothoracic glands are the major source of ecdysteroids during larval development. Ecdysteroids are synthesized from cholesterol or phytosteroids in the diet. During the past three decades, the progress has been made for the discovery and development of novel compounds that interferes with the biosynthesis of ecdysone 20-monooxygenase. This leads to the ecdysteroid agonists and identified very successful ecdysteroid mimic, RH 5992 (tebufenozide), is currently marketed under the trade names Mimic, Confirm and Roman .RH-2485, the newest member of the bisacylhydrazine class, seems to be even more active than tebufenozide, acting against a wide range of lepidopteran pests.

The natural molecule with molt-inhibiting activity is azadirachtin, a tetranortriterpenoid plant (neem tree, Meliaceae) limonoid with ecdysteroid-like structure. Its strong antifeedant, insect growth regulatory and reproductive effects are well documented.

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Chitin Synthesis Inhibitors (CSIs) [Ghanim and Ishaaya, 2010]

The insect cuticle consists of mainly of protein and chitin fractions. The different enzymes are responsible for the biosynthesis of chitin in insects and are potentially targets for the development of compounds that interfere with the enzymes responsible for the chitin synthesis. These types of compounds acting on different insects by inhibiting chitin synthesis causing abnormal moulting. The first CSI belongs to the benzyl phenyl urea (BPUs) group led to the discovery of first novel molecule, diflubenzuron. They act mainly by ingestion, but in some species they suppress fecundity and exhibit ovicidal and contact toxicity andselectively effective against larvae of Lepidopterans and also effective against Coleoptera and Diptera pests. Several effective BPUs that are far more potent than diflubenzuron have been developed, such as chlorfluazuron, teflubenzuron, hexaflumuron, and novaluron. They are very effective in controlling insect pests of cotton and vegetable crops (Horowitz and Ishaaya 2004).Another novel molecule, Buprofezin is a thiadiazine-like compound used against homopteran pests especially against nymphs of brown plant hopper, leaf hopper and white flies. It inhibited chitin synthase enzyme and influenced the development of larvae. Insect growth regulators are often very species-specific insecticides and in general are not active as aphicides, but rather against other pest insects, e.g. whiteflies (buprofezin and pyriproxyfen), Lepidoptera (methoprene, fenoxycarb, and benzoylphenyl ureas), Heteroptera (e.g. fenoxycarb), Orthoptera and Hymenoptera (pyriproxyfen) and Diptera (cyromazine). Insect growth regulators are in general much slower in providing full efficacy against pest insects compared to insecticides interfering with neuronal target sites.

Insect Neuropeptides:

Insect Neuropeptides are small molecule proteins produced in neurosecretary cells in various parts of the nervous system. The presence of substances that control physiological and biochemical functions from a distance was suggested by Kopec (1917) who reported that moulting and metamorphosis in the gypsy moth larva. *Lymantria dispar* are regulated by a neuroendocrine factor. The first insect neuropeptide, proctolin was isolated and identified from cockroach (Starratt and Brown, 1975). After the discovery of first hormone, proctolin, the numbers of insect neurohormones have been characterized and functions have been well defined that includes immune system, water and ion-balance, feeding behaviour, sex attraction, reproduction and muscle activity.

Pheromone biosynthesis activating neuropeptide (PBAN) is a responsible neurohormone in female moth insects for the stimulation and synthesis of sex pheromones. This is a basis for the development of highly effective and environmentally safer pheromone based neuro molecules with different mode of action which is effectively fitted in the current scenario of IPM programme. Sex pheromones used in pheromone traps can be used for the purpose of mass trapping, monitoring and mass killing in pest management programme.Eg. (Z)-11-hexadecenal and (Z)-9-hexadecenal (97:3) for *Helicoverpaarmigera*; (Z, E)-7-11-hexadecadien-1-ol acetate and (Z, Z)-7-11-hexadecadien-1-ol acetate (1:1) for *Pectinophora gossypiella*; (Z, E)-9-11-tetradecadienyl acetate and (Z, E)-9-12-tetradecadienyl acetate (10:1) for *Spodoptera litura* etc.

Therefore, neuropeptides can be explored for the discovery and development of neurobased chemical molecules for interferes in the physiological and biochemical functions of the insects. It has the great opportunity to explore newer control molecules based on the insects own natural products to develop fourth generation insecticide molecules. These type of novel neurobased molecules have the different mode of actions and this could be interfere in the biosynthesis of neurohormones and their disruption of release into the hemolymph and their interaction with the target cell present in the insect membranes.

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Table 1. List of Selected Insect Hormones and their functions

S.No.	Active principle	Origin	Function role
1.	Ecdysone (moulting hormone)	Ecdysial gland	Initiate moulting in insects
2.	Juvenile hormone	Corpora allata	Controls metamorphosis, to produce vitellogenin,
3.	PTTH hormone	Brain	Stimulates and regulates production and release of ecdysone
4.	Bursicon hormone	Neurosecretory cells	Stimulates sclerotization and melanization of cuticle
5.	Allatoststins and allatotropin	Brain	Inhibits and stimulates JH production
6.	Diuretic hormone	Brain, corpora cardiac	Controls dieresis
7.	Proctolin	Brain	Muscle contraction
8.	Adipokinetic hormone	Corpora cardiac	Lipid mobilization

Table 2. Insect growth regulators and their activity for insect pest control

S.No.	Activity	Name and target
1.	Chitin synthesis inhibitor	Diflubenzuron (Lepidoptera, Coleoptera and Diptera), Novaluron (Lepidoptera), Lufenuron (Lepidoptera), Diafenthiuron, Buprofezin (Sucking pests-Homoptera-brown plant hopper, white fly)
2.	JH mimics	Hydroprene, Kinoprene, Methoprene, Fenoxycarb (Lepidoptera)
3.	Ecdysone analogues	Halofenozide, Methoxyfenozide, Tebufenozide, Diofenolan (Lepidoptera-caterpillars)

Neonicotinoids (Nauen, R and Bretschneider 2002;Matsuda *et al*., 2001; Casida and Durkin, 2013 & Simon-Delso*et al*., 2014)**:**

Neonicotinoids are a class of novel molecules that act as agonists of the insect nAChR located in the central nervous system. Neonicotinoids interact with nicotinic acetylcholine receptors at the central and peripheral nervous system, resulting in excitation and paralysis, followed by death. They are effective against sucking insects especially aphids, whiteflies and planthoppers, some beetles and lepidopteran pests. It can be used as foliar sprays, seed treatments and as soil application. Neonicotinoids are not showing any cross-resistance to the different insecticidal groups belongs to carbamate, organophosphate, or synthetic pyrethroid insecticides and make these molecules fit well into the insecticide resistance management programme. Moreover, neonicotinoid insecticides are applied as lower dose rates when compared to conventional insecticides. Available neonicotinoid insecticides include: Chloronicotinyl compounds (Imidacloprid, Acetamiprid and thiacloprid); Thionicotinyl group compounds (Thiamethoxam); Furanicotinyl group compounds (Dinotefuran); Clothianidin; Cycloxaprid;; Nitenpyram; Sulfoxaflor;.

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The first generation of neonicotinoids included nitenpyram, imidacloprid, acetamiprid, and thiacloprid.

Imidaclopridis the most widely used insecticide worldwide in different crops within the mode of action group. It is applied as foliar treatments for crops including: cereals (Rice, maize), cotton, soybean, legumes, potatoes, rice, mango and vegetables. It is a systemic molecule with particularly effective against sucking insects with a long residual activity. It is also applied to soil, timber as well as well-known seed treatment compound. Under the second generation neonicotinoid insecticide,

Thiamethoxamwas developed and belonging to the thianicotinyl subclass. The chemical structure is slightly different from other neonicotinoid insecticides, making it highly water soluble and thus it is readily translocated in plant tissue.

Clothianidin (metabolite of thiomethoxam) is a neonicotinoid class of insecticides that act on the central nervous system of insects as an agonist of acetylcholine, the neurotransmitter that stimulates nAChR, targeting the same receptor site (AChR) and activating post-synaptic acetylcholine receptors but not inhibiting AChE. This compound was developed to last longer than other neonicotinoids, which is more toxic and which breaks down too quickly in the environment. Clothianidin can be used for spray, dust, soil drench, injectable liquid as well as seed treatment molecule.

Dinotefuranis belongs to the third-generation neonicotinoid and interact with insect nAChRs. Dinotefuran can exhibit a nerve-excitatory activity, which is lower than that of imidacloprid and comparable to that of clothianidin, and a nerve-blocking activity, which is comparable to that of imidacloprid and slightly higher than that of clothianidin. This compound and its derivatives are better correlated to nerve-blocking activity which is a characteristic of this compound.

Sulfoximines targeting sap sucking insects: (Babcock *et al*., 2011; Zhu*et al*., 2011&Sparks *et al* 2013)

Sulfoxaflor ([N-[methyloxido[1-[6-(trifluoromethyl)-3-pyridinyl] ethyl]-k4-sulfanylidene] cyanamide] represent a fourth-generation neonicotinoid that exhibits a high insecticidal activity against a broad range of sapfeeding insect and well fit into the insect resistance management programmes.It showed a well-known mode of action ie.an agonist at insect nicotinic acetylcholine receptors (nAChRs) and functions in a manner distinct from other insecticides acting at nAChRs. Lacks of cross-resistance with other molecules, the sulfoximines such as sulfoxaflor are poor substrates for the metabolic enzymes involved in resistance to other classes of insecticides. The symptoms are initially excitatory and include tremors, antennal waving, and leg extension or curling, followed by partial or complete paralysis and death.

Cycloxaprid (cis-nitromethylene neonicotinoid insecticide) (Cui *et al*., 2012):A novel neonicotinoid prepared from the (nitromethylene) imidazole (NMI) analogue of imidacloprid and a cis-neonicotinoid also belonging to the fourth generation neonicotinoids.It has good contact and root-systemic activity. This compound disturbs the feeding activity of sucking pests especially aphids.

γ-Aminobutyric acid (GABA) chloride channelagonists/antagonists: (Nauen, R and Bretschneider 2002)**:** These are located in the insect central nervous system and peripheral nerves where they mediate the proper integration of neuronal activity and muscle relaxation by inhibitory actions. GABA-receptors are target sites for three important classes of insecticides and the symptomology of poisoning induced by compounds acting as antagonists on inhibitory GABA receptors resemble those induced by agonists of excitatory receptors, e.g. hyperactivity, convulsions and leg tremor.

Phenyl-pyrazole group (Simon-Delso*et al.*, 2014):

Fipronil: A potent blocker of GABA-gated chloride channel i.e. inhibits neuronal receptors. It is highly active via ingestion, contact and systemic routes in the insect system. Fipronil exerts its insecticidal activity by acting on the inhibiting system of the nervous system. It binds to GABA receptors and to glutamate receptors coupled to chloride channels. It blocks by inhibiting receptors leading to an excitation of the nervous system. It leads to neuronal hyperexcitation due to accumulation of the neurotransmitter (GABA) at the synaptic junctions. Fipronil is appropriate for soil application, seed treatment and as well as for foliar application. It is effective against pest complex of rice, stem borer of sugarcane and termites.

Macrocyclic lactones (Avermectin)(Nauen, R. and Bretschneider, 2002)**:**

Abamectin : It is a natural fermentation product of the soil bacterium, *Streptomyces avermitilis*. These are chemically referred as macrocyclic lactones. Abamectin is a mixture of avermectins containing more than 80% avermectin B1a and less than 20% avermectin B1b. These avermectins are insecticidal, acaricidal and antihelmintic compounds. They bind with high affinity tosites in the head and muscle neuronal membranes of various insect species, thereby acting as agonists for GABA-gatedchloride channels. They affect thenervous system of arthropods by increasing chloride ion flux at the neuromuscularjunction, resulting in cessation of feeding and irreversible paralysisand finally death.

Emamectin benzoate:A new semisynthetic avermectin derivative, where the hydroxy-group in the terminal sugar ring is replaced by a methylamino group. Non-systemic insecticide, which penetrates leaf tissues by translaminar movement. It acts on nerve cells to suppress muscle contraction and paralyses the lepidopteran larva, which stops feeding within hours of ingestion, and die 2-4 days after treatment.

Spinosyns(Nauen, R. and Bretschneider, 2002)**:**

Spinosad: This compound is derived from the fermentation products of actinomycetes, *Saccharopolyspora spinosa*. Spinosad, the macrocyclic natural compound is a mixture of the two naturally occurring macrolides spinosyn A (85%) and spinosyn D (15%), which were isolated from the soil microorganism *Saccharopolyspora spinosa*. This mixture is particularly effective against pest lepidopteran noctuid larvae, a group of leaf-feeding insect pests not covered by neonicotinoid insecticides. Spinosad is generally not active against sucking pest insects such as aphids and whiteflies. The mode of action of spinosad is the allosteric activation of insect nAChRs and a prolongation of acetylcholine responses. Spinosad has a different binding site on the nAChR than imidacloprid and other nAChR based insecticides.

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Spinetoram: New class of chemical in the spinosyn group of insecticides and consists of spinetoram- J and L which have a macrocyclic lactone structure. It is a derivative substances of spinosyns produced by *Saccharopolyspora spinosa* and discovered by Dow Agrosciences which is a semi-synthetic spinosyn in modification studies of fermenting substances of actinomycetes. It has a broad insecticidal activity with rapid action along with shorter pre-harvest interval.

Voltage-gated sodium channel agonists/antagonists(Nauen, R and Thomas Bretschneider 2002)**:** It is an important molecular target having different binding sites for several synthetic insecticides. The rapidly depolarizing phase and propagation of action potentials in many excitable cells due to rapid increase in membrane sodium conductance is mediated by voltage-gated sodium channel.

Oxadiazine group:

Indoxacarb: It is the only chemical insecticide available from this group. It interferes with a group of ion channels by inhibiting the flow of sodium into nerve cells, causing pest paralysis and death. The primary route of entry into the target insects is through ingestion and activated by insect esterases although the product is also absorbed through cuticle. It is especially active on lepidopteran larvae. Indoxacarb is a proinsecticide with only weak activity on voltage-gated sodium channel. It is metabolically activated by cleavage of the N-methoxycarbonyl group. The resulting NH-derivative is a potent sodium channel blocker.

Inhibitors of Mitochondrial electron transport(Lovell*et al*., 1990; Nauen, R and Bretschneider 2002&Raghavendra *et al*., 2011&)

Pyrroles:

Chlorfenapyr: It has a broad spectrum of activity against lepidopteran and sucking pests as well as acaricidal activity. Chlorfenapyr is a pro-insecticide and oxidative removal of the N-ethoxymethyl group of chlorfenapyr by mixed function oxidases leads to a toxic form identified as CL 303268 which functions to uncouple oxidative phosphorylation in the mitochondria, resulting in disruption of ATP production and loss of energy leading to cell dysfunction and subsequent death of the organism.This product is derived form on the natural product dioxapyrrolomyc in which has moderate insecticidal activity, led to the interesting group of the insecticidal 2-aryl-pyrroles. It is commercially used as termite control and crop protection against a variety of insect. This molecule has low mammalian toxicity and is classified as slightly hazardous insecticide as per WHO criterion.

Pyridine azomethine (Nauen, R. and Bretschneider, 2002):

A new molecule, **Pymetrozin** was developed and selectively active against aphids, whiteflies and plant hoppers. It is a novel azomethin pyridine insecticide affecting the nerve that controls the salivary pump of some sucking pests, causing irreversible cessation of feeding, followed by starvation and death. The biochemical mode of action is not well known. It acts on nerves related to salivary pumps leads to obstruction of stylet penetration causes an immediate inhibition of feeding leading to death by starvation. It exhibits systemic and translaminar activities and can be used as drench or in foliar application. It is also effective in lessening aphid-transmitted diseases caused by persistent viruses.

Pyridine carboxamide: (Morita *et al* 2000):
Tolfenpyrad has broad insecticidal activity against a variety of pests on egg, larval, nymphal and adult stages and is used on a variety of crops. The pesticidal mode of action is thought to be the inhibition of complex I of the respiratory electron transport chain in the mitochondria. This leads to the cessation of movement and feeding, lack of fecundity and eventually leads to the death of pests. It controls the various pests of orders namely, Hemiptera,Coleoptera,Diptera,Lepidoptera,Thysanoptera,Orthoptera andAcarina. It exhibits ingestion, contact and antifeedant activity against Lepidopteran pests. It also shows sufficient control activity against powdery mildew.

Flonicamid(N-cyanomethyl-4-trifluoromethylnicotinamide) [Morita *et al*., 2011) &www.iskweb.co.jp): It belongs to a new class of systemic aphicides, the trifluoromethylpyridine derivatives and is a novel systemic insecticide with translaminar activity and selective activity against hemipterous pests, such as aphids and whiteflies, and thysanopterous pests. This compound inhibited the feeding behaviour of aphids causes symptoms such as convulsion, and this antifeeding activity was not recoverable until death. The main insecticidal mechanism of flonicamid is starvation based on the inhibition of stylet penetration to plant tissues but the exact mechanism of biochemical mode of action was not known. It is active by foliar as well as by soil application.

Insecticidal anthranilic diamides: potent ryanodine receptor activators(Lahm *et al*.,2005 & 2007 and technical bulletin of Bayer Crop Science and Dupont PVT.)

Calcium channels represent a novel target for insect control. Calcium homeostasis plays a key role in multiple cell functions with particular importance in muscle control. Coordinated muscle contraction involves activation of two distinct classes of calcium channels: voltage-gated channels, which allow external calcium entry and the ryanodine receptor (RyR) is a non-voltage-gated calcium channel located in the sarcoplasmic reticulum of muscle cells and endoplasmic reticulum of non-muscle cells. RyRs regulate the release of intracellular calcium stores critical for muscle contraction. Its name is derived from the natural insecticide ryanodine, a plant metabolite from *Ryania speciosa* that has been found to affect calcium release by locking channels in a partially opened state. Diamide insecticides bind to the ryanodine receptors and cause the calcium channel to remain open, leading to an uncontrolled release of calcium stores. Calcium plays an important role in different cell processes at the organisms and loss will leads to lethargy, feeding cessation and eventually death.

Flubendiamide: The discovery of the anthranilic diamides followed from work related to the emerging class of insecticidal phthalic diamides. Flubendiamide, a new insecticide is active on a broad range of Lepidoptera. The mechanism of action is also that of ryanodine receptor activation. Presence of an orthohalo substituent adjacent to the alkyl amide and the presence of an ortho-methyl substituent on the aniline ring. The alkylsulfonylamide and heptafluoroisopropyl group are also unique features of this molecule.

Rynaxypyr(anthranilic diamides)**:** The first new insecticides from this class, Rynaxypyr (Chloranthraniliprole) and Cyantraniliprole and is characterized by its high levels of insecticidal activity against Lepidopteran insect-pests and low toxicity to mammals attributed to a high selectivity for insect over mammalian ryanodine

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receptors. Rynaxypyr binds to the RyR, causing uncontrolled release and depletion of internal calcium, preventing further muscle contraction. Insects treated with Rynaxypyr exhibit rapid cessation of feeding, lethargy, regurgitation and muscle paralysis, ultimately leading to death. It is highly potent and efficacious against a wide range of economically important Lepidoptera species. In addition, Chlorantraniliprole controls whitefly, leafminer, beetle, and termite species, while cyantraniliprole is effective in controlling a large number of Lepidoptera, Homoptera, Coleoptera, Diptera and Thysanoptera species. In addition to foliar uses, chlorantraniliprole and cyantraniliprole can be delivered to insect pests via plant root-systemic uptake and are thus amenable to use for application directly to the soil. Chloranthraniliprole possesses low acute mammalian toxicity with an acute oral LD50 of >5000 mg/kg in rats.

Cyclic Ketoenols (Tetramic and tetronic acids):(Schobert and Schlenk (2008)&Marčić*et al* 2011**)**

Spirodiclofen: Atetronic acid derivative and the first cyclic ketoenol with a novel biochemical mode of action ie. Inhibition of acetyl-CoA-carboxylase which is involved in lipid biosynthesis with a broad spectrum of acaricidal activity. Highly toxic to eggs and immature stages of mites. It provides excellent control of important mite pests with low use rates, a very long lasting efficacy and good plant compatibility in allrelevant crops. These compounds interfere with lipogenesis in mite development.

Spiromesifen: Another molecule developed from tetronic acid acts as acaricidal as well as selectively having insecticidal activity recommended for control of phytophagous mites and whiteflies. It also shows excellent translaminar along with contact action. As a Lipid Biosynthesis Inhibitor (LBI) it interferes with insect/mite lipogenesis by preventing proper biosynthesis of fatty acids and their subsequent biochemical derivatives. This is moderately active against whitefly adults and has an ovo-larvicidal activity.

Spirotetramat: It is also a tetramic acid derivative and the third member of the ketoenol group. This molecule is primarily an insecticide effective against a wide spectrum of homopteran insect pests, such as aphids, whiteflies, psyllids, soft scales, armoured scales and mealybugs.

Table 3. List of newer molecules and theirs mode of action

S.No.	Group	Mode of action	Active ingredient
1	Phenylpyrazole	GABA-gated chloride channel antagonists	Fipronil
2	Oxadiazine	Voltage-dependent sodium channel blockers	Indoxacarb
3	Spinosyns	Nicotinic Acetylcholine receptor agonists	Macrocyclic lactones (Spinosad)
4	Neonicotinoids	Nicotinic Acetylcholinereceptor agonists /antagonists	Imidacloprid Thiomethoxam Acetamiprid Thiocloprid
5	Anthranilic diamides	Ryanodine receptor Modulators	Chloranthraniliprole

6	pthalic acid di-amides		Flubendiamide
7	Avermectins	Chloride channel activators	Ememectin benzoate
8	Chlorfenapyr	Uncouplers of oxidativephosphorylation viadisruption of proton gradient	Chlorfenapyr
9	Tetronic acid derivatives	Inhibitors of lipid synthesis	Spirodiclofen, Spiromesifen

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Effective Use of Solar Energy for Irrigation Purposes on Indian Farms

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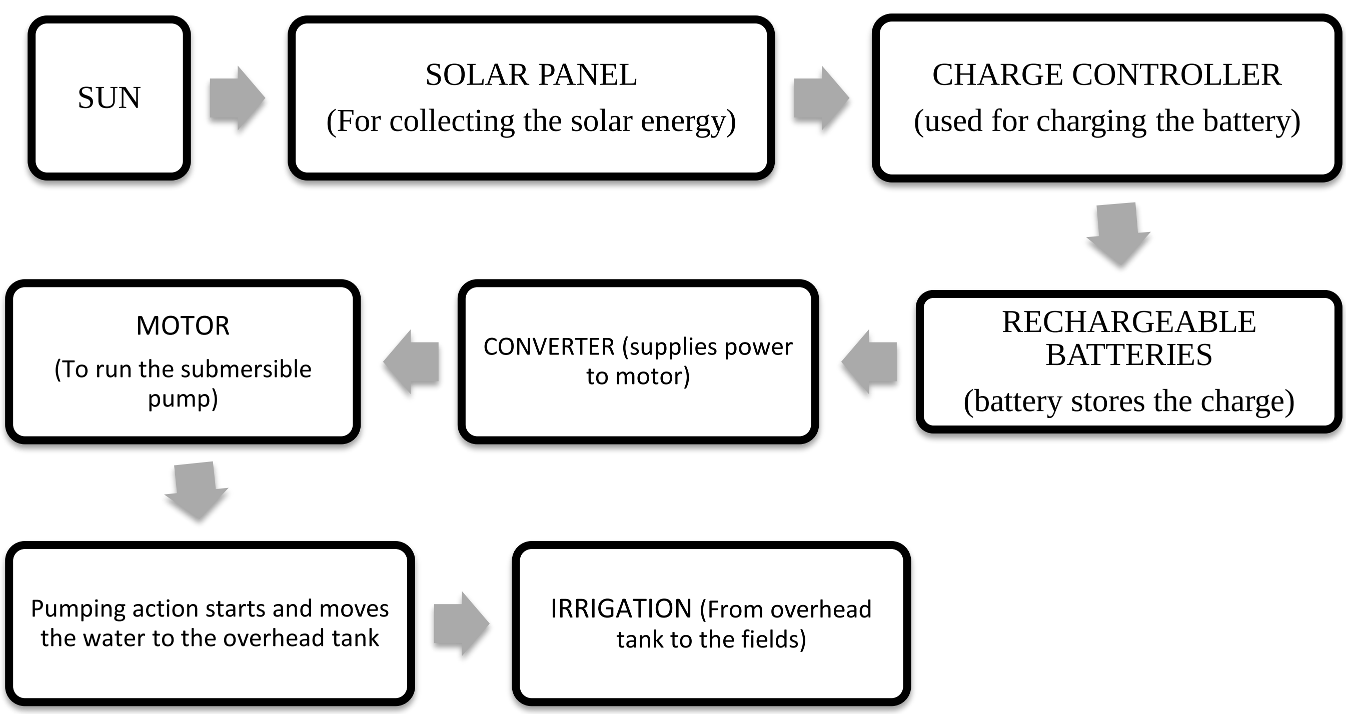
The supply of electricity may not be reachable for every corner of village and at the same time, the unit cost of electricity will become high when it reaches to every corner of village. Indian farms require energy for irrigation purposes at free cost, as well as, the energy should be abundant in nature so that it can be reachable to every corner. Hence the solution is usage of solar energy. Irrigation system using solar energy is the best available alternative for Indian farms. After some initial investment is made on automatic solar irrigation system, the solar energy, thus available can be utilized at free of cost. This solar irrigation system requires a solar panel, moisture sensor and a controller. The energy that is collected by the solar panel can be used effectively for pumping water from bore wells to tank and to the field. Besides, using solar energy for pumping of water along with optimization of usage of water.

INTRODUCTION

The energy which is available abundant in nature is solar energy. Solar energy is a non-conventional renewable source of energy. Irrigation system using solar energy is a cost-effective system which is necessary for present agriculture. This system not only conserves the electricity by reducing the grid power but also conserves water by reducing the water losses.

Working of Solar based irrigation system



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Solar panel is used for collecting the solar energy. It is then connected to charge controller unit, which is used for charging the battery by using energy from the solar panel received from the sun. Rechargeable batteries connected to the controller unit stores the energy. The converter unit supplies power to motor to run the submersible pump. Before releasing the water into the field, the water collected by the submersible pump is stored in a tank temporarily. The level of moisture present in the soil is sensed by the moisture sensor, which consists of level detection module in which a reference value is set based on the type of crop and moisture required by the particular crop. Moisture sensor gives signal to a controller which excites the motor. So then immediately, the pump starts working and moves the required amount of water to the field until it reaches the reference water level. The motor is then stopped and power to driver circuit is stopped and controller is kept automatically into sleep mode for lower power consumption. When the moisture in soil is dried and reaches a level less than the reference water level, then the controller comes out of sleeping mode and flow of water is regulated till it reaches the reference water level. The process repeats and keeps the soil moisture level as per the crop requirement.

Some of the advantages of solar energy irrigation system

1. It helps in efficient use of solar energy.
2. It uses available free sun light.
3. There is no fuel cost.
4. There is no requirement of electricity.
5. It can be operated for a very life time.
6. It can work everywhere. Hence it reaches to every corner of the village freely
7. It can be useful not only for irrigation purposes but also for clean, drinking water sanitation
8. It increases returns for farmers by increasing no of crops.
9. Marginal and small farmers also can be utilized effectively.

Some of the disadvantages of solar energy irrigation system

1. High initial investment cost.
2. Works only when sun is available
3. Large number of solar panels are required for the large power production. Hence effective for small power production.
4. Efficiency of solar power is less when compared to other sources of energy
5. It occupies more space.
6. There are chances to theft solar power panels.

CONCLUSION

Solar energy is easily available in every corner of the village at free cost. Hence adopting solar based systems can not only increases the returns to the farmer but also helps in effective use of energy by minimizing the losses. It increases the yield of the crop. It is a non-conventional renewable form of energy which can be a competitor for available conventional sources of energy. Taking the right step at a right time changes the fate of the Indian farmers.

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E-Choupal an ITC initiative-Transforming Rural India

Article id:
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e-Choupal is an India-based business initiative by ITC Limited that provides Internet access to rural farmers, started in the year 2000 in MP with soybean farmers. E-Choupal is a Hindi word which means a village meeting place, and "E" here stands for electronic so it is a village meeting place on an electronic platform. E-Choupal It is a virtual market place where farmers can transact directly with a processor and can realize better price for their products. E-Choupal is an initiative of ITC (Indian tobacco company) Limited a conglomerate in India, to link directly with rural farmers via the Internet for procurement of agricultural and aquaculture products like soybeans, wheat, coffee, and prawns. e-Choupal tackles the challenges posed by Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of intermediaries. The program installs computers with Internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information.

Why e-Choupal?

the e-Choupal model has been specifically designed to tackle the challenges posed by the unique features of Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of numerous intermediaries. Traditionally farmers sell their produce to traders operating in mandis, and farmers rarely have any information on market conditions prior to the sale. The traders, on the other hand, are well informed about crop prices prevailing in different markets and the prices offered by processing companies. Clearly, this is the single biggest reason why middlemen traders are able to exploit the farmers.
-

Advantages:

1. disruption of the trader-mandi-farmer dynamic.
2. Internet is used as a low-cost medium of communication providing the latest information.
3. Intermediaries are still used, but only for physical delivery of produce maintaining low cost.

Project Goals

1. Helps to enhance farm productivity by

Disseminating latest information on the district level Weather forecasts for short and medium terms Best practices in farming Supply of quality inputs (seed, herbicide, fertilizer, pesticides, etc) in the village itself.

2. Helps improve price realization for farm produce by

1. Making available live data on markets - Location / Buyer wise prices offered.
2. International market prices of relevant agri-commodities.
3. Up-to-date information on supply & demand.
4. Expert opinion on expected future price movements.

3. Helps minimize transaction costs in marketing farm produce by

1. Buying output at the farmers doorstep
2. Through transparent pricing and weight management practices.

E-Choupal Infrastructure

- **ITC Kiosk with Internet Access**

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In the house of a one trained farmer, *Sanchalak* Within walking distance of target farmers.

- **Warehousing Hub**

  Managed by the middleman, Within tractor able distance of target farmers.

Key Intermediaries:

a. Sanchalak (1 per cluster of 5-6 villages).
b. Sanyojak (1 per group of 30-40 choupals).
c. in all other cases where the sanchalak enables transactions, he gets paid a commission ranging from 0.25% (fertilizers) to 15% (insurance policies).
d. Medium-sized farmer with good communication skills having studied up to the 10th or 12th grade**.** while an upa-sanchalak (deputy manager) operates at the village level and shares the commission with the sanchalak for transactions enabled by him.

How Farmers Use e-Choupal

Every evening, ITC updates the mandi prices of soya bean (and other relevant crops) in the markets where they have an e-Choupal presence.If the price is suitable, the farmer comes by the next morning to collect tokens from the sanchalak - a prerequisite to completing the sale at the nearest hub. Depending on the state, different local language options are available for the sanchalak.

CONCLUSION

The e-choupal system is acting as a catalyst in rural transformation by providing access to the latest information of the agro sector, developing local leadership and creating a profitable distribution.It helps in alleviating rural isolation, improves productivity and income, creates transparency for farmers which improves the economic condition of rural areas.But there are some challenges to tackle out Illiteracy about computers in rural areas as well as rural population has low trust in the electronic system. Selection of an educated, intelligent, reliable and matured person as a sanchalak. The vicious circle of intermediaries. The improper and complex user interface on e-choupal.Lack of rules and regulations related to electronic choupal.

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Role of new generation plant growth hormones in fruit crops

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INTRODUCTION

Plant growth regulators or phytohormones are organic substances either natural or synthetic, controlling or modify the growth and influence physiological functions at a site remote from its place of production and active in a low concentration. The term hormone was first used by Starling in 1906s. Plant hormones are common in production and postharvest management of fruits and many other horticultural produces. Generally plant growth regulators are five major types they are Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid these are well known in fruit crop production and postharvest, apart from these other new growth substances include Brassinosteroids (Brassins), Salicylic Acid, Jasmonic Acid and polyamines these novel hormones significant role and mechanism is still less known. Recently, effects of exogenous brassinosteroids (BRs) application in fruit production and postharvest have been investigated by several researchers. (Nirmal *et. al.,* 2019).

Plant hormones regulate plant growth and development by affecting an array of cellular, physiological, and developmental processes including cell division and elongation, stomatal regulation, photosynthesis, transpiration, ion uptake and transport, initiation of leaf, flower and fruit development, and senescence. Among the newly emerged plant growth hormones both BRs and SA are ubiquitous in the plant kingdom, affecting plant growth and development in many different ways, and are known to improve plant stress tolerance. In this review discussed current knowledge about the practical application and role of different novel growth hormones to improve the production and post-harvest quality and also overcome abiotic stress (soil salinity) in fruit crops.

Essentiality of new generation plant growth hormones and their significant role in fruit crops

1. Brassinosteroids

Brassinosteroids are a new group of phytohormones with significant growth promoting properties (Bishop and Yokota, 2001). Brassinosteroids are a range of over 60 steroidal compounds, typified by the compound brassinolide that was first isolated from Brassica pollen. Significant use of brassinosteriods and its analogous could alter the ripening process, quality, chilling tolerance and postharvest diseases in various fruits. Brassinosteroids have been reported to counteract both abiotic and biotic stress in plants. They produce effects on growth and development at very low concentrations and play a role in the endogenous regulation of these processes.

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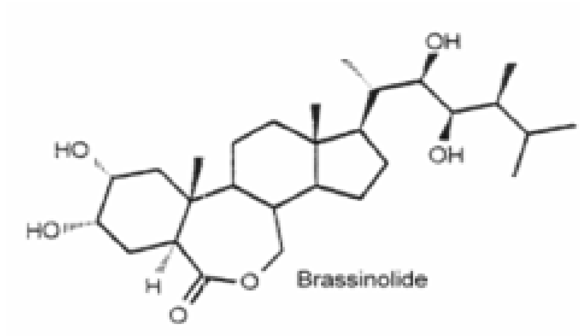

Structure of Brassinosteroids

Brassinolide is synthesized from precursor, campesterol involving number of pathways. Novel techniques have been developed in many laboratories to detect the additional components in BRs signaling pathway. Among those, proteomics (Tang *et. al*., 2008) and mass spectrometry (Hink *et. al*., 2008), bioinformatics and screening tools (Nam and Li, 2004), have been used to provide essential data in identifying new components like: BRI1 interacting proteins: BRI1associated receptor kinase 1 (BAK1), BRI1 kinase inhibitor 1 (BKI1), transthyretin-like (TTL), and BR signaling kinases (BSKs) (Yang, 2011). It leads to further separation of negative regulator like, BKI 1from plasma membrane.

Physiological role in plants

- ✓ Cell division, stem elongation and cell elongation
- ✓ Differentiation of xylem tissues and inhibit leaf abscission.
- ✓ some protection to plants during chilling and drought stress
- ✓ Promotion of ethylene biosynthesis and epinasty
- ✓ Inhibition of root growth and development

Reports have documented that BRs can regulate abiotic stress by influencing various types of osmo protectants **(**Kohli *et. al.,* 2018; Kaur *et. al.,* 2071). The fruits of *Prunus persica* that were kept in cold storage were shown to be protected from chilling injury through changes in proline metabolism when treated with 24-epibrassinolide. Effects of BRs on polyamines in relation to abiotic stress tolerance have come to light, which indicates some crosstalk between the two that leads to stress tolerance.

Harindra Champa, (2013) reported that grape vines were treated twice with different concentrations of BRs (0.0, 0.1, 0.5 and 1.0 mg L-1) at pea stage and at veraison among these, treatment of 1.0 mg L^{-1} BRs improved initial grape quality, while, BRs at the dose of 0.5 mg L-1 proved effective in maintaining postharvest quality.

BRs also regulate the activity of defense related enzymes which could develop strong defence mechanism against different microorganisms. It was reported found that altering the level of endogenous BRs, promotes fruit quality (Li *et. al*., 2010; Lieselotte *et. al*., 2014).

Luan *et al*. (2013) showed that brassinosteroids at the concentration of 0.4 mg/l enhanced total anthocyanin content in grapes over control grapes.

In grape BRs and Brassinazole promoted ripening in berry whereas brassinazole the delayed ripening and senescence (Symons *et al*., 2006)

Some of the research findings reported that exogenous application of BRs enhance ripening in grape (Symons *et. al.,* 2006), mango (Zaharah and Singh, 2012) and in delaying senescence in Jujube (Zhu *et. al*., 2010).

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EBR (24epibrassinolide) treatments was observed to augment osmo-regulation of material and amount of antioxidant enzymes viz, superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and ascorbate peroxidase in juvenile grapevines, whereas decreased the damage caused by reactive oxygen species (ROS) and lipid peroxidation (Xia *et al.*, 2009a).

Roghabadiand Pakkish (2014) reported that pre-harvest application of BR 0.75 mgl-1 + post-harvest application of BR 0.2 mgl1 strongly affected shelf life and had better shelf life of 'TakDanehe Mashhad' sweet cherry.

2. Jasmonic acid

Among different phytohormones, jasmonates (JAs) are considered as one of the important phytohormones that have a significant role in abiotic stress tolerance. Jasmonic acid (JA) regulates different plant responses including generegulation, biosynthesis of special proteins, as well as secondary metabolism under a broad spectrum of stressful conditions. There is also a related hydroxylated compound that has been named tuberonic acid which, with its methyl ester and glycosides, induces potato tuberization. Jasmonic acid is synthesized from linolenic acid, while jasmonic acid is most likely the precursor of tuberonic acid.

Physiological role in plants

- ✓ Jamonates inhibit many plant processes such as growth and seed germination.
- ✓ They promote senescence, abscission, tuber formation, fruit ripening, pigment formation and tendril coiling.
- ✓ JA is essential for male reproductive development
- ✓ JA has been shown to inhibit growth of certain plant parts and to strongly promote leaf senescence (Salisbury and Ross, 1992).
- ✓ The major function of JA and its various metabolites is regulating plant responses to abiotic and biotic stresses as well as plant growth and development (Delker *et. al.*, 2006).
- ✓ Jas-induced abiotic stress tolerance has been considered as a promising approach carried out under numerous stresses such as salt, drought, heavy metals, pesticides, as well as light and temperature stress (Sharma *et. al.*, 2018).
- ✓ JAs signaling has a synergistic effect on PAs biosynthesis under stressed conditions.

3. Salicylic acid

Salicylic acid is biosynthesized from the amino acid phenylalanine.SA is one of numerous phenolic compounds, containing an aromatic ring with a hydroxyl group or its derivatives, found in plants.Exogenously supplied SA was shown to affect a large variety of processes in plants, including stomatal closure, seed germination, fruit yield and glycolysis (Cutt *et. al.*, 1992). Only recently has there been evidence that SA has unique and specific regulatory roles. Salicylic acid is water soluble antioxidant compound which can also regulate plant growth. Salicylic acid negatively regulates the jasmonate dependent pathway in many plants was shown including *Arabidopsis.*

Salicylic acid treatment enhanced total free aminoacids, prolines, spermidine as well as total polyamines (Fatma Abd E1-Lateef Gharib, 2006).

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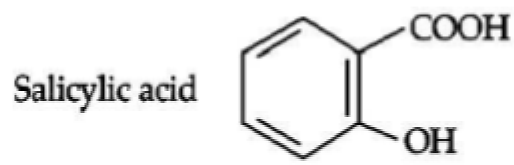

Structure of Salicylic acid

Physiological role

- ✓ SA is the calorigenic substance that causes thermogenesis in Arum flowers.
- ✓ It has also been reported to enhance flower longevity, inhibit ethylene biosynthesis and seed germination, block the wound response, and reverse the effects of ABA.
- ✓ Salicylic acid plays a main role in the resistance to pathogens by inducing the production of 'pathogenesis related proteins'. It is involved in the systemic acquired resistance response (SAR) in which a pathogenic attack on older leaves causes the development of resistance in younger leaves, though whether SA is the transmitted signal is debatable.
- ✓ Exogenous application of SA induced salt tolerance and water stress tolerance in wheat.
- ✓ The role of SA as an endogenous signaling molecule in flowering

4. Polyamines

Polyamines are a group of aliphatic amines. The main compounds are putrescine, spermidine and spermine. They are derived from the decarboxylation of the amino acids arginine or ornithine. The conversion of the diamine putrescine to the triamine spermidine and the quaternary amine spermine involves the decarboxylation of S-adenosylmethionine, which also is on the pathway for the biosynthesis of ethylene. As a result there are some complex interactions between the levels and effects of ethylene and the polyamines.

Physiological role

- ✓ They are widespread in all cells and can exert regulatory control over growth and development at micromolar concentrations.
- ✓ In plants where the content of polyamines is genetically altered, development is affected.
- ✓ Polyamines have a wide range of effects on plants and appear to be essential for plant growth, particularly cell division and normal morphologies.
- ✓ At present it is not possible to make an easy, distinct list of their effects as for the other hormone.
- ✓ It appears that polyamines are present in all cells rather than having a specific site of synthesis.

In grape (*Vitis vinifera*) under drought conditions increase in the contents of Putracine, Spermidine and Spermine (Toumi *et. al.,* 2010). Under cold observed that increased in the contents of proline and soluble carbohydrates (Karimi and Ershadi, 2015).

Other novel growth hormones are strigolactones were originally identified as compounds that stimulated the germination of parasitic plant seeds, and were also demonstrated to induce hyphal branching in arbuscular mycorrhizal (AM) fungi. The biosynthesis of this class of compounds is regulated by soil nutrient availability, i.e. the plant will increase its production of strigolactones when the soil phosphate concentration is limited, and decrease production when phosphates are in ample supply.

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Karrikins are a chemically defined family of plant growth regulators discovered in smoke from burning plant material. Karrikins are potent in breaking dormancy of seeds of many species adapted to environments that regularly experience fire and smoke. The recent discovery that karrikins trigger seed germination and control seedling growth in taxa that would rarely experience fire indicates that their significance could extend far beyond fire ecology.

CONCLUSION

Plant growth regulators and retardants play vital roles in a plant's life from dormancy to senescence, therefore these substances are very important in horticultural industry. Now a days newly emerged plant growth regulators or retardants are in trend similar to that of general growth regulators. Some of the advantages by using new growth hormones synthesized naturally in plants. These novel growth hormones play a major role in defense mechanism, stress resistance, increase the nutritional qualities, shelf life of fruits and also triggers the stress induced proteins in plants. Research is still going on different crops for their effective use.

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Pests of Solanaceous crops

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INTRODUCTION:

The Solanaceae (nightshades) family that developed first during the Mesozoic era belongs to the order Solanales and class Magnoliopsida (dicotyledons) (Olmstead *et al*., 1999). It includes a number of economically important agricultural crops. This family consists of 90 genera and 3000-4000 species (Gebhardt, 2016) which are diverse in habitat, ecology and morphology. Some of cash crops belonging to this family are potato, tomato, tobacco, chilli, brinjal or eggplant. The most important genus of this family is *Solanum* (consisting of almost half of all the species) which involves potato *(Solanum tuberosum),* aubergine or egg plant *(S. melongena),* tomato *(S. lycopersicum)* while *Capsium* genus which includes both chilli and bell peppers also fall under this category. Besides, some ornamental plants such as *Petunia*, *Lycianthes,Browalia* and the plants which are the sources of psychoactive alkaloids such as *Datura* and *Atropa belladonna* are also included in this family.

Lesser known members of this family are tomatillo *(Physalis ixocarpa)* and tree tomato or tamarillo *(Solanum betaceum)* which is widely used in Central America, Andes and Mexico. Crops such as *Petunia* and tobacco are used as model organism to conduct cellular, molecular and genetic level studies. Members of this family are found throughout the world, while the greatest diversity in the family is present in Central America and South America.

Importance of Solanaceous crops:

The members of solanaceae family are the source of food, medicines and spice for people throughout the World.These are the indispensable component of human diet since they are rich in Vitamin A, B, C, E, minerals and dietary fibres which play a prominent role in human nutrition and help to cope with malnutrition. Tomato is the 2nd most highly produced and consumed vegetable in the world. It is the highest source of lycopene (71.6%), second highest source of Vit. C (12%), flavanoids (22.2mg/kg) and third as a source of vitamin E (6%). Potassium, foliate, pectin, cellulose and hemicellulose are also present in considerable amount in tomato.

Brinjal contains 70% nasunin (flavanoids) and high amount of chlorogenic acid (predominant phenolic compound which is one of the most potent free radical scavengers found in tissues). It also serves as an excellent source of Mn (bone building), Mo, K , Vit. B (63.5%) and dietary fibres. It has high water content and the amount of calories is very low in it. *Capsicum* genus is rich in Vit. C, K, P, Fe, Mn, Mg, carotenoids and flavonoids. More than 20 capsaicinoids have been identified in this genus that belong to two groups, capsaicin and dihydrocapsaicin which are responsible for about 70% and 30% pungency in chilli respectively. Potato after wheat and rice ranks as the third most important food crops. It has high amount of starch, tuber storage protein (patatin) and compound such as kukoamines (lowers Blood pressure), Vit C (10 to 104 mg/Kg),Vit. B6, K, antioxidants.

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Pests of Solanaceous Crops:

In addition to being nutritionally and medicinally important these crops are under frequent attack by plethora of insect pests from diverse orders. Aphids, whitefly, leafhopper, mealy bug, brinjal lacewing (hemiptera), thrips (thysanoptera), mites (acarina), *Spodoptera litura, Helicoverpa armigera, Tuta absoluta*, Potato tuber moth, brinjal shoot and fruit borer, brinjal stem borer, cutworms (Lepidoptera), hadda beetle, ash weevil, white grub (coleoptera), serpentine leaf miner and gall midge (diptera) are the major pests attacking these economically, important crops.

Nature of damage and symptoms:

Hemipterans: the pests belonging to this order are polyphagous sucking pests. Both nymphs and adults of these pests cause direct damage to the crop by sucking cell sap from ventral surface of leaves. Yellow discolouration appears, leaves get curled, photosynthetic rate is reduced and fruit setting is affected thereby crop yield is declined. They also produce honeydew which acts as a sugary substance serving as an attractant for the ants resulting in the mutualistic association between hemipterans and ants. Some of these pests such as brown leaf hopper in brinjal (*Cestius phycitis*) is responsible for transmitting little leaf of brinjal disease and whitefly (*Bemisia tabaci*) in tomato transmits tomato leaf curl virus (begomo virus). Potato aphid (*Myzus persicae*) acts a vector of Potato leaf roll virus, Potato virus A, Y and Potato virus M.

Lepidopterans: tobacco caterpillar (*Spodoptera litura*) lays egg in masses covered with brown hairs mostly under the surface of leaves while fruit borer (*Helicoverpa armigera)* lays eggs singly either on leaves, buds or stem. Initial early instar caterpillar feed on leaves by scrapping the chlorophyll content leading to skeletonization of leaves and once the larval instars grow in size they defoliate the leaves. After fruit formation they damage the fruits by boring and feeding on its inner contents.Cutworm (*Agrotis segetum and A. ipsilon*) caterpillar cut the seedlings at ground level especially at tender stem point and feed on young leaves. Potato tuber moth (*Pthorimaea operculella*) form mines on leaves and bore holes on tender shoot and tubers in potato. Brinjal stem borer (*Euzophera perticella*), shoot & fruit borer (*Leucinodes orbonalis*) larva bores into tender shoots resulting in drooping/drying of tips which latter bores into fruit and plug the bore hole with excreta rendering the fruits unfit for marketing and consumption purpose. Tomato pin worm or tomato leaf miner (*Tuta absoluta*) is one of the most destructive invasive pests observed for the first time in Pune (Maharastra) during October, 2014. The plants are damaged by direct feeding on leaves, buds, stem, fruits and also by the invasion of secondary pathogens which enter through wounds made by this pest. This pest may cause 90% yield loss under field or greenhouse condition. At Pantnagar this pest was reported in the year 2017 with 24.70 larva/plant under polyhouse condition while 0-10 percent infestation with 4.22 larva/pant was observed under field condition.

Coleopterans: The grubs and adults of brinjal ash weevil (*Myllocerus subfasciatus*) damage the plant. The grubs feed on roots whereas adults damage by notching the leaves. Spotted/hadda beetle (*Henosepilachna vigintioctopunctata*) skeletonize the leaves. The grub of whitegrub (*Holotricha lonipennis, Melolontha spp., Brahmina coriacea*) feed on roots and tubers causing huge loss in quality and quantity of produce.

Dipterans: maggots ofserpentine leaf miner(*Liriomyza trifolii*) mines into the leaf between the upper and lower surfaces and feed on the mesophyll tissues. Young leaves have small and thin mine, in older leaves mines are long and circular. Similarly, maggots of gall midge *(Asphondylla capsici)* in chilli feed on ovary of

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flower bud, flower and tender fruits. The affected bud remains unopened, while the affected flower dries and drops.

Thysanopterans: thrips *(Scirtothrips dorsalis)* are the major pest of chilli. The nymphs and adults lacerate the leaf tissue and suck sap causing upward curling of leaves, reduction in the leaf size, leaf becomes bronze in colour, plant growth is stunted and dropping of flower buds and fruits. They cause 30-50 percent yield loss.

Acarina: nymphs and adults of red spider mites (*Polyphagotarsonemus latus)* suck cell sap from lower surface of leaves that result in white patches. The affected leaves become mottled, turn brown and fall. In severe infestation mites form silken webs mainly on lower surface of leaves, photosynthetic rate and crop yield is adversely affected.

The insect pest infestation result in huge economic loss for example, in chilli the insect pest and mites together cause upto 50-85% economic loss while in potato, tuber moth alone can cause upto 60% economic loss. Similarly, in brinjal sucking pests and borers can lead to 70-92% loss in crop yield (Chakraborti and Sarkar, 2011). Thrips and mite are responsible for transmitting viral diseases such as potyviruses which cause the damage ranging from 10.2% to 57.2% (Ansari, 1998). Chilli also suffers from a malady known as “murda” disease with characteristic leaf curl symptoms accompanied by pluckering and swelling of veins caused by the attack of thrips and tarsonemid mites.

Owing to the high economic importance of all these crops and to prevent the yield loss farmers mostly resort to insecticidal application for lowering the pest population below Economic threshold level. However, excessive reliance and indiscriminate use of agrochemicals to manage these pests has resulted in disturbances to the environment, pest resurgence, secondary pest outbreak, pest resistance to pesticides, lethal and sub-lethal effects on non-target organisms, including humansand all this has brought about a phenomenal change in crop pest scenario. The practice of using agrochemicals as a first solution has drifted the pest management strategies from its ecological roots. Therefore, an alternative to this problem was the development of an Ecofriendly Pest Management approach to prevent the intensification of existing pest and prevent the emergence of new insect pest.

Ecofriendly Pest Management is based on an understanding of pest ecology and relies on a range of preventive tactics and biological control to keep pest populations within acceptable limits. Reduced-risk pesticides are used if other tactics have not been adequately effective, as a last resort, and with care to minimize risks (Reddy, 2012). There are two components of ecofriendly pest management:

1. Proactive components: involves redesigning the agroecosystem to the disadvantage of the insect pest population and to the advantage of its predator and parasite. It includes practices such as cultural control, host plant resistance and transgenic crops.

2. Reactive components:involve all the measures that are taken after the emergence of the pests in the field. This option involves mechanical and physical control, biological control and use of reduced risk pesticides.

This pest management strategy mainly focusses on the use of locally available resources that are cost effective and easily acceptable.

CONCLUSION

Owing to the economic importance of solanaceous crops, the severity of damage and extent of loss in these crops resulting from the pest attack focused the need to manage the pest population. While the intensive use of agrochemicals resulted in several detrimental effects to the environment and non-target organisms the need is manage the pest population by integrating the traditional knowledge with the modern agriculture which keeps the insect pest population below the economic threshold level and also manages the pest population in as ecofriendly and sustainable manner.

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Trolley Mounted Solar Operated Low Volume Boom sprayer

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Solar energy is the amount of energy received by the earth from the sun. It is a renewable form of energy. The total amount of solar energy recieved from the sun by the earth is vastly in excess of the world's current and anticipated energy requirements. The trolley mounted low volume spinning disc sprayer was developed and evaluated in college of agricultural engineering, Bapatla. The sprayer works on low-volume spraying technique and can almost be used for all the vegetable crops, pulses etc. the sprayer is very suitable for spraying of insecticide, fungicide and herbicide soluble in water because there are no agitation facilities. The sprayer can also be used for spraying water based nutrient formulations. The machine is proper balanced and can be very easily operated by a single man. There are both facilities for operating the sprayer, but, pulling the sprayer by the operator is found to be the most convenient by assuring the safety of the operator.

INTRODUCTION

From time immemorial, the sun has been the primary source of energy for life on earth. The solar energy was being used directly for purposes like drying clothes, curing agricultural produce, preserving food materials etc. Even today, the energy we derive from fuel-wood, petroleum, paraffin, hydroelectricity and even our food originates indirectly from sun. Solar energy is virtually inexhaustible. With dwindling supplies of petroleum gas and cool, tapping solar energy is a logical and necessary course of action. Application of non-conventional sources of energy is the only alternative solution for conventional energy demand. One of the major areas which finds large number of applications of renewable energy are in agricultural sector. This technology can be applied for spraying purposes on the plants by using newly developed trolley mounted low volume boom type sprayer.

Working procedure of trolley mounted lowvolume boom sprayer

The trolley mounted low volume boom type sprayer consists of wheels, Chassis, spray boom, disc heads, chemical container, handles, water pump, battery, control panel, solar panel, way channel, on-off valve and sprayer stand.

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Fig 1. Trolley mounted solar operated low volume boom sprayer

Chassis is a rectangular structure made up of M.S. angle 19mm fitted at a height of 480mm from the ground level with tank and battery fitted on the chassis. The front end is connected to the handles and a spray boom is hinged at the lower side middle of the chassis. The spinning disc head is fitted on the boom. The spinning disc diameter is fitted on an electric motor powered with 12V D.C. This body is supported at the center with a two pneumatic wheels and axles. The chassis carries a chemical tank of 20 litres sitting on the axle fastened with the rectangular box made of cast iron attached with an iron sheet for providing strength to bear load. Tank is lighter in weight and provided with lid and strainer. The chemical tank has a circular support to bear vibration during operation. The cylindrical shape of the tank helps in easy movement of spray solution to the disc with the help of water pump installed front and lower side of the tank as well as chassis. The solar panel is installed at the top of the frame connecting the chassis. It produces 20W having 72 cells. It receives solar energy from the sun and convert them into electric energy in order to charge the battery attached to it. Solar panel is clamped and fastened with a ball bearing arrangement to rotate it in the direction where the sun rays falls. Control panel is equipped with the charging kit which serves as a media for charging the battery with solar panel installed. Charging input from solar panel at same junction power output slots for water pump and nozzle. It also contains the switches associated for functioning on-off of the sprayer. It is kept beside the battery on the same rectangular box where battery lies.

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Fig 2. Calibration of solar sprayer in laboratory

The field calibration was carried out with the known area and the spray tank was filled with known quantity of water. The marked area was sprayed carefully maintaining the swath width along with the time required to cover the known area. The conclusions regarding the trolley mounted solar operated low volume boom sprayer are as follows.

1. The sprayer works on low volume spraying technique with 117.5 l/ha application rate.
2. It requires a short time period per unit area spraying, the field capacity of the sprayer was 0.324 ha/h which is the most prerequisite of a low volume spraying technique.
3. It can be easily operated in filed, both at load and no-load conditions because of proper balancing and use of bicycle wheels with tire, tubes and bearing.
4. This sprayer is useful for treating the different crop heights by the adjustment of boom height.
5. It is useful in early crop growth stage in cotton, castor, but always useful in low height crops like vegetables, groundnut, soybean and oilseed crops.
6. It can be successively used for spraying insecticide, fungicide and also herbicide of water-soluble formulations, because of no agitation.
7. The contamination of the operator by the pesticide is very less as the operator is always kept at a distance of 1500cm from the spray heads with the help of crossbar given in the handles.

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Roof gardening – beneficial purpose through ornamental plants

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INTRODUCTION

A roof garden is a garden on the roof of a building. Besides the decorative benefit, roof plantings may provide food, temperature control, hydrological benefits, architectural enhancement, habitats or corridors for wildlife, recreational opportunities, and in large scale it may even have ecological benefits.

The practice of cultivating food on the roof of buildings is sometimes referred to as rooftop farming. Rooftop farming is usually done using green roof, hydroponics, aeroponics or air-dynaponics systems or container gardens.

Concepts

Upper Typar® layer prevents downwash of humus into the drainage layer. Bottom Typar® SF layer protects the waterproof membrane from puncturing and acts as a roof barrier.

Definition

A roof garden is like a normal garden but the plants grow in the roof it is amazing. But the plants not only can grow on roofs.

Fig: 1. Roof gardening

Beneficial purpose

- ✓ Improve aesthetics
- ✓ Provide green space
- ✓ Improve public relation.
- ✓ Increase property value
- ✓ Government and municipality incentives.
- ✓ Acts as natural insulation for hot and cold air and a save energy for your building
- ✓ Reduces CO_2 levels and increase oxygen and improvement air quality
- ✓ Improvements thermal insulation and energy efficiency.

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- ✓ Provides protection to buildings from adverse temperature and hence improves the life expectancy of the buildings.
- ✓ Mitigate urban island heat effect.
- ✓ It holes rain water, proving food and shelter for wildlife.
- ✓ Means a saving of 25% on air conditioning systems.
- ✓ More silence. The roof garden is an enviable urban noise barrier.
- ✓ Less drain. The roof virtually eliminates the need for gutters and other drainage systems for rainy season.

Planning and its purpose

Before planning a roof garden certain points are to be checked:

Flower beds can be made directly on the roof. This can be achieved by placing the soil between the outer wall or the parapet and a wall built on the inner side with the help of moisture-proof wood shuttering stones, or bricks. The width of such boxes will vary according to the available space, the nature of the plants to be grown, and other factors. Such beds directly constructed on the roof surface are not preferred always, as they are of permanent nature and may also damage the roof. Alternatively, the best method will be to arrange a series of containers holding soil, such as boxes, pots troughs, tubs, etc., These are placed over wedges or bricks to leave a clear gap between them and the roof for proper drainage and passage of air.

The first thing to check before starting a roof garden is whether the roof surface can bear the weight of the soil. Soil, especially wet soil, is much heavier than one can usually conceive. Secondly, the roof should be made water-proof to prevent seepage of water into the room below and finally, it should have adequate drainage so that rain and irrigation water drains off quickly.

The concept of roof gardening itself is artificial; therefore, while planning and designing this point should be kept in mind. As for example, it is not possible to create natural scenery with hills and valleys or natural forest scenery. As for any other gardening a roof garden should also have a dominant focal point, like lawn or water garden or rock garden or a prominent climber (e.g., *Bougainvillea, Clerodendron splendens*, *Bignonia venusta*, climbing rose).

On a roof the space available for gardening is limited; therefore, it will be a good idea to encourage vertical growth. This is the reason why a roof garden lover should use more climbers and trailers in his garden, some of which can climb over a supporting pillar while others can grow rampantly over the boundary wall and spill over the top and hang down the side of the building. *Ficus repens* is a good root climber which can cover a wall. Other attractive creepers include *Cobaea scandens* (annual), railway creeper, *Vernonia elaegnifolia (*Curtain creeper*)*, passion flower, *Thunbergia alata* (annual), etc.

Hanging baskets should play a major role in a roof garden. Various types of basket either containing flowering or foliage plants can be displayed with great advantage at suitable places. One can also display with advantage the collection of bonsai and few alpine plants. One or a few vertical gardens can also be displayed in a planned manner in the roof garden. It is possible to grow a wide range of plant materials in a roof garden excluding, of course, the large shrubs and big trees.

Steps of gardening

- ✓ **Preparation** – Survey, measuring available space etc.
- ✓ **Design** – Virtual design, selecting materials 7 plants etc.
- ✓ **Making** – Structural making and plantation

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- ✓ **Maintenance** – Post production service in short/long term.

Growing medium

Growing mineral selection is critical to the long and short term success of a green roof. The following factors should be considered for selecting growing medium –

- ✓ Load bearing capacity
- ✓ Slope
- ✓ Climate
- ✓ Drainage
- ✓ Plant species

Natural mineral components of roof garden substrate include sand, clay, lava, pumice, gravel, etc.artificial or modified mineral components such as perlite, vermiculite, etc. are used in roof garden. Organic materials such as peat, composts are also added to the substrate formulation. The light weight soil amendments reduce substrate weight and support plants growth. The pH should be 5.5 to 8.0 the air content and water storage capacity should be more than 20% and 45% by volume.

Plant species selection

Plant species selection is dependent on a number of factors -

- ✓ Maintenance investment and resources
- ✓ Aesthetics
- ✓ Function and weather
- ✓ Structural load bearing
- ✓ Roof gardening
- ✓ Plant growth rate and nutrient demand
- ✓ Supply and availability.

Ornamental plants Suited for roof gardening

Table 1.0 Ornamental plants Suited for roof gardening

Sn.	Group of ornamental plants	
1.	Low growing succulents	Cordifolia, Portulaca, Crassula spp. Sedum, Aptinia,
2.	Large succulents	Aloe, Jade plant
3.	Perennials	Marigold, Alternaria
4	Grasses	Zoysia, Korean grass, Bermuda grass, Ornamental grasses
5.	Herbs	Thyme
6.	Trees	Plumeria alba, *Araucaria cookii,* Brassia *actinophylla, Callistemon lanceolatus, Gliricidia maculata*
7.	Ground cover	Gourds, Wedelia, Setcreasea
8.	Flowering annuals	Antirrhinum, stocks, dwarf sweet peas, pansy, dahlia, chrysanthemum, marigold, sweet alyssum, phlox, pinks (Dianthus) and verbena
9.	Water plants	Water-lilies

10.	Herbaceous Perennials	Daisy, canna, *Mirabilis jalapa*, *Portulaca*, *Solidago canadensis, Vinca rosea* and perennial verbena.

Roof gardening method

- ✓ Trough/benches
- ✓ Trough (newly house)
- ✓ Pots/Containers

Planting equipments

1. Trough, 2. Trays, 5. Benches,
2. Pots/containers, 4. Plastic pots, 6. Polythene bags 7. Seed box

Tools for roof gardening

1. Hand hoe 3. Rose can 5. Spade/Showel
2. Hand sprayer 4. Garden hose 6. Jute strings

Irrigation

Additional watering should be carried out regularly at roof garden. This may be provided by using a hose, sprinkler type or drip type hoses, or overhead irrigation system or automated watering system.

Drainage

Keep access to the drainage system free and clear is a priority. Can be done on green roofs by maintaining a gravel ring and filter cloth layer around roof drains and overflow scuppers. On rooftop gardens, ensure that any deck strapping or containers are aligned in such a way that they don't block the flow of water to the drain. Watch and determine where water flows to on your roof and ensure those areas and drainage paths are maintained roof is designed such to withstand pooling of water. An added layer of protection should be provided over the roofing membrane to protect if from standing water that may collect from watering plants.

Limitations

The difficulties encountered in a roof garden are completely different from that of gardens at the ground level.

- ✓ Since the garden is at a high level from the ground, the cost maintenance may go up as everything has to be carried up.
- ✓ 2. But the more fundamental difference is in the depth of the soil. At ground level the depth may be unlimited with a source of groundwater, whereas on the roof the depth of the soil is shallow, not exceeding 90 cm, but generally varying between 20 and 60 cm.
- ✓ 3. Not only the depth is shallow in roof garden, but the drainage is also good and hence water has to be replenished constantly by frequent watering.
- ✓ 4. Large trees and shrubs are generally not grown on the roof as the growth of the tap root is limited by the roof below.
- ✓ Moreover, because of shallow depth, good drainage and frequent watering, the plant food in the soil leaches off more rapidly and is to be made good by more frequent replacement.

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Maintenance

To maintain clear access to the roofing membrane and drains for maintenance and repair, install using containers of any height or size, arranged in sections on roof. Designing roof garden in sections will avoid removing the entire garden area each time the roof needs some repair work. Remember to factor in the weight of each container and its wet soil when designing the garden.

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Therapeutic Value of Stevia (*Stevia rebaudiana*)

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INTRODUCTION

Stevia rebaudiana (Bert.) is a herbaceous perennial plant of the Asteraceae family. Stevia, commonly known in Sanskrit as “madhu patra,” meaning sweet leaf is a natural and healthy alternative to sugar and artificial sweeteners. It is also known as “honey yerba” and “honey leaf” and by some other variations of these names (Pemba & Amit,2016). All India import figure of Stevia extract is around 5 tonnes per annum. Stevia production, particularly considering the fact that it is around 300 times sweeter than sugar, will elegantly meet the requirement of pharmaceutical industries and soft drink industries in India (Ahmed *et al*., 2011).

One out of the six basic taste sensations in humans is sweetness. Honey, coconut sugar, blackstrap molasses, table sugar, high fructose, corn syrup, maple syrup and other natural sweeteners contain glucose, fructose, and sucrose as their primary constituents. However, sweeteners obtained from natural sources possess a high caloric value, which may lead to obesity, diabetes, and cardiovascular diseases. There has been a gradual rise in the number of diabetic patients all over the world. India has become the diabetic capital of the world with about 72 million cases of diabetes in 2017 (International Diabetes Federation, Diabetic Atlas, 2017). Due to the growing health awareness, there has been a huge demand for sugar substitutes that would provide lesser or no calories and possess better sweetening potency. There is a variety of artificial zero-calorie sweeteners on the market, e.g. saccharin, aspartame, acesulfame potassium, cyclamates, etc. However, artificial sugar substitutes became associated with health complications, and the use of these artificial sugar substitutes has subsequently been restricted. Thus, there is a continuous search for high intensity low calorie or non-caloric sweeteners of natural origin that are safe for consumption. Stevia, which plays an important role as a non-nutritive natural sweetener, emerged as a safe sugar substitute that does not pose any threat to human health (Savita *et al*., 2004).

Table 1. Comparison of Stevia leaf powder and Stevia white extract with granulated sugar.

Sr. No.	Granulated sugar Stevia	Stevia leaf powder	white extract
1.	1 teaspoon	1/8 teaspoon	Dust on spoon
2.	1 tablespoon	3/8 teaspoon	1/2 pinch
3.	1/4 cup	1/2 teaspoon	Pinch
4.	1/2 cup	1 tablespoon	1/8 teaspoon
5.	1 cup	2 tablespoons	1/4 teaspoon
6.	3.75 pounds	7.2 ounces	0.3 ounces
7.	10 pounds	19.2 ounces	0.8 ounces

Source: (Goyal *et al*., 2010).

THERAPEUTIC VALUE

Anti-Diabetic Properties

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Stevia leaf extract can defeat plasma glucose level and significantly increase glucose tolerance because it has the ability to increase insulin effect on cell membrane, thus increases insulin production and stabilizes blood sugar level. Stevia leaf either in powder form or dried form is used as supplementary food products for diabetic patients which increases natural sweetness and it also helps in rejuvenating the pancreatic glands. Stevioside enhances glucose-stimulated insulin secretion, but does not affect fasting insulinemia (Xiao and Hermansen, 2005; Chen *et al*., 2006).

Blood Pressure Regulation

Stevia is used as a heart tonic that regulates blood pressure levels, heartbeat and other cardiopulmonary actions. Hot water leaf extract of stevia lowers the systolic and diastolic blood pressure in humans. S. rebaudiana leaves (steviolglycosides) contain non-caloric sweeteners on regular consumption reduces cholesterol in blood (Atteh *et al*., 2008), improves cell regeneration and blood coagulation, suppresses neoplastic growth and strengthens blood vessels (Barriocanal *et al*., 2008) which exert beneficial effects on human health. They relax arteries and lowers the blood pressure (Suresh *et al*., 2018).

Hypoglycaemic Action

Hypoglycemia, is known as low blood sugar is when decreases to below normal and symptoms including clumsiness, trouble talking, confusion, loss of consciousness, seizures, or death(Pemba & Amit,2016). A feeling of hunger, sweating, shakiness, or weakness may also be present. hypoglycemia caused kidney failure, certain tumors, liverdisease, hypothyroidism, starvation, inborn error of metabolism, severe infections, reactive hypoglycemia, and a number of drugs including alcohol(Yanai *et al*., 2015; Schrier, 2007).

Effects on the Skin

Liquid extract of stevia has the ability to help remove skin problems. Researchers reported that it is effective when applied to acne, seborrhea, dermatitis, eczema, etc. When placed directly in cuts and wounds a more rapid healing without scarring is evidenced. Frequent application of Stevia poultices and extracts is believed to smoothen skin with softer feelings when touched. Stevia is also known for skin shining and tightening properties, and has found its way in several commercial skin tighting product or anti-wrinkle product (Pemba & Amit, 2016).

Antimicrobial Effect

The ability of Stevia to inhibit the growth and reproduction of bacteria and other infectious organisms is important in at least two respects. First, it may help to enhanced products report a lower incidence of colds and flues, and second, it has fostered the invention of a number of mouthwash and toothpaste products reported that *Streptococcus mutans, Pseudomonasaeruginos, Proteus vulgaris* and other microbes do not thrive in the presence of the nonnutritive Stevia constituents. This fact, combined with the naturally sweet flavour of the herb, makes it a suitable ingredient for mouthwashes and for toothpastes. Stevia has even been shown to lower the incidence of dental caries (Pemba & Amit, 2016).

Obesity

The leaves of stevia contains zero calories natural sweetener ent-kaurene diterpene glycosides (stevioside and rebaudiosides) that they do not metabolize to produce energy and its sweetness is 300 times more than sucrose. Thus stevia helps in reduction of weight loss in humans (Kaushik, 2010).

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Lowers Cholesterol Levels

Consumption of stevia leads to a significant reduction in bad LDL, cholesterol and triglyceride levels and an increase in the HDL cholesterol levels, which is healthy cholesterol and is essential for good lipid profile.

CONCLUSION

Stevia *(S. rebaudiana)* is considered as a non-caloric natural sweetener. Apart from sweet contents, the other constituents of *Steviarebaudiana* exert various health benefits, such as anti-hyperglycemic, anti-cancer, hepatoprotective, antihypertensive, anti-caries, antiulcer, antioxidant, and antimicrobial.

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Enhancing the productivity of degraded lands in coastal ecosystem

Article id: 22421

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The management of agricultural land to improve farm income in coastal degraded (waterlogged saline soil) areas is quite challenging due natural calamities. Under such fragile environment sustaining the livelihoods of these resources poor farmers become a real challenge both for technology developers as well as policy makers. In the coastal area the land shaping technique, particularly farm pond and paddy-cum fish models, are unique technology for addressing the key challenges like land degradation (salinity), drainage congestion and scarcity of fresh water for irrigation and in turn have the potential to enhancing production, productivity, income and employment. These techniques particularly farm pond, paddy-cum-fish, salt tolerant variety and agronomic practice are a financially viable and attractive proposition for the degraded lands of coastal ecosystem.

INTRODUCTION

The coastal ecosystem is one of the most fragile ecosystems of the globe and the problem is acute in India, which has a long coastline of 8129 km spread over as many as 9 States, 2 Union Territories and 2 Island ecosystems. Natural calamities like, cyclones, storms, tsunami, seawater ingress, tornado are the frequent visitors in this area causing monumental losses to the lives and properties of the people living in the coastal regions. The farming operation often becomes risky due to natural calamities that increases the risk of farming or restricted the farm operation and ultimately increases the instability of farm income. The management of agricultural land to improve the farm income in coastal ecosystem is quite challenging because, firstly, most of the agricultural area is characterized by mono-cropping with low yielding rice varieties during *kharif* season. Due to the problem of water logging, tall rice varieties are cultivated which have low yield potential as compared to high yielding short varieties. Secondly, after rainy season, as the fields gradually dries up salinity building-up occurs and during *rabi* season it becomes difficult to grow any crop due to severe scarcity of freshwater which is essential for management of degraded land in respect to soil salinity and water logging. Therefore, the management of rainwater for agricultural use becomes extremely important for increasing the crop productivity particularly during *rabi* season. Under such fragile environment sustaining the livelihoods of these resources poor farmers become a real challenge both for technology developers as well as for the policy makers. To increase the farm income under the degraded lands of coastal ecosystem, strategies have been discussed to increase the income and livelihood for farmers by adopting the salt resistant crop varieties and land shaping technologies.

Land Shaping Technologies

Land shaping is nothing but articulation of land arrangement so as to overcome certain hydrologic problems in agricultural area for potential crop cultivation. Some of the land shaping techniques, which can be used by farmers, are given below and discussed one by one.

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Raised crop beds with coconut husks (RCBCH)

A mound sized 1 m wide and 0.3 m high is prepared, and compost is mixed with soil for fertilization. Coconut husks cover the ridge to guard vegetables against continuous and heavy rains (Fig.1) as well as for salinity management. The advantages of the RCBCH method are increasing microbial content in the soil and the improvement of acidic soil by increasing soil pH. The coconut husks also serve as a rich source of potash.

Broad Bed and Furrow System (BBF)

Inhibited growth of vegetables and the dilution of fodder are caused by excess rainfall during the rainy season (June–December). In contrast, during the dry season vegetable production is significantly damaged by snails, bacterial wilt and a shortage of water. The BBF system for soil and water management is a kind of integrated farming system to grow vegetables, enhance fodder and to rear fish (grass carp) in rice fields using water harvested in furrows throughout the dry season. As shown in Fig.2, the BBF system has a central broad bed (4 m wide and 1 m in height) and furrows (6 m wide and 1 m deep). Vegetables crops are planted in the broad bed. Grass carps are rearing in the furrows and harvested water is used for irrigation. The resulting net returns for the first year were 62,000 Rs. per ha, from the combined sales of the vegetables, rice and fish. In the second year, income nearly doubled (117,000 Rs. per ha). The small return in the first year was due to the construct costs associated with the BBF system.

Fig 1: Raised beds with coconut husk application **Fig 2: BBF system for soil and water management**

Pond based integrated farming system (IFS)

Farm ponds, as one of the suitable options of land shaping, form the centre of integrated farming system (Fig.3). It may store in situ rainfall or harvest surface runoff from surrounding areas depending upon the available rainfall in a region. In high rainfall areas, like A&N Islands where average annual rainfall is about 3100 mm, even in-situ rainwater storage in farm pond serves the purpose. However, in areas where surface runoff is the main source of water, the contributing drainage area or watershed should be large enough to maintain desired water level in the farm pond. The requirement of expensive overflow structures may be avoided by optimizing the catchment vs. storage area. The required catchment area depends on soil type, land use and land slope. Following steps should be made while planning, designing and constructing a farm pond: (i) rainwater availability, (ii) crop water requirements, (iii) design dimension of farm pond, (iv) location of the farm pond and (v) lining requirement for seepage control. A comprehensive work on rainwater management in Sundarban delta, West Bengal (Ambast et al., 1998) suggested to convert 20% of the farm/watershed area into on farm reservoir (OFR) to harvest excess rainwater. Further, simulation of surface drainage improvement by rainwater harvesting with and without OFR indicated surface drainage improvement up to 75%, which provides

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scope for cultivation of high yielding rice varieties in rainfed humid rice lowlands. Optimal land and water allocation using linear programming model indicated benefit-cost ratio of 2:1 (excluding income from fishery and horticulture), and thus justified the investment in OFR. For A&N Islands, Gupta et al., (2006) suggested that excess rainwater available during May to December should be stored in situ in the dugout farm ponds to provide supplemental irrigation during dry spells in wet season and life saving irrigation for crop cultivation during dry season. Further, on the basis of crop evapotranspiration and water requirement of different crops the size of the pond was optimized as 15% of the land holding to irrigate the remaining 85% area for summer crops.

Paddy cum fish system

Integrating aquaculture with agriculture assures higher productivity and year round employment opportunities for farmers. The plots utilized for rice cum fish system is mainly based on organic fertilization with a varieties of animals excreta such as poultry dropping, pig excreta, cow dung and wastes of plants such as rice husks and ashes from household burnt and remains of burnt straws after the harvest is over. Compost fertilizer like decomposed straws, weeds and stalks. The rice field can be utilized for fish culture in the following two ways. Fishes can be reared from the month of May to September when the paddy crops grow in the field. The fish culture can also be taken up from the month of November to February after harvesting of paddy crops is completed and transplantation for the next season begins. The culture of fishes in paddy fields, which remain flooded even after the paddy is harvested, may also serves as an occupation for the unemployed youths. Paddy field is suitable for fish culture because of having strong bund in order to prevent leakage of water, to retain up to desired depth and also to prevent the escape of cultivated fishes during floods. The bunds built strong enough to make up the height due to geographical and topographic location of the paddy field. Bamboo mating was done at the base of the bunds for its support.

Three tier land farming system

It is another form of land shaping option so as to introduce crop diversification in the low-lying mono-cropped paddy area. In this, one third part of the land is dugged to a depth of 2 m or more depending upon the site specific condition and the dugged soil can be spread to the other extreme of the field so as to raise this part by at least 1 m whereas some soil can be used for making bunds around the pond. The middle part of the field remains at the original ground level. In the raised part, vegetables can be grown whereas in the middle part rice is grown. The rainwater can be harvested in the dugged part and fish can be integrated. This enhances the net return of the farms.

Ridge and furrow system

In low lying areas, the paddy land is converted into ridges and furrows (Fig.4). This system is semi-permanent type, which could be lasted for 3-5 years. Regular maintenance is required for proper shaping of ridges. The paddy land is converted into ridges by cutting the soil and making the ridge. The width of the ridge and furrows are 1.0-1.5 m and height of up to 0.5 m. The earth cutting and filling operation could be accomplished manually by spade in the summer. At the time of filling the soil should be compacted. It will prevent the soil erosion. The ridges are used for plating of coconut, arecanut and banana. If possible vegetable crops could also be grown on the ridges.

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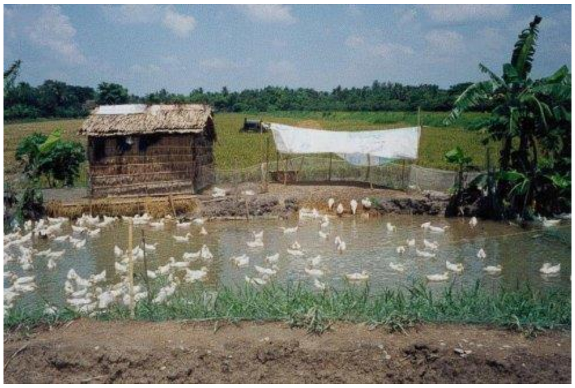


Fig. 3. Pond based integrated farming system Fig. 4. Ridges and furrows system in converted paddy land

Agronomic Strategies and Salt Tolerant Paddy Varieties

Table 1. Recommended rice varieties for different land situations

HYV for unaffected areas	Salt tolerant cultivars
For mono-cropping: IET 9188, IET 7991, IET 8021 **For double cropping**: IET 11754, IR 18350229-3, Vytilla 3, IR 31851-6-3-3-2-2 (Short duration); Quing Livan 1, Taichung Sen Yu, Milyang 55, Nanjing 47161 (Medium duration)	CSR 10, CSR 23, CSR 30, CSR 36, Canning 7 (CSSRI) Vytilla 4, and Vytilla 5 (KAU) CO 43, TRY 1, Pokkali (TNAU); PSBRc 50, PSBRc 88, PSBRc 90 (IRRI); BTS 24, BRRI dhan40, BRRI dhan41 (BRRI)

Table 2. Vegetables and fruit crops with their salinity tolerance for coastal areas

Vegetable crops	Varieties	Salinity levels (dS/m)
Brinjal	Pusa Hybrid 6 and Pusa Uphar	8
Tomato	Pusa Ruby, Pusa 120 and Pusa Rohini	8
Chilli	CA 960, Suryamukhi and Pusa Jwala	7
Watermelon	Sugar sweet and Sugar Baby	6
Sapota	Badami, Cricket Ball and Kalipatti	10
Guava	KG, Kashi and L-49	6

In the degraded low-lying waterlogged fields, farmers grow tall, extremely long duration traditional Burmese paddy cultivar, C 14-8. It covers about 60-70% of the rice cultivated area. The farmers used to transplant the rice and revisit the farm only for harvest with virtually no management inputs in terms of nutrient application or pest/disease management. A yield of 1.82.2 t/ha provides livelihood in subsistence mode. On the other hand, modern long duration high yielding paddy varieties could produce about 4-5 t/ha, of course with management at semi-intensive scale. Based on evaluation of different varieties, CIARI recommends Ranjeet and Varshadhan as the alternate high yielding long duration paddy varieties.

In some areas after tsunami, rice cultivation became an uphill task owing to high salinity and associated nutritional problems. Moreover, there is a need to increase the cropping intensity, diversify from rice cropping and shift to some vegetable crops. In areas where soil salinity is between 4-8 dS/m, CSR-23 and CSR 36 have

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shown better performance and can be used for obtaining high yield. Some other salt tolerant rice cultivars are given in Table 1. Salt tolerances of some other common crops are given in Table 2.

CONCLUSION

In coastal areas the land shaping technique is a unique technology for addressing the key challenges like land degradation (salinity), drainage congestion and scarcity of fresh water for irrigation and in turn have the potential to enhancing production, productivity, income and employment. These techniques particularly farm pond and paddy-cum-fish are financially viable and attractive proposition for the coastal region. In addition to that, agronomic strategies and salt tolerant varieties of crops under soil salinity is between 4-8 dS/m, have shown better performance and can be used for obtaining high yield. The techno-economic evaluations of these systems were evaluated. Therefore, these techniques may be adopted by the farmers of the coastal ecosystem depending upon the specific farmer field location.

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Technology for challenges and challenge in crop insurance

Article id: 22422

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INTRODUCTION:

Giving crop insurance in India is a challenging task. The total number of farms in India with an average size of 1-1 hectare was 138–35 million of the total arable operational land (last agricultural census 2010–11).

Being divided into pieces of these farms, providing traditional indemnity-based insurance on these farms proves very expensive. Due to the distribution of farms in small holdings, which farmer owns the rights of these fields remains a matter of dispute. Each farm has to be visited individually to see the damage done in these fields, which is a difficult task.

Weather based insurance system:

This system can be particularly effective. In this system individual crop losses are not to be assessed at the field level. To give the sum assured, only a few weather related standard rainfall are associated with day and night temperature and relative humidity. Deviations of these important factors in the crop cycle cause heavy damage to the crop.

Such as- Kharif crop (decrease in rainfall after sowing paddy). Farmers are paid for the insured crop in case of such abnormal incidents.

Note- This system is only related to the deviation of weather based factors. Therefore, the loss of crop damage due to any epidemic or pest cannot be recovered. Not all farmers of a geographical area start farming at the same time and they use different methods to grow a crop. Therefore, weather-based insurance system also may not be beneficial for all farmers.

Harvesting usage for insurance determination:

Assessing the crop obtained by harvesting can be the only option for determining crop insurance. Under the Pradhan Mantri Crop Insurance Scheme, all those insured farmers are eligible for insurance amount, whose crop yield is less than the average crop yield of that area. The yield is assessed on the basis of crop harvesting experiment. Under the Prime Minister Crop Insurance Scheme, the insurance unit Gram Panchayat has been created.

Four crops are used for each crop by the Gram Panchayat and the result obtained is sent to the State Government and a compensation claim is submitted to the insurance companies within one month of the receipt of the last crop.

Possibility of error:

There are about 25 lakh gram panchayats in the country and (crop harvesting) To assess the loss of a single crop under this insurance scheme, 10 lakh crop harvesting experiments will have to be evaluated. Thus, if more than one crop is produced in the same gram panchayat in the year, then there is a possibility of a big mistake by repeating this process.

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Techniques in Insurance:

WHITCAM

International Food Policy Research Institute has developed the WHITCAM app, a photo-based insurance app that Kisan Bhai can download from his mobile phone's Play-Store. Farmers can take pictures at regular intervals from sowing to harvesting through this app. On taking pictures through this, these pictures are automatically uploaded on the servers of insurance companies. Authorities for assessing insurance companies compensation claims Instead of sending, the crop analyzes the images sent from the smartphone and assesses the loss. Since these pictures are taken by the app, they cannot be edited or photoshoped nor can the pictures be uploaded from the smartphone's gallery.

CONCLUSION

In this type of system, farmers have direct involvement that satisfies them. Through these means, the farmer brothers can easily recover their losses and do not have to be forced to face economic disparities for the next crop. Insurance companies also do not have to monitor that notified area. Therefore, it is also a cheaper system for them.

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Role of Transportation of Agricultural produce in Indian Agriculture

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Transportation of Agricultural goods and raw material plays an important role in Indian Agriculture which facilitates the physical movement of these agriculture goods along with individuals from one place to another. Transportation is necessary for carrying raw material and goods to the place of production and distributing finished products for consumption. Easy transportation of manures, seeds, fertilizers, pesticides and agriculture equipment should be made possible in time according to the means of road transport. Rural transport between farms, roads and markets is crucial. Transportation and rural roads are essential for sustaining agriculture development. Distance barrier can be easily reduced by means of transportation. Animal driven transport and motor driven transport are the two means of rural transportation in India.

INTRODUCTION

Transportation means physical movement of the goods and raw materials from one place to another place in time. Transportation facilities are very much essential to move the agricultural products in right time, right from the production centers to the doors of farmers located in all over the country and by providing easy movement of bulky and surplus agricultural commodities. Without the transportation facility, carrying the crop residues or harvest from the field to village is a major constraint. The delay in carrying the harvest will lead to severe losses. With carts and other local transportation system, the harvest or agricultural produce can be carried out easily in time.

The farmers which have access to proper and adequate transportation facilities can find it easier in transporting the agricultural produce, purchasing farm inputs such as seeds, fertilizers, pesticides. The framers who are having the carts, trailers can easily transport crop residues more effectively, even in rural areas which increases both farm production and productivity and brings profit to the farmer by eliminating losses.

Some of the advantages of transportation

1. Better transportation benefits in changing the pattern of agricultural production by diverting the production from food crops to commercial crops.
2. Farmer with better transportation facilities like animal driven carts or motor driven trailers can carry more produce to market very quickly without any middlemen.
3. Transportation is necessary for increasing farm production and productivity by reducing losses.
4. It provides easy access to the market centers and cities.
5. Perishable goods can transport more easily by means of transportation by reducing losses.
6. Easy provision of door to door services.
7.Transportation also brings desirable knowledge and communication related to agriculture in rural areas.
8. Transportation is more important in rural areas where commercial crops are produced because of need of everyday transportation.
9. Easy transportation gives profit to the farmer by selling the agriculture produce to the market by themselves at more price instead selling for middle men at less price.
10. It protects framers from brokers and middlemen.

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CONCLUSION

Transportation not only transfers agricultural produce from one to place to another place but also incorporates desired knowledge and communication related to agriculture produce and farm inputs to the local rural farmers by breaking the isolation of villages. Farmer can be more beneficial and can increase the production and productivity by eliminating the losses. The farmers never get the actual price or the least nearest prices due to selling of goods to the local middlemen at low rates. This can be reduced by means of transportation which a rural farmer can reach to the cities for acquiring better prices.

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Crop and varietal introduction - An approach for flower improvement

Article id: 22424

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History of crop improvement of flower crops

(a) Rose

In the 16th century when the Muslim Mughal emperors came from Persia and Afghanistan to rule India, they brought camel loads of roses. In fact the first Mughal emperor, Babar, is said to have brought the damask rose into India.

(b) Gladiolus

- ✓ *Gladiolus tristis,* a sweet scented species closely related to *G. grandis,* was first introduced to U.K in 1745.
- ✓ Breeding work in gladiolus has been carried out at IARI, New Delhi; IIHR, Hessaraghatta; NBRI Lucknow and Horticulture Experiment & Training Centre, Chaubattia, Uttrakhand and IHBT Palampur.

(c) Bougainvillea

- ✓ The Bougainvillea improvement work in India started with the introduction of a few varieties by the Agri Horticultural Societies at Calcutta and Madras. 'Scarlet Queen' named by Sir Percy Lancaster in 1920 is probably the first Bougainvillea raised in India.
- ✓ A large number of cultivars have been developed at IARI New Delhi, IIHR Bangalore and NBRI, Lucknow.

(d) Chrysanthemum

- ✓ Work on chrysanthemum improvement was taken up at NBRI, Lucknow; IIHR, Hessaraghatta; PAU Ludhiana and BCKV Kalyani.

(e) Carnation

- ✓ At I.A.R.I., New Delhi, experiments on mutation breeding were carried out. Seeds of different lines of carnation have been irradiated with 6 to 20 kr. dosage of gamma rays and some interesting mutants with variegated leaf were obtained (Kaicker, 1988).
- ✓ Development of new hybrids through in vitro mutation breeding is also in progress at Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan and the mutants are under evaluation.

Fig: 1.0 Plant introduction

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Plant introduction

- ✓ It consists of taking a genotype or group of genotypes into a new environment where they have not been grown before.

Types of Introduction can be categorized as:-

1. Primary Introduction
2. Secondary Introduction

Primary introduction

An introduction is said to be primary introduction when the introduced variety is well suited for new environment.

- ✓ It is released for commercial cultivation without any alteration in original genotype.
- ✓ In floricultural crops, the commercial varieties of rose, carnation, gerbera etc. which are presently being grown for commercial cut flower production or export have been introduced from different parts of the world.

Secondary introduction

- ✓ The introduced variety may not be suitable for direct cultivation and can be subjected to selection to isolate a superior variety suitable for a particular area.
- ✓ The introduced variety may also be hybridized with local variety to transfer one or two characters from it to local variety.

Purpose of plant introduction

(a) Use in Agriculture, Forestry and Industry

- ✓ New varieties of plants or crops are introduced from various places for use as food, fibre, wood or medicinal purposes as well as the breeding material for hybridization work.

(b) For Aesthetic Interest

- ✓ Various ornamental plants are introduced for beautification.

(c) For germplasm conservation

- ✓ The spread of high yielding varieties causes a danger to old varieties to get lost from an area. But germplasm collection and conservation help to maintain lines, clones, mutants, cultivars, etc. from as many sources as possible.

(d) For Studying Origin and Distribution

The distribution of crop plants and their various forms in different parts of the world gives an idea of their origin and evolution.

Role of plant introduction in floriculture

- ✓ Main purpose of introduction is to improve the economy of the country.
- ✓ Introduction has proved to be one of the most potential methods of crop improvement in commercial cut flower production because most of the commercial cultivars of different crops have been introduced in India.

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Advantages of plant introduction

1. It provides entirely new crop plant which has not being grown earlier e.g. Alstroemeria, Bird-of-paradise etc.
2. It may provide superior variety directly or after selection or hybridization. Many superior varieties of different floricultural crops roses have been introduced in the country for direct cultivation e.g. 'Passion',' Grand Gala' in rose.
3. Introduction and export are the only feasible and fastest means of collecting germplasm and to prevent variability from genetic erosion.
4. It is quick and economical method for crop improvement particularly when introductions are released as a variety directly or after simple selection.
5. If a particular location is prone to some particular disease or insect attack, plants may be introduced in new disease free areas directly to protect them from damage.

Procedure of Plant Introduction

(a) Procurement of germplasm

- ✓ The new germplasm is procured through NBPGR, New Delhi.
- ✓ Scientists, individuals and institutions can submit their requirement to Director, NBPGR, Pusa Complex N.Delhi-12.
- ✓ If the bureau is unable to meet the request from its own stock or from known source it attempts to procure them from the counterparts in other countries.
- ✓ Generally the material is obtained through correspondence as gifts or exchange of germplasm in consideration of past gifts to the Bureau or in anticipation of future gifts.
- ✓ The Bureau participation in the activities of NBPGR aims at free exchange of germplasm and is helpful in arranging supply of needed germplasm.
- ✓ The plant part depending on the crop species e.g. seeds; tubers; suckers, bulbs or cuttings etc. can be procured.

(b) Quarantine

- ✓ It is to keep the material in isolation to prevent spreading of diseases etc.
- ✓ All introduced material is thoroughly inspected for contamination with diseases, weeds and insects. Plants that are suspected to be contaminated are fumigated or are given other isolation for treatments and observed for insect pests and disease.
- ✓ The entire process is known as quarantine and the rules which are used for this are known as Quarantine rules.
- ✓ It is essential that all the material being introduced must be accompanied by an authentic phytosanitary certificate.
- ✓ The plant material being introduced or exported must confirm to certain quarantine regulations and quarantine control is exercised by NBPGR at different points of entry.
- ✓ The phytosanitary certificate is thoroughly inspected and returned back to the sender or owner.

(c) Cataloging

  - ✓ All the plant material which is introduced is given an entry number and information regarding agency, place of origin, adaptation etc and is well documented.
  - ✓ Plant material is classified in three categories
  - ✓ Exotic collection (EC)

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- ✓ Indigenous collection(IC)
- ✓ Indigenous wild collection

(d) Evaluation

The plant material is sent to sub stations of the bureau and evaluated with respect to various characters to assess the potential of new introductions.

(e) Acclimatization

- ✓ It is the process that leads to the adaptation of a variety to a new environment.
- ✓ Variability must be present in original population so that natural selection could lead to acclimatization. The extent of acclimatization is determined by range of genetic variability in original population and duration of life cycle of crop.
- ✓ Cross pollination leads to far more gene recombination than self pollination. The greater the initial variation the more is acclimatization.

(f) Multiplication and distribution

Plant material which is introduced is to be multiplied and further tested at various locations. The suitability of cultivation in different regions of the country should be assessed before using it as a commercial variety.

Table 1.0: Flower crops introduction

Sn.	Flower crops	Varieties	Description
1.	Gladiolus	Apple Blossom, Bis Bis, Melody, Oscar, Sylvia, Patricia, Ratna's Butterfly, Snow Princess, George Mazure,	IARI, New Delhi
		Camellia, Friendship, Green Woodpecker, Lady Killer, Life Flame, Rose Spire, Stormy Weather, Thunderbird, Old Gold,	Regional Station, Flowerdale, Shimla (IARI, New Delhi)
		Anne Virginia, Cardinal Spellman, Double Frills of Pink, Exotic Double Sister Elitz, Florence Nightingale, Kenny, Hawaii, King Lear, La Paloma,	Regional Fruit Research Station, Mashobra (Shimla)
		Beauty Spot, Cherry Blossom, Friendship, Melody, Picardy, Snow Princess, Watermelon Pink, Wild Rose, Tropic Sea	IIHR, Bangalore
2.	Tuberose	Calcutta single and Calcutta double	Calcutta single and Mexican single are promising ones for large scale cultivation
3.	China -aster	Perfection white, perfection rose	Introduced from Australia
		Sky blue star, blue lady	Introduced from Canada
		Rose, pink	Introduced from USA
4.	Rose	Golden Gate, Passion, Grand Gala, Superstar, Queen Elizabeth	---
5.	Carnation	Master, Sangaria, Dover, Yellow Dot Com, Tasman,	---

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		Farida	
6.	Alstroemeria	Alladin, Serena, Pluto, Capri, Cindrella	---

Review

- ✓ Cantor .M, Buta .E and cantana C (2009). The cultivars studied have a rich range of colours (white, red dark, salmon, apricot, bengal pink, striped or spotted etc.) are vigorous with great number of petals/flower, repeat flowering, excellent disease in garden , a bushy well-branched habit. Fragrances in roses of all types have always been important to us and remarks: Acapella, Black Velvet, Caprice de Meilland and Valencia. The most representative Rose cultivars can be used for landscape design in borders, gardens, or are grown as cut flowers for bouquets or arrangements. Organizing some green spaces to be more and more attractive requires a well knowledge of the morpho-biological and cultural characteristics of the rose cultivars and the choice of the most suitable combinations.
- ✓ Cantor .M, Cristea .G (2011). 37 gladiolus cultivars for improve our floral collection in order to test in climatic condition. The best cultivars fellows to propagation and to recommend for cultivate or for use as genitors in breeding program for create new varieties. The cultivars studied had a great diversity of color, length of spike, number of florets, resistance to diseases etc. All the data obtained concerning the main characteristics of the Gladiolus cultivars were analyzed.
- ✓ Datta . S.K (2018). Induced mutation combined with in vitro technique has tremendous potential to change one or a few characters of an otherwise outstanding cultivar without altering the remaining and often unique genotypes.
- ✓ Cantor .M , Buta .E (2014). Observations is that the main morpho-decorative characters such as: colors, high plants, circumference of plant, number of flower/inflorescence, diameter of flower, diameter of receptacle, number of branched stem per plant, number of ligules and resistance to diseases. The results obtained include great varieties between the characters analysed. The color of the varieties are white cream (Lady Coral Creamy White), yellow (Sea Starlet Yellow, Harlekin Yellow), pink (Lady Coral Rose), red (Sea Starlet Bright Red, Juwel Purpurit) and blue-violet (Lady Coral Light Blue, Sea Starlet Lavender, Sea Starlet Violet). The flower head are variable from 7.1cm (Harlekin Yellow) to 10.7cm.

CONCLUSION

A lot of breeding work can be done in Flower crops (especially on rose) to develop new genetic variations using conventional breeding techniques in segregating population due to its high heterozygosis and polyploidy nature. Breeding technique and wise selection of parents for hybridization will help to some extent achieve the desired results through directive breeding.Hybridizers in India can achieve success in developing desired varieties according to the demand of international markets if they have proper laboratory facilities and patronage, suitable trial ground, monetary benefits and markets, recognition and royalty as their counterparts in other countries. Selective breeding has now been realized as the most essential to develop varieties according to requirement of the trade

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Panchgavya: A Boon in Liquid Fertilizer for Organic Farming

Article id: 22425

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INTRODUCTION

Organic farming is based on the system-oriented approach and the use of organicliquid product like Panchagavya resulted in higher growth, yield and quality ofcrops and hence there had been an increasing interest in the use of liquidformulations. The liquid formulations such as panchagavya, jeevamruth andbeejamruth were eco-friendly organic preparations made from products of cow (Sugumaran, *et al.,* 2018). Among these, panchagavya is one of the widely used traditional liquid organicformulations, which is a fermented product made from five ingredients obtainedfrom cow, such as milk, urine, dung, curd and clarified butter (Amalraj et al., 2013).Organic agriculture is a comprehensive production management system which promotes andenhances health of agro-ecosystem, including bio-diversity, soil biological activity and biological cycles. It gives importance to the use of management practices particularly the use of off-farm inputs, taking into account that regional conditions require locally adapted systems (Raghavendra*et al.,* 2014). Panchagavya is a special preparation made from five by-products of cow along with certain other ingredients, has the potential to play the role of promoting growth and providing immunity in plant system. Panchagavya plays a major role in organic farming.

Table 1: Ingredients used for preparation of panchagavya

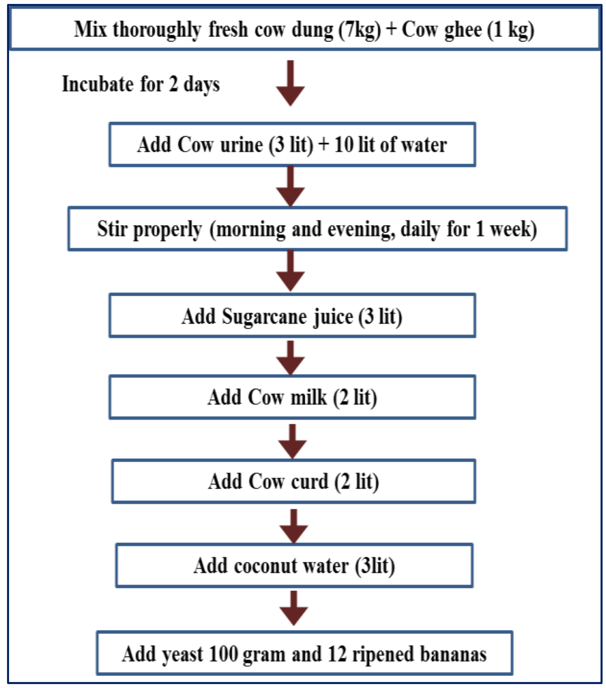
Fresh cow dung	10 kg
Cow urine	10 lit
Cow milk	2 lit
Cow curd	2 lit
Cow ghee	1 kg
Tender coconut water	3 lit
Sugarcane juice	3 lit
Ripened banana	12 numbers
Yeast	100 gm

Sugarcane juice and coconut water are used to accelerate the fermentation which also help in minimizing the bad odour.

Protocol for Panchagavya Preparation

The whole mixture is to be incubated for two weeks and the preparation should be filtered through double layered muslin cloth and stored in bottle under refrigerator and used as and when required.

The container should be kept open under shade. The content is to be stirred twice a day both in morning and evening. The Panchagavya stock solution will be ready after 30 days. (Care should be taken not to mix buffalo products. The products of local breeds of cow is said to have potency than exotic breeds). It should be kept in the shade and covered with a wire mesh or plastic mosquito net to prevent houseflies from laying eggs and the formation of maggots in the solution. If sugarcane juice is not available add 500 g of jaggery dissolved in 3 liter of water.



Physico chemical and biological properties

Physico-chemical properties of Panchagavya revealed that they possess almost all the major nutrients, micro nutrients and growth harmones (IAA & GA) required for crop growth. Predominance of fermentative microorganisms like yeast and lactobacillus might be due to the combined effect of low pH, milk products and addition of jaggery/sugarcane juice as substrate for their growth.

The low pH of the medium was due to the production of organic acids by the fermentative microbes as evidenced by the population dynamics and organic detection in GC analysis. Lactobacillus produces various beneficial metabolites such as organic acids, hydrogen peroxide and antibiotics, which are effective against other pathogenic microorganisms besides its growth. GC-MS analysis resulted in following compounds of fatty acids, alkanes, alconol and alcohols.

Table 2. Various compositions

Chemical Composition	
pH	5.45
EC dSm2	10.22
Total N (ppm)	229
Total P (ppm)	209
Total K (ppm)	232
Sodium	90
Calcium	25
IAA (ppm)	8.5
GA(ppm)	3.5
Microbial Load	
Fungi	38800/ml
Bacteria	1880000/ml
Lactobacillus	2260000/ml
Biochemical parameters	
IAA (µg/ml)	4.45
GA (µg/ml)	26.76
Cytokinin (µg/ml)	3.12
AscorbicAcid(µg/ml)	13.00
Source: Chakrabortyet *al.*, 2019	

Recommended dosage

Spray system: 3% solution was found to be most effective compared to the higher and lower concentrations investigated. Three litres of Panchagavya to every 100 litre of water is ideal for all crops. The power sprayers of 10 litre capacity may need 300 ml/tank. When sprayed with power sprayer, sediments are to be filtered and when sprayed with hand operated sprayers, the nozzle with higher pore size has to be used.

Flow system : The solution of Panchagavya can be mixed with irrigation water at 50 litre per hectare either through drip irrigation or flow irrigation

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Seed/seedling treatment: 3% solution of Panchagavya can be used to soak the seeds or dip the seedlings before planting. Soaking for 20 minutes is sufficient. Rhizomes of Turmeric, Ginger and sets of Sugarcane can be soaked for 30 minutes before planting.

Seed storage: 3% of Panchagavya solution can be used to dip the seeds before drying and storing them.

General schedule of application of Panchagavya

At Pre flowering phase : Once in 15 days
At Flowering and pod setting stage : Once in 8-10 days
At Fruit/Pod maturation stage : Once during fruit/pod maturation

Table 3: Time of application of Panchagavya for different crops

Crops	Time schedule
Rice	10,15,30 and 50th days after transpalnting
Sunflower	30,45 and 60 days after sowing
Black gram	1st flowering and 15 deays after flowering
Green gram	15, 25, 30, 40 and 50 days after sowing
Castor	30 and 45 days after sowing
Groundnut	25 and 30th days after sowing
Bhendi	30, 45, 60 and 75 days after sowing
Moringa	Before flowering and during pod formation
Tomato	Nursery and 40 days after transplanting: seed treatment with 1 % for 12 hrs
Onion	0, 45 and 60 days after transplanting
Rose	At the time of pruning and budding

Effect of Panchagavya

In leaf Plants sprayed with Panchagavya invariably produce bigger leaves and develop denser canopy. The photosynthetic system is activated for enhanced biological efficiency, enabling synthesis of maximum metabolites and photosynthates. In case of stem, the trunk produces side shoots, which are sturdy and capable of carrying maximum fruits to maturity. Branching is comparatively high.The rooting is profuse and dense. Further they remain fresh for a long time. The roots spread and grow into deeper layers were also observed. All such roots help maximum intake of nutrients and water.There will be yield depression under normal circumstances, when the land is converted to organic farming from inorganic systems of culture. The key feature of Panchagavya is its efficacy to restore the yield level of all crops when the land is converted from inorganic cultural system to organic culture from the very first year. The harvest is advanced by 15 days in all the crops.It not only enhances the shelf life of vegetables, fruits and grains, but also improves the taste. By reducing or replacing costly chemical inputs, Panchagavya ensures higher profit and liberates the organic farmers from loan.

General Advantages of Panchagavya

- It improves soil health and fertility
- It is used against pest and diseases
- It increases yield and quality of produce

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- No chemicals are used
- Eco-friendly approach
- Cost required for preparation is less
- Reduces cost of cultivation by reducing chemicals like fertilizers, pesticides, fungicides, growth regulators etc

Problems, Constraints, Barriers and Difficulties in Adopting Panchagavya

- Lack of awareness about its uses
- Sometimes during fermentation contamination occurs
- Slow action
- Limited availability of its products in markets

CONCLUSION:

Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for organic farming to protect soil and plant health. Organic farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment. The increasing concern for environmental safety and global demand for pesticide residue freefood has evoked keen interest in crop productionusing eco-friendly products which are easily biodegradable and do not leave any harmful toxic residues besides conserving nature. So it is necessary to use natural products like Panchagavya to produce chemical residue free food crops and hence Panchagavya can play a major role in organic farming.

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Vertical Farming: A new way to produce and control pollution

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Increasing food demand and water scarcity due to a growing population along with ever decreasing arable lands poses one of the greatest challenges for sustainable agriculture production. Industrial development and urbanization are main reasons behind losing arable lands every day and scientists says, that the Earth has lost a third of its arable lands over the last 40 years. So, there are challenges to produce more in fewer natural resources (land, soil, water and sunlight). Many believe that vertical farming can be the answer to this challenge. Is vertical farming acceptable in future? Let us find out! As humanity grows larger, space keeps becoming an issue. So vertical farming could be an alternative to conventional farming for reliable agriculture.

Reasons to shift from conventional to vertical farming:

a) **Exponential population explosion:** Population of India growing day by day and it is estimated that it will crosses china population very soon. These numbers present an even bigger challenge with natural resources such as water and arable land becoming scarce. Vertical farming, indeed, is the most favorable solution for this.

b) **Increase in quality food production:** A vertical farm makes farming within the confines of a city and when the farms are nearby, the produce quickly delivered and always fresh; when compared to the refrigerated produce usually available at supermarkets.

c) **Negligible wastage of water:** Agricultural industry, across the globe, is one of the biggest polluters using up to 90% of world's water. But that could change with vertical farming. Due to the regular circulation of water, vertical farms use, in some cases, 95% less water.

d) **Optimum use of energy:** **S**olar energy used in the vertical farms and leads to energy savings.

Vertical Farming: An option from traditional farming to vertical farming

Vertical farming is the practice of producing food on vertically inclined surfaces. Instead of growing vegetables and other foods on a single level, such as in a field or a greenhouse, this method produces foods in vertically stacked layers commonly integrated into other structures like a skyscraper, shipping container or repurposed warehouse. The main goal of vertical farming is to produce more crops in a limited space. Beyond their space saving capability, there are additional benefits to vertical gardens; plant will receive much greater exposure to sun and oxygen and protected from many pest in heights. Using Controlled Environment Agriculture (CEA) technology, this modern idea uses indoor farming techniques. The artificial control of temperature, light, humidity, and gases makes producing foods and medicine indoor possible. In many ways, vertical farming is similar to greenhouses where metal reflectors and artificial lighting augment natural sunlight. To make it more sustainable and conservable, this kind of farming uses features to offset energy cost of farming. It uses up to 95% less water. Here are some vegetables for vertical farming like tomatoes, Peas, Cucumbers, Melon, Kiwis, Passion fruit, Green beans, Corn, okra, lettuce and basil. These plants naturally grow vertical and do not need any support and peas, beans are climbers and do not need much water and fertilizer.

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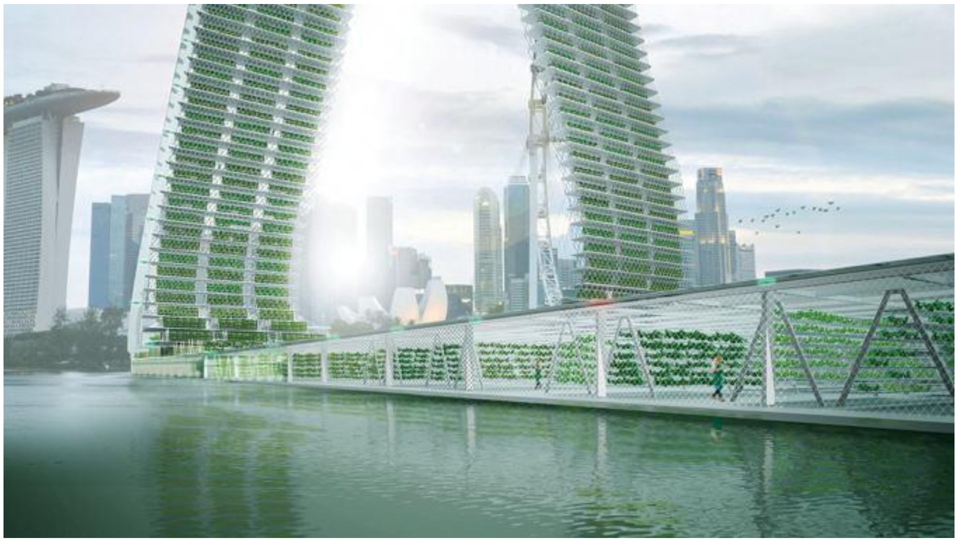

Figure: Vertical farming on buildings

Vertical gardens/farming to fight Air Pollution

In urban area, plants can eliminate harmful toxic gases in the air caused by various pollution sources including vehicle pollution. These plants can reduce the levels of toxic gases by 50 to 80 percent and plants grown using the hydroponics method use 90 percent less water than the conventionally grown soil-based ones. There is need for making a sustainable setup, which will ensure the vertical garden are not a one-time event but becomes a permanent part of the city. In many cities like Delhi, Noida, Pune, Benglaru etc the concept of vertical garden has tested where public praises it. Indoor air-purifying plants such as Mahatma, set flora, the sun of India, haze and snake plants and other varieties has been used so that people can breathe fresh air while it will also help bring down temperatures in and around the nearby area. In big cities, vertical gardens had installed in pillars of the city's flyover. Delhi generates over 131 ton of dust every day, which is one of the leading causes of the degrading air pollution in the capital. Delhi government action plan is in accordance with the efforts of Ministry of Housing and Urban affairs to check air pollution, especially dust pollution. Project of vertical gardens is of paramount importance to the capital city as host of departments and agencies are involved in giving a pleasing look to Delhi. A variety of ferns, focus species, ribbon grass and blade grass will adorn these vertical gardens. The vertical garden are being planned in two ways in which plastic pots is hung over plastic frames and another with a coco-pit-based medium for plants with a bigger root system. A green wall is a wall partially or completely covered with greenery that includes a growing medium, such as soil or a substrate. Most green walls also feature an integrated water delivery system. Green walls are also known as living walls or vertical gardens.

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Figure: Vertical gardens on Flyover pillars

Advantages and Disadvantages of Vertical Farming/Gardens

Benefits

- Green walls mitigate air pollution levels by lowering extreme summer temperatures through photosynthesis, trapping particulate matter, and capturing gases
- It uses significantly less water
- Weather doesn't affect the crops
- There is less exposure to chemicals and disease
- Cleans outside air of pollutants and dust and offsets the carbon footprint of people and fuel emissions
- Growing of vegetables and flowers can also solve the food scarcity problems
- Reduces stress among people.
- Creates habitats for birds and beneficial insects, increasing biodiversity
- Increases real estate value
- The ability of green walls to provide thermal insulation for buildings means less demand on power
- Human and Environmentally Friendly farming technique

Disadvantages

- It could be very costly to build
- Pollination would be very difficult and costly
- It would involve higher labor costs
- It relies too much on technology and one day of power loss would be devastating

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CONCLUSION

Vertical farming technologies are still relatively new and it depends on technology. In future vertical farming will determine how important a role it will play in the future to face the challenge of growing food demand. With proper management, vertical farming could be a good option/alternative to conventional farming and can also helpful to curb the pollution.

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Importance of organic mulch in Horticulture

Article id: 22427

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Mulch is layer of covering material either organic or inorganic form applied on the soil surface to reduce evaporation losses and maintain soil temperature in winter, rainy and summer season. Main role of mulch improve microorganism in soil. The mulching layer can also significantly reduce weed propagation, which will also result in higher water use efficiency. Mulching is a superb horticultural technique that is helpful to all plants in the garden and mainly useful during dry and winter periods. Grass clippings, wheat straw, wood chips, bark chips and leaf debris is fairly larger by-product. So many producers previously generate these mulching materials and at present use resources to dispose of them. Mulching using this waste is a cost effective practice which would conserve water, soil erosion, moderate soil temperature, reduce waste and improve microorganism in the soil, which will also result in improve soil health.

INTRODUCTION

Our country population increase day by day and we have cultivated land area is limited so how to take maximum production per unit area. What do we do to restore the health of our soils, add nutrients to our soils, maintain a good micro-flora, a fine balance of micro-organisms in the soil, conserve the soil moisture and control the weeds in our lands? These question, answer is easy and simple, to adopt the mulching technique in our horticulture fields. Now-a-day, getting move return from per unit area of land has received due focus from growers and researchers alike. Good return is expected only when the plant is grown in good health condition. In this regard mulching is core input. So what is Mulch?

Mulch is layer of covering material either organic or inorganic form applied on the soil surface to reduce evaporation losses and maintain soil temperature in winter, rainy and summer season. Main role of mulch improve microorganism in soil. The mulching layer can also significantly reduce weed propagation, which will also result in higher water use efficiency. Mulching is a superb horticultural technique that is helpful to all plants in the garden and mainly useful during dry and winter periods. Consider improving the growth, development, yield and quality of fruits and vegetable plants with mulching. Grass clippings, wheat straw, wood chips, bark chips and leaf debris is fairly larger by-product. So many producers previously generate these mulching materials and at present use resources to dispose of them. Mulching using this waste is a cost effective practice which would conserve water, soil erosion, moderate soil temperature, reduce waste and improve microorganism in the soil, which will also result in improve soil health. Mulching is one cultural practice of cultivation which can be used to addresses this problem. Covering the ground layer with mulch saves water by preventing surface evaporation (Patil *et al.,* 2013). The process is used both in commercial crop production and in gardening, and when applied correctly, can dramatically improve soil productivity by mulching.

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Mulches are used as a soil covering, for a variety of reasons:

1. Soil moisture retention
2. Heat trapping
3. Reduce runoff losses
4. Increases germination percentage
5. It improve soil structure
6. Weed prevention and control
7. Protecting roots from fluctuating and extreme temperatures
8. To help control soil erosion

Organic mulches:

Organic mulches decay over time and are temporary. The way particular organic mulch decomposes and reacts to wetting by rain and dew affects its usefulness. Some time organic mulches harmful effects on crops due to bacteria and fungi that decompose the materials remove nitrogen from the surrounding soil for growth. Mulch made with wood can contain or feed termites, so care must be taken about not placing mulch too close to houses or building that can be damaged by those insects. Some organic mulch material such as grass, peat moss, wood chips, straw, dry leaves, bark chips, saw dust and compost. These has capacity to easy decompose due to attract of insects microbial activity, cutworms and slugs that eat them and it will help to degraded quickly and it add some amount of organic matter and nutrient in soil. Organic mulch is most useful in fruit crops like strawberry, raspberry, banana, papaya, citrus, mango, cap gooseberry, and temperate fruit crops like apple, pear, peach and plum. The example of organic mulches and their uses are given below:

Grass Clipping:

Grass clipping, from mowed lawns are sometimes collected and used elsewhere as mulch after dry. This is most useful and easily available mulch materials across the country. If included fresh in soil, it added some amount of nitrogen to the soil. It also provides some organic matter in the soil. But, If we use green grass material it has capable for germination and develop root system it will harmful effects on crops growth and development. So, use of dry grass as mulch material is suggested.


Grass mulching practices in *Khirni* (*Manikara hexandra*) plant at College of Horticulture and Forestry Jhalawar, AU-Kota

Straw:

Paddy wheat and barley straw and many other crop residues like stubbles, groundnut shells, cotton shells, mustard stalk etc; are used as mulching materials on soil surface for moisture conservation and temperature maintain. They are biodegradable and neutral in pH. They have good moisture retention and weed controlling properties but also are more likely to be contaminated with weed seeds. However straw is

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poor in nutrient value but after decomposition, it makes soil more fertile. Straw mulches reduce both the amount of energy absorbed by the soil and its movement above the soil and hence reduce evaporation.

Straw mulching practices in strawberry at College of Horticulture and Forestry Jhalawar, AU-Kota

Newspaper:

Newspaper is mainly useful as mulch when you are trying to open up a new planting bed by killing grass and/or weeds across a large area. Newspaper mulching helps to control weeds and also add some organic matter in soil. One to two cm thick or one to twenty sheet of newspaper should be used according to plant requirement and edges should be fastened with materials like pebbles gravels etc. The use of newspaper mulch should be avoided on a highly windy, rainy days and avoid the color ink newspaper for the reason that it will harmful.

Newspaper mulching

Dry leaves:

Leaves, a simply and in large quantities available material, from deciduous tree and other crop residues are good for mulching. Although leaves are good for protecting dormant plants during winter by keeping them warm and it help to initiate germination during cold season but dry but due to light weight they may be blown away even by light wind. To reduce these problems to used stone, bark or any other material that help to reduce wind problem. Dry leaves application in winter mulches to protect plants from freezing and thawing in areas with cold winters; they are normally removed during spring.

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Dry leaves mulch

Bark clippings:

These are good mulch materials as they are long lasting and allow proper ventilation to the soil underneath. The chips are used to conserve soil moisture, moderate soil temperature and suppress weed growth. Bark clipping a layer two or three inches deep are usually used, bark is relativity still and it's decompose does not demand soil nitrates. Bark chips are also available in various colors. Wood bark has capacity to hold more water and bark mulch material is used in both the area very dry and very wet for the reason that if rain is too much the bark will absorbed excess water and decrease waterlogged situation. When rainfall is very low, the wood chips will released the water it have holding, providing to plants in dry times. Hardwood bark clipping having more nutrients contains than soft wood bark but bark clippings are not simply and in large quantities available and some bark products may cause phytotoxicity.

Saw dust:

Saw dust, obtained during final operation of wood and furniture it is having very poor in nutritive value. It decomposes slowly. It should not be used in acidic soils because it is acidic in nature so use for acid-loving plant like blueberries, strawberry and fig.

Saw dust mulching

Compost:

The compost is most useful and best mulching materials. Add a 2- to 4-inch layer of compost over the soil around all the perennials, extending the layer outward about 12 inches from the plants. This layer will slowly work its way into the soil during the growing season, so add additional layers of compost mulch every month or so during the summer and fall.
Compost mulch is increases microbial population, improves the soil health, maintains soil temperature, reduces soil erosion and adds some amount of nutrients. Compost tends to be slightly acidic, so it's an especially great

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addition to a soil with alkaline nature. However, compost has one disadvantage. It is having very well contains of NPK nutrients, so it doesn't have a large amount weed suppressing capability.

Compost mulching

Advantages of Organic Mulching:

- Organic mulch plays vital role to reflect solar radiation. It is maintains soil temperature and help to prevent evaporation.
- If organic mulch roofed with soil suppressed the weed germination because they do not get light that need to germination and growth.
- Organic mulch is increases microbial population, improves the soil health, maintains soil temperature, reduces soil erosion and adds some amount of nutrients.
- Organic mulches improve the soil health, root growth of plants, increases water holding capacity and create a very good porous of the soil.
- Early germination almost 2-3 days.

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Women and calcium together in journey of life

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Calcium

Calcium is a chemical element that is essential for living organism, including humans. It is the most abundant mineral in the body and vital for good health. We need to consume a certain amount of calcium to build and maintain strong bones and healthy communication between the brain and other parts of the body.

Roll of calcium in different ages-

The body's need for calcium relative to skeletal growth and remodeling varies by life stages. The major physiological activities include bone accretion during skeletal growth and maintenance of bone mass after growth is completed. Later in adult life, net calcium is lost from the body when bone formation no longer keeps up with bone reabsorption.

Infancy-

At full -term birth, the human infant has accrued about 26-30g of calcium, most of which is in the skeleton. When calcium transfer from the placenta causes at birth, the new born infant is dependent on dietary calcium.

Childhood adolescence-

Calcium deposition in to bone is an ongoing process throughout childhood and in adolescent, reaching maximal accretion during the pubertal growth spurt. Measures of bone density in adolescent girls indicate the about 37% of total skeletal bone mass is achieved between pubertal stages 2 (means age 11 years) a 4 (means 15 age years), with an average daily calcium ascertain rate of 300-400 mg / day. Approximately 40% of total skeletal bones mass is acquired with in relatively short window 3 to 5 years, gonad steroids and growth hormone secretion are maximal. During this time, bone formation for outpaces resorption and longitudinal growth, and consolidation of bones occurs. The most recent estimate of average calcium ascertains is 92-210 mg / day calcium in 9-18 years old boys and girls and bone calcium accretion can peak at 3000 to 400 mg / day (Matkovic *et al.*, 1994).

Young adults-

In postmenopausal women, estrogen loss increases the rate of bone remodeling, characterized by an imbalance between ostolcast and osteoblast activity. Estrogen loss can further accelerate bone loss through its affect on decreased absorption of calcium and increased urinary loss of calcium.

The range of bone loss in the 7 to 10 years around the onset of menopause can range from 3 to 7 % annually. In women over age 65, the rate of boneloss shows again to 0.5 to 2 % / years. Later in menopause and in men over 70 years of age – if reduced calcium intake occurs, it contributes **to** a secondary from of hyperparathyroidism, which severs as a compensatory mechanism to maintain extracellular calcium balance (Ilich and Kerstetter, 2000; Anderson, 2001).

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Pregnancy and lactation-

Pregnancy-

Pregnant women consuming moderate (800-1000 mg / day) to high (1, 950 mg / day) levels of calcium are oftenhypercalciuric due to increased intestinal calcium absorption, and such as pregnancy. It can be a risk factor for kidney stones [Cross *et al.*, 1995].

Lactation-

Breast milk calcium content is homeostatic ally regulated, and maternal calcium intake does not appear to after the breast milk calcium content. Generally, human breast milk will provided two three times the amount of calcium to the infant during 6 months of lactation as the pregnant women will have provided to the fetus during the preceding 9 months of pregnancy (Kalkwarf *et al.,* 1997).

Menopauses-

Menopauses can intake osteoporosis through elevated bone remodeling, which occurs characteristically in post menopausal women. Remodeling activity, although designed to repair weaken bone, actually makes it temporarily weaker. When remodeling is excessive. Although it is unclear to what extent calcium intake can mitigate such bone loss; in adequate calcium intake can exacerbate the situation.

Old age-

Like women, you may have memorized the minimum daily calcium requirement 1000(mg) a day for women ages 50 and younger and 1200 mg for women over 50- and followed it faithfully in an effort presence your bones.

CONCLUSION

Humans absorb about 30 percent of the calcium present in foods, but this varies with the type of food consumed. Bioavailability is generally increased when calcium is well solubilized and inhibited in the presence of agents that bind calcium or form insoluble calcium salts. The absorption of calcium is about 30 percent from dairy and fortified foods (e.g., orange juice, tofu, soy milk) and nearly twice as high from certain green vegetables (bokchoy, broccoli, and kale). If a food contains compounds that bind calcium or otherwise interfere with calcium absorption, such as oxalic acid and phytic acid, then the food source is considered to be a poor source of calcium.

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Location in seed and transmission of seed borne viruses

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INTRODUCTION

Cultivation practices have undergone transformation during the past one or two decades. The trend is towards -intensive and extensive culturing of any given crop. Genetic materials are continuously being evolved with only one objective of yield increase and for this, there has been an intense global activity pertaining to the movement of germplasm. Any promising genetic material finds itself quickly disseminated. This has undoubtedly, contributed substantially to agricultural outputs beyond imagination. The term "seed" is used throughout in the botanical sense, i.e., a sexually derived propagule.

Seed transmission of viruses is indeed a complex, poorly understood phenomenon. Successful transmission is the end product of interplay of several factors, i.e., host cultivar or a particular strain, virus strain, and environmental conditions, particularly the ambient temperature at the time of embryo initiation and seed setting. In general, invasion of the embryo and eventual retention of infectivity during seed maturation are critical aspects in positive transmission of any virus and even before embryo invasion the virus has to survive in gametophytic, haploid tissues, i.e.,ovule and/or pollen. The seed infection occurs in relatively small proportion. Needless to say that this constitutes a major safeguard against catastrophic situation which would result otherwise.

Table 1: Seed bone viruses

Crop	Virus
Alfalfa	Alfalfa mosaic virus (AMY)
Barley	Barley stripe mosaic virus (BSMV)
Bean	Bean common mosaic virus (BCMV) Bean common mosaic necrosis virus (BCMNV) Cucumber mosaic virus (CMV)
Broad Bean (Faba)	Pea seed-borne mosaic virus (PSbMV) Broad bean stain virus (BBSV) Bean yellow mosaic virus (BYMV) Alfalfa mosaic virus (AMV)
Cowpea	Cowpea mosaic virus (CPMV) Cowpea mild mottle virus (CPMMV) Cowpea aphid-borne mosaic virus (CABMV) Cowpea severe mosaic virus (CPSMV) Southern bean mosaic virus (SBMV)
Cucumber	Cucumber mosaic virus (CMV) Squash mosaic virus (SqMV)
Groundnut	Peanut motde virus (PeMoV)
Lettuce	Lettuce mosaic virus (LMV)

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Pea	Pea seedbome mosaic virus (PSbMV) Bean yellow mosaic virus (BYMV) Pea enation mosaic virus (PEMV)
Pepper	Cucumber mosaic virus (CMV) Tobacco mosaic virus (TMV) Potato virus Y (PVY) Tobacco etch virus (TEV) Pepper mottle virus (PMV) Tomato spotted wilt virus (TSWV) Alfalfa mosaic virus (AMV)
Soybean	Soybean mosaic virus (SMV) Tobacco mosaic virus (TMV) Tobacco ring spot virus (TRSV) Cowpea mild mottle virus (CPMMV) Bean pod mottle virus (BPMV)
Tobacco	Cucumber mosaic virus (CMV) Tobacco mosaic virus (TMV)
Tomato	Tomato mosaic virus (ToMV) Cucumber mosaic virus (CMV)

Symptoms caused by plant viruses:

1. **Mosaics:** These are characterized by light-green, yellow, or white areas intermingled with the normal green of the leaves or fruit, or of whitish area intermingled with areas of the normal colour of flower or fruit. Depending on the intensity or pattern of discolorations, mosaic-type symptoms may be described as mottling, streak ring pattern, Jine pattern, vein-clearing, vein banding, vein-thickening, chlorotic sporting etc.
2. **Mottles:** It is a kind of mosaic, where on the leaves there develops an irregular pattern of indistinct light and dark areas. Like mosaics, there are green and white or green and yellow areas.
3. **Yellows (chlorosis):** In extreme cases of mosaics and mottles the leaf may become almost completely yellow due to chlorosis.
4. **Vein-clearing:** There is chlorosis of leaf tissue in close proximity to the veins. The tissue close to veins turns yellow, remaining area appears green. This is very common in bhindi.
5. **Vein-banding:** The parenchyma close to the veins is green and rest of the lamina surface shows chlorosis i.e. becomes yellow.
6. **Ringspots:** These are characterized by the appearance of chlorotic or necrotic rings on leaves and sometimes also on fruit and stem.
7. **Enations:** These are small outgrowths on leaf, stem etc. This is usually associated with mosaics. Ex. tobacco enations.
8. **Leaf-curling or leaf-rolling:** These are common in papaya, tomato, potato *etc*, where leaves become curled and rolled to varying extents.
9. **Fern-leaf, shoe string:** Leaf lamina is greatly suppressed.
10. **Stunting:** The general growth of entire plant is affected resulting into unusually shorter size of plant.
11. **Virescence:** Entire flower or petals turn to green colour. It is a type of phyllody.

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12. **Tumors:** These are gall-like structures developing on roots or stems. In Fiji disease of sugarcane, elongated galls on leaf are formed.
13. **Witche's broom:** Leaves become very much reduced, intemodes are also shortened. There is abnormal growth of leaves turning to a densely-packed broom-like structure.
14. **Little leaf:** Leaves are reduced in size. In fern-leaf, there is much suppression of the lamina.

- **Location in seed**

All the seed parts can be colonized some important pathogens known to infect different seed parts are the following.

1. **Embryo**
2. **Endosperm and perisperm :**

Seed Transmission

“Seed transmission refers to the passage of inoculums from an infected or infested seed to a plant”. The mechanism of seed transmission varies with host and pathogen and is governed by specific host pathogen reaction. The process is broadly classified as

A) Systemic seed Transmission:

Systemic seed transmission is occurs when infected or infested seeds on germination result in a systemic disease in the plant to a stage of seed development. Systemic seed borne pathogens are transmitted either by infection of different seed parts i.e. embryo, endosperm or seed coat or by contamination of the seed coat.

B) Non systemic seed transmission

Nonsystematic seed transmission result in a either pre or post emergence infection of seedling or local infection of growing plant by establishment of inoculum that survive in the soil. Non systemic infection occurs from the seed infection contamination on the seed surface or admixture of fungal propagules with the seeds.

Virus transmission

Plant viral infections are generally systemic and invade almost all parts of the plant However, in contrast to fungi and bacteria few viruses have been recorded as seed-borne. Nearly 25 per cent of more than 300 viruses have been reported to be transmitted through true seeds. Again the family Leguminaceae has the distinction of having largest number of seed transmitted viruses. The reason why such large number of viruses is transmitted through seed of legumes is unknown. As many as 85 viruses have been reported seed transmitted.

Plant viruses rarely come out of the plant spontaneously. Therefore, viruses are not disseminated by wind or water. Even when they are carried in debris or plant sap, they would cause infections only when come in contact the with contents of wounded live cell. Viruses are transmitted from plant to plant (i.e. they actually spread) in a number of ways-vegetative propagation, mechanical transmission through sap, seed, pollen, dodder and specific insects,mites, nematodes, and fungi.

Rate of Virus Transmission through Seed

The percentage of seed transmission varies from virus to virus and for the same virus in different host plants and cultivars. For example, seed transmission of tobacco ring spot virus in soybean is 100 per cent and that of

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lettuce mosaic in lettuce is only 3-10 per cent the transmission of barely stripe mosaic virus through barley seed varies from variety to variety and this variation has been attributed to varietal resistance. Similar case is for cowpea mosaic virus in cowpea cultivars. The seed transmission is more in susceptible varieties than in resistant varieties. Variation in seed transmission may be due to stage at which the plant became infected. In general, earlier a plant became infected with a virus the more the percentage of seed transmission. A high percentage of transmission resulting from early infection is found in stripe mosaic virus, tobacco ring spot virus in soybean, lettuce mosaic virus in lettuce and cowpea mosaic virus in cowpea. It is common observation that plants grown from infected seeds produce a higher percentage of infected seeds than plants that contact infection during growing season.

Mechanisms of Transmission

Very often the question why many viruses are not transmitted through seed, has lead to detailed study on the mechanism of seed transmission. The results obtained so far have lead to two following plausible causes:

- Elimination of virus from embryos of mature seed
- Exclusion of virus from developing seed

Virus Vector:

- Vegetative propagation:
- Mechanical transmission through sap:
- Seed transmission:
- Pollen transmission:
- Mite transmission:
- Nematode transmission:
- Fungus transmission:
- Transmission through bacteria:
- Transmission through parasitic phanerogams:
- Insect transmission:

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Nutrient Supply in Organic Agriculture

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INTRODUCTION

Use of plant nutrients in organic agriculture is viewed differently than in conventionalagriculture. Nutrients are supplied in organic forms or as untreated mineralswith low solubility in the belief that plants will obtain balanced nutrition through theactions of roots and soil microbes and through weathering of minerals. The premiseof organic agriculture is to supply the soil with nutrients but not directly feed theplants with soluble nutrients. Organic agriculture was founded on the dogma, asopposed to the hypothesis, that the use of organically bound nutrients and untreatedminerals is superior to the use of artificial fertilisers, which are classified as beingunnatural. Therefore, all fertilisation practices are designed and characterized according to this dogma. Over time, this has led to the commonopinion that the exclusion of soluble inorganic fertilisers contributes towardsincreased soil fertility and conservation of resources, and is a sound form of nutrientmanagement. However, the most central question is whether the exclusion of artificialfertilisers can be justified scientifically. Is the naturalness of organic manuresand untreated minerals associated with superior characteristics and functioning?Another idea central in organic agriculture is to view farms as sustainable unitsbased on nutrient recycling and use of local resources.

The Organic Principle – To fertilise the soil and not feed the crop with artificial fertilisers

The Humus Theory and Plant Nutrients

The founders of organic agriculture regarded a living soil and the release of nutrientsthrough soil biological activity as the proper way to supply crop demands. Additionof artificial, water-soluble fertilisers was deemed an unnatural way of plant nutrition.During the search for plant nutrients through history from Aristotle (384–322BC) to Thaer (1752–1828 AD), the prevailing view was that organic manures suchas animal wastes, composts, etc. increase soil fertility and that soil humus is the source of plant growth. Thaer (1837–1839) viewed humus as the residues of animal

and plant putrefaction, a black body that formed the source for plant dry matter(Feller et al., 2003). Later, von Liebig (1840) added new, substantiated knowledgeto this standpoint by showing that plants take up nutrients in the form of dissolvedsalts. von Liebig introduced the 'Law of the Minimum', meaning that crops requirea minimum of mineral substances for growth. von Liebig (1840) wrote that'even to great leaders in plant physiology, carbonic acid, ammonia, acids and basesare sounds without meaning, words without sense, terms of an unknown language,which awake no thoughts and no associations'. von Liebig proved that humus is nottaken up by crops as such but is a source of plant nutrients released in water-solubleform. He provided the missing knowledge for understanding how humus acts insoil, and thereby corrected and complemented the humus theory with a mechanisticexplanation. He showed that independent of origin, a number of essential

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elementsdissolved in the soil solution act as plant nutrients, and this concept forms the basisfor modern plant nutrition.

Water-Solubility of Nutrients Supplied with Organic Fertilisers and Untreated Minerals

Artificial fertilisers are excluded in organic agriculture, primarily due their functionof directly feeding the crop, which is the result of their high or complete solubility inwater. However, a closer examination of natural products used in organic agriculturereveals that these products can also be highly water-soluble (see Table1). For example,urine contains more than 94% of its nitrogen as soluble ammonium/ammonia(e.g. Kirchmann and Pettersson, 1995) and animal slurries contain 50–70% of totalN as ammonium (e.g. Bernal et al., 1993). Ulen (1984) found that up to one-third ofthe P content from clover/grass leys was released upon freezing. The vacuole of eachmature plant cell contains most of the plant potassium, phosphate, calcium and magnesium,which are released upon freezing or mechanical destruction of the plant.Ploughing under of green manure crops also provides substantial amounts of solubleminerals to the soil. The release of P and K from fresh, unground barley strawhas been shown to amount to 60 and 90%, respectively, of its total content uponcold-water leaching, with inorganic ions being the main form.Moreover, a number of natural minerals approved for organic agriculture are highlywater-soluble, e.g. halite (NaCl), kieserite ($MgSO_4 \times 2\ H_2O$), crude potassium salts e.g. kainit ($KMg(ClSO_4)4 \times 11\ H_2O$), and ash containing e.g. potash (K_2CO_3). Incontrast, even artificial fertilisers may not be completely water-soluble, for exampledi-ammonium phosphate of fertiliser grade quality contains 5–20% water-insolublephosphates.

Dynamics of Nutrient Release from Organic Matter in Soil

Inorganic ions present in or released from organic fertilisers are identical to ionsreleased from artificial fertilisers. Nutrient uptake by crops is mainly through inorganicions, with organic nutrient uptake being of minor importance. As plant roots do not distinguish betweensolutes due to origin, except for possible discrimination against heavier isotopes,ions derived from artificial fertilisers or natural materials are involved in the sameprocesses in the soil and in the crop. In other words, a molecule, for example,ammonium in slurry or in nitrogen fertiliser, undergoes the same reactions in soilsince the chemical properties of a molecule are not affected by its origin. However,despite identical characteristics of soluble nutrients derived from organic manures,untreated minerals or artificial fertilisers, a sophisticated argument against artificialfertilisers has been presented by the founder of organic-biological agriculture. It is pointed out that the dynamic release of nutrients from soilorganic matter and the availability of nutrients over time is the main difference. Artificialfertilisers cause a high initial nutrient concentration in soil solution upon addition,but it is assumed that there is synchrony regarding the releaseof nutrients from soil organic matter and the demand of growing crops. Addition ofartificial, soluble salts is regarded as by-passing nutrient release from the soil and isthus considered an unnatural form of supply.

It can be argued that cold-temperate climatic conditions have no representativenessand therefore limited relevance as proof of evidence. In fact, analysis of biologicalactivity in soils in different climatic zones in Africa (Andren et al., 2007)has shown that there is better synchrony between release and uptake of nutrientsunder warm climatic regimes. Crops are sown at the beginning of a rainy periodand nutrients are only released during crop growth. However, synchrony between

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nutrient release and crop demand under certain climatic regimes does not mean thatsufficient nutrients are released. Crops may still suffer from undernourishment orimbalances when only supplied with nutrients from soil biological actions.

Table 1 Water-solubility of organic materials, wastes and minerals approved for organic Agriculture

Type of material and nutrient	Water-solubleportion (%)
Organic wastes	
Animal slurry–N	50–70
Animal dung-N (anaerobicstorage)	51–75
Urine–N	94
Green manures and crop residues	
Clover/grass foliage-P	11–33
White clover foliage-N	36–41
Potato haulm-N	35
Barley straw-N	33–58
Barley straw-P	60
Barley straw-K	90
Industrial wastes	
Vinasse-K	100
Untreated minerals	
Kieserite–Mg and S	100
Kainit-K	100
Halite-Cl	100

Nutrient Balances of Organic Farms

The strategy of being independent of nutrient purchaseaccording to the ideal of a self-sustaining system has no scientific support. Organicsystems are not sustainable without purchase of nutrients, and use of off-farmproducts is necessary to counteract depletion and keep deficits of P and K to a minimum.However, despite removed nutrients being replaced through purchase, thereis concern that the level of available plant nutrients in soil may decrease. Nutrientsbecome less plant-available in organically managed soils over time, a subject whichis addressed below.

Conventional Agriculture as a Nutrient Supplierof Organic Systems

Despite official regulations, organic agriculture is relianton nutrients derived from conventional farming and is not sustainable withrespect to nutrient supply. This dependence, and thus non-sustainability, is seldomrecognised or pointed out. Moreover, the reliance of organic systems on productionsystems fertilised with inorganic fertilisers cannot be maintained if a large proportion of conventional farms convert to organic agriculture. If organic farming wereto become the dominant form of agriculture, there would be no surplus of fodder,straw or manure. The transfer of nutrients from conventional to organic productionwould stop and only

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untreated minerals would remain purchasable for organicfarms.Applying organic cropping principles on previously nutrient-fortified soils has atleast two consequences. The plant availability of nutrients in soil again declines tolow levels similar to those before application of artificial inorganic fertilisers, sinceorganic agriculture can only apply less soluble nutrient sources. Thus, the pool ofplant-available nutrients is mined and not replaced. Furthermore, yields may fail toincrease and may even decline over time.

CONCLUSION

The organic principle of excluding water-soluble fertilisers and fertilising thesoil rather than directly feeding the crop with nutrients has no basis in science.It is also important to note that input of fullywater-soluble nutrients to soil also takes place on organic farms through organicmaterials.While the soil biological community on organic farms may differ from thaton conventional farms, it cannot compensate for the lack of readily availablenutrients in fertilisers.

Two major conditions determine the sustainability of an agricultural system.Firstly, plant nutrients removed or lost from soil must be replaced to avoid depletion.Secondly, the availability of nutrients to plants must be maintained. Boththese conditions are far more difficult to fulfil through organic agriculture thanthrough conventional fertilisation practices.

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Conservation Agriculture (CA) for Climate Change and Sustainable Intensification

Article id: 22431

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INTRODUCTION

Climate change has great impacts on agricultural productivity by modifying agricultural production systems worldwide. Plant response to climate change is dictated by complex interactions among carbon dioxide, temperature, solar radiation and precipitation (Hatfield *et al.*, 2011). It is observed be many studies that climate change has reduced growth in crop yields by 1-2% per decade over the past century, and adverse impacts are projected to be increase in the coming future (IPCC, 2014). The World Bank, recognized five major factors through which climate change affects agricultural productivity and these are; changes in precipitation, temperature, carbon dioxide fertilization, climate variability, and surface water runoff. Crop productivity is directly influenced by precipitation and temperature.

The effects of carbon dioxide (CO_2) fertilization on crop yields and yield response for C_3 and C_4 crops to elevated CO_2 concentrations will be varied. The CO_2 concentrations levels in 2020 and 2050 are expected to be consistent. Thus, for 2020 crop yield is expected to increase by 5.5 and 2.4% at 418 ppm for C_3 and C_4 crops, respectively. CO_2 concentration levels in 2050 are expected to be 522 ppm, increasing C_3 crop yields by 12.6% and C_4 crop yields by 5.2%. However, the CO_2 fertilization effect is not strong enough to compensate world food losses caused by higher temperatures and uncertain availability of water for farming (Meena and Jha, 2018). The world food production is expected to decrease by around 2.5% due to the complex interactions between precipitation-temperature-CO_2. A joint analysis of the main climate variables affecting agricultural production (precipitation, temperature, river flow and CO_2 fertilization) shows that global food production will decline by around 0.5% in the 2020s and by around 2.3 in the 2050s. Climate change will lead to reduction in total water use world-wide by around 1.3% in the 2020s (82 cubic kilometers) and around 2.3% in the 2050s (187 cubic kilometers). At the regional level, total water use will decline largely in the Middle East, the former Soviet Union, Southeast Asia and the United States.

Concepts and Principles of Conservation Agriculture (CA)

During the green revolution era, the approach of “more inputs–more outputs” has been followed, which is considered as ecologically intrusive and economically and environmentally unsustainable against suboptimal use of efficiency of inputs. The resource intensive agricultural production system practiced, especially during the post-green revolution era, have led to challenges like declining factor productivity, soil health deterioration, multiple nutrient deficiency, depleting water table at an alarming rate, loss of biodiversity due to monotonous crop rotations, etc., rendering the agricultural production system unsustainable (Jat*et al.*, 2016). Therefore, intensification of the agricultural system through efficient resource use remains the only available option to enhance production with no additional land use, as competition for land and water is increasing from the non-farm sectors. This warrants a paradigm shift in agronomic management optimization, not only to produce more but with a higher efficiency of production inputs, while sustaining a natural resource base and reducing environmental footprints (Jat*et al*., 2016).

The decrease in soil carbon due to tillage occurs more rapidly in the tropics due to higher temperature. Soils under intensive tillage-based farming lose their original structure, thus depriving the soil microbial population of their habitat and organic matter. The current degraded state of soil health is visible due to the effect of loss of soil biodiversity, increased soil compaction, runoff, soil erosion, infestation by pests, pathogens and weeds, reflect the current degraded state of soil health globally.

Conservation agriculture is as an approach to farming that seeks to increase food security, alleviate poverty, conserve biodiversity and safeguard ecosystem services. Conservation agriculture practices can also contribute to making agricultural systems more resilient to climate change and has the potential to contribute to the climate change mitigation. In many cases, conservation agriculture has been proven to reduce farming systems' greenhouse gas emissions and enhance their role as carbon sinks.

The conservation agriculture approach mainly based on three principles and that called as 3 Pillar of Conservation Agriculture.

1. **Minimum soil disturbance:** Zero tillage is enough, but controlled tillage can practice which causes 20-25% soil disturbances.
2. **Retention of crop residues and other soil surface cover:** 30% organic soil cover as the minimum, but ideal level is site specific.
3. **Use of crop rotations:** Crop rotation can reduce weeds, pests and diseases. Intercropping (with legumes) can be followed.

Compensations of CA

1. **Stable yield:** The water and soil conservation effects of CA helps to stabilize yields against weather extremes.
2. **Drought buffering:** The soil water content increased by CA via increasing infiltration and reducing evaporation and runoff.
3. **Reduced field preparation cost:** The costs associated with tillage and weeding are reduced by CA. In India, for mechanized rice-wheat cropping system, the field operational cost is 15% lower under CA.
4. **Reduced soil erosion:** Reducing tillage and maintaining soil cover with crop residues can reduce erosion by up to 80%. CA also generally increases soil organic matter in topsoil.
5. **Climate change mitigation:**The CA approach may contribute to climate change mitigation through carbon sequestration and reduced GHG emissions.

Challenges to adopt CA

Even though, CA has multiple benefits, experience shows several common constraints for its adoption.

1. **Appropriate soil type:** Wetlands and soils that have poor drainage are generally challenging for CA.
2. **Sufficient availability of crop residues or other mulch:** If crop yields are very low (i.e. areas of less than 500 mm rainfall in Africa), there may be insufficient quantity of residues to effectively practice CA.
3. **Affordable access to fertilizer and herbicides:** The appropriate use of fertilizers as a complement to legume residues is necessary when initiating CA to increase crop yields and available quantity of crop residues.
4. **Weed control:** Weeds are a major challenge in smallholder cropping systems.

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5. **Delayed yield benefits: For long term yield effect of CA,** farmers may need to wait 3 to 7 years to see yield increases. It takes time for farmers to gain experience with CA, and the improvement of soil structure and fertility is a slow process.

   Existing CA technologies are not universally applicable, but innovativeskills and ideascan expand the area of conservation agriculture.

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Using plastic mulches and drip irrigation for vegetable production

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INTRODUCTION:

Plastic mulch was first used for vegetableproduction in the 1960s and more growers are usingplastics each year because of the advantages theyprovide. They are used commercially for bothvegetables and small fruit crops. Vegetable cropsthat are well suited to production with plastic mulchare typically high value row crops. Muskmelons, tomatoes, peppers, cucumbers, squash, eggplant, watermelons, and okra are vegetable crops that have shown significant increases in earliness, yield, and fruit quality when grown on plastic mulch. Some less-valuable crops such as sweet corn, snap beans, southern peas, and pumpkins have shown similar responses. Some of the advantages and disadvantages of using plastic mulches are outlined below.

ADVANTAGES:

1. **Increased soil temperature:** At a 2-inch depth: 4 to 5^0F under black mulch, 5 to 8^oF with infrared transmitting (IRT) (clear green), or 8 to 10^0F under clear mulch.
2. **Reduced soil compaction:** Soil under plastic mulch remains loose, friable and well-aerated. Roots have access to adequate oxygen and microbial activity is excellent.
3. **Reduced fertilizer leaching:** Water runs off the impervious mulch, resulting in maximum utilization of the fertilizer.
4. **Reduced drowning of crops:** Water is shed from the row area and excess water runs off the field thus reducing drowning and other excess soil water stresses.
5. **Reduced evaporation:** Soil water does not escape from under plastic mulch. Plant growth on mulch is often at least twice that on bare soil. The resulting larger plants will require more water, so mulching is *not* a substitute for irrigation.
6. **Cleaner product:** A mulched crop is cleaner and less subject to rots due to elimination of soil splashing on the plants or fruits. Note: Beds should be firm and tapered away from the row center. Plastic should be tight to promote run-off. There should be no puddles on the mulched beds!
7. **Root pruning eliminated:** Cultivation is not necessary except for the area between the mulched strips. Therefore, roots are not pruned.
8. **Reduced weed problems:** Black and IRT plastic mulch provides good weed control in the row. Clear plastic will require use of a herbicide, fumigation or lifting the mulch and cultivating. Often, weeds between mulch strips can be controlled by a herbicide.
9. **Earlier crops:** Black plastic mulch can result in 2 to 14 days earlier harvest while clear plastic can result in a 21-day earlier harvest.
10. **Increased growth:** Plastic mulch is practically impervious to carbon dioxide (CO_2), a gas that is of prime importance in photosynthesis. Very high levels of CO_2 build up under the plastic, because the film does not allow it to escape. It has to come through the holes made in the plastic for the plants and a "chimney effect" is created, resulting in localized concentrations of abundant CO_2 for the actively growing leaves.

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DISADVANTAGES:

1. **Costly to remove:** Plastic mulch and drip irrigation tube must be removed from the field annually. Black plastic does not break down and should never be tilled into the soil. Clear plastic does break down with time but leaves a messy garden. Photo- and bio-degradable plastics hold promise.
2. **Greater initial costs:** Plastic mulch and drip irrigation will increase cost of production. These costs should be offset by increased income due to earlier harvests, better quality fruit and higher yields.
3. **Increased management:** Plastic mulch and drip irrigation must be carefully monitored (daily) to be successful.
4. **Increased soil erosion:** Soil erosion increases in middles between plastic strips.

Preparation of the Soil: The first step is to take 2 soil samples in early fall. Have one sample assayed for mineral content and one for nematodes. If the soil test suggests applying lime, apply enough in the fall to reach pH 6.0 to 6.5 using dolomitic lime if magnesium is low.

Fertilization: Using the soil test report as a guide, apply fertilizer during bed preparation. Consult Horticultural Information Leaflets for specific crop recommendations. Amounts to be side dressed need to be included in the total fertilizer requirements.

Caution: Using fertilizers with ammonical N in fumigated soils can result in ammonium toxicity to the crop. Normally, at least 50% of the nitrogen (N) should be in the nitrate (NO_3) form. Use calcium nitrate (15.5-0-0), sodium nitrate (16-0-0) or ammonium nitrate (33.5-0-0) as a nitrate side dress source.

When using drip irrigation with plastic mulch, one half of the N and K and all of the P should be incorporated at bedding. The remaining N and K should be applied through the drip tube using soluble fertilizers (e.g. calcium nitrate, sodium nitrate, 20-20-20, 15-0-14, or potassium nitrate).

Bedding the Soil: Raised beds should be used. Be sure that enough soil is pulled up so that the bed has good sharp corners. Bedded rows should be spaced on 5- or 6-ft centers. A bed with a 30 inch top should slope from the center to the edge with a drop of 1.25 inches, allowing excess rainfall to run off the mulch.

Transplanting: For extra earliness in peppers and tomatoes, large containers (cell sizes 3 to 4 inches) should be used. For the other vegetable crops use 1 to 2 inch cell sizes. Transplants can be set by punching a hole in the plastic and placing the plant in the hole. When transplanting by hand, several tools can be used to make holes in the plastic such as a long handled bulb setter or a sturdy can or cylinder welded onto the end of a handle. The hole should be 2 to 4 inches wide and deep enough for the plants to be transplanted. A hand tobacco plant setter or long handled bulbsetter works well. The use of a "starter solution", a soluble fertilizer high in phosphorous (P) will often get the plants off to a good start. Examples are 12-52-12, 10-20-10, or 12-48-8.

Irrigation: Drip irrigation is recommended for use with plastic mulches although other types can be used successfully. The frequency of irrigation will depend on soil type and stage of crop growth.Irrometers at the 6-inch and 12-inch depth in the mulched bed are recommended as an aid in determining irrigation needs. Frequent probing with a soil tube near the plant row will also help to keep a check on soil moisture. Normally, the area around the drip tube is very soft to the touch and the side of the row away from the tube should be only slightly soft. Do not use plastic mulch without irrigation.

Double Cropping the Plastic Mulch: Once the first crop has been harvested, it is recommended that a second crop be grown on the mulch (**See Table 1**). This "intensive cropping" results in two acres of production from each acre of actual land. The second crop can be fertilized (1) through the drip line using soluble fertilizers and

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a fertilizer injector, (2) through overhead fertigation, or (3) by placing fertilizer in holes in the plastic between plants. Consult Horticultural Information Leaflet No. 33-C for additional information on injecting fertilizers through the drip line.

Windbreaks: Strips of rye should be established to protect vegetable seedlings from prevailing winds. Each rye strip should be 4 to 6 ft wide (6 to 8 rows) and far enough apart to plant 5 or 6 rows of vegetable seedlings. Well-grown rye strips planted in the fall will promote earliness and provide protection for the young transplants. Spring topdressing in February will help assure a good thick rye stand.

Reflective Plastic Mulches: The reflective properties of aluminum-faced plastic have been shown to interfere with the movement of aphids which spread the watermelon mosaic virus. This virus causes the green streaking in yellow squash during fall planting. By using this mulch, a gardener is able to harvest solid green or yellow squash for a longer period of time in the fall. Also, painting the plastic with aluminum paint or white paint increases its reflectivity and cools soil for later planted crops, thus causing less stress and resulting in better fruit quality.

Infrared Transmitting (IRT) Mulch: Infrared transmitting (IRT) mulch is a recent development. These plastics transmit the warming wavelengths of the sun, but not those that allow weeds to grow. These materials result in warmer soils than black plastic, but cooler soils than clear plastics. The IRT mulches retard the growth of weeds including nutsedge. Crops grown on IRT mulch will develop 7 to 10 days earlier than crops grown on black plastic.

CONCLUSION: Consider advantages such as seasonextension, water savings, and weed controlover the increased costs of using plasticmulch.

• Determine if additional equipment will beneeded for your operation.
• Choose from the various types, thicknesses,and colors of mulch available.
• Take particular care to prepare fields andinstall plastic correctly to fully realizebenefits.
• Decide on planting method and choose

Table 1: Comparison of the effect of different colors of plastic on light and weed control.

Plastic Color	SoilTemp. (2-4''depth)	Light Reflectivity	Light Absorptivity	Light Transmission	Weed Suppression	Comments
Black	Increases (3 to 5 °F)	Low	High	Low	Excellent	Most common. Does well in temperate climates.
Clear	Increases (4 to 16 °F)	Low	Low	Very high	Poor	Best in cool regions and for fall crops.
White/ silver	Decreases (-2 to 0.7 °F)	High	Low	Low	Excellent	Reflection interferes with movement of aphids. Best for tropical climates.
Infrared	Increases	Low	High	High	Excellent	Selective light transmission.Transmits

Transmitting (IRT)	(5 to 8 °F)					the sun's warming wavelengths (like clear), but not those that allow weeds to grow (like black).

(Angima 2009, Penn State Extension 2015, and Sanders 2001.)

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IPM approach for thrips management in vegetable and ornamental crops

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INTRODUCTION

Thrips are among the most important pests of horticultural and ornamental crops globally. Thrips reduces yield and value of the crop directly by using them as food and oviposition site and indirectly by transmitting viral diseases. Their infestation can negatively impact global trade due to the quarantine risks associated with several species in the order. Thrips are tiny slender insects with fringed wings comes under the order Thysanoptera. The majority of scientific literature related to economics of thrips deals with four globally important thrips species. Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), is one of the most destructive insect pests of commercial greenhouses worldwide, feeding on a wide variety of horticultural crops. The chilli thrips, *Scirtothrips dorsalis* Hood, is an important pest of various vegetable, ornamental and fruit crops in southern and eastern Asia, Africa, and Oceania and is one of the limiting factors for chili production in India. Onion thrips, *Thrips tabaci* Lindeman, is a major pest of importance in commercial onion production in India and Asian countries with significant yield losses. Melon thrips, *Thrips palmi* Karny is a polyphagous species, but is best known as a pest of *Cucurbitaceae* and *Solanaceae*.

Damage caused and symptoms of thrips infestation

The pest status of thrips can be attributed to its polyphagous nature, high reproductive rate, short generation time, high survival of cryptic (nonfeeding prepupa and pupa) instars, ability to reproduce without mating (parthenogenesis), ability to transmit plant pathogens, and development of resistance to insecticides. They feed by puncturing the epidermal (outer) layer of host tissue and sucking out the cell contents, which results in stippling, discoloured flecking, or silvering of the leaf surface. Thrips feeding on plants can damage fruit, leaves, and shoots and very noticeably affect plants cosmetic appearance. Extensive feeding can stunt plant growth and causes damaged leaves to become papery and distorted, develop tiny pale spots and drop prematurely.

Apart from causing direct damage by feeding on its host, several thrips also transmits a number of deadly viral diseases to plant. Chilli thrips, *S. dorsalis* vectors seven plant viruses including chilli leaf curl virus (CLC), peanut necrosis virus (PBNV), peanut yellow spot virus (PYSV), tobacco streak virus (TSV), watermelon silver mottle virus (WSMoV), capsicum chlorosis virus (CaCV) and melon yellow spot virus (MYSV). Western flower thrips also transmits Tomato spotted wilt virus (TSWV), which can severely damage or kill certain vegetable crops. Onion thrips is known to transmit (TSWV), tomato yellow fruit ring virus (TYFRV), and impatiens necrotic spot virus (INSV) in other crops.

Thrips management - An integrated approach

Incursions of thrips are difficult to control due to their inconspicuous nature. IPM is an approach that aims to reduce pest status to tolerable levels by using methods that are effective, economically sound while minimizing environmental impact. Effective management of thrips can be achieved through integrated program that combines the regular pest monitoring, use of natural enemies, good cultural practices, and the use of most selective and least-toxic insecticides.

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Monitoring of thrips infestation

Early detection and regular monitoring of insect pest infestation in field is the key to implement integrated pest management tactics. One essential component of IPM is field monitoring/scouting and growers use information gathered from scouting to select and schedule appropriate control tactics.

One method frequently used for detection of thrips infestation is branch beating or gently shaking foliage. If thrips are a suspected cause of plant damage, thrips adults and larvae can be monitored by branch beating or gently shaking foliage or flowers onto a light-colored sheet of paper, beating tray, or small cloth. For thrips that feed in buds or unexpanded shoot tips, clip off several plant parts suspected of harbouring thrips, place them in a jar with 70% alcohol (ethanol), and shake vigorously to dislodge the thrips. This method can be effectively used in greenhouse and small farms.

Among other monitoring methods, use of blue and yellow sticky traps has been demonstrated to be helpful for evaluating the degree of thrips infestation in various greenhouse and field crops. Additionally, sticky traps can also provide a way to control pest insects on various crops.

Biological Control

Natural enemies of insect pests play a key role in reducing the levels of pest populations below those causing economic injury. Both natural and applied biological control tactics can be important in successful management of pest populations.

Various biological control agents, including predatory thrips, green lacewings, minute pirate bugs, mites, and certain parasitic wasps help to control plant-feeding thrips. Minute pirate bugs, *Orius* spp. (Hemiptera: Anthocoridae) and entomopathogenic nematodes, *Thripinema* spp. (Tylenchida: Allantonematidae), have been reported to effectively control field populations of the chilli thrips. Adults of *Orius insidiosus* feed on all the life stages of thrips. *Orius insidiosus* also feeds on aphids, mites, moth eggs and pollen, its population does not decline strongly even if thrips populations are drastically reduced. Two phytoseiid mites, *Neoseiulus cucumeris* and *Amblyseius swirskii*, are potential biological control agents of the chilli thrips. *Amblyseius swirskii* can be a promising tool in managing chilli thrips on pepper.

Thrips parasitoids are found in three families (Eulophidae, Trichogrammatidae, Mymaridae) and several genera. Eulophid wasps in the genera *Ceranisus*, *Thripobius*, *Goetheana*, *Entedonastichus* and *Pediobius* are solitary internal parasitoids of thrips larvae. Other natural enemies like lacewings, *Chrysoperla* spp., ladybird beetles predatory thrips, such as *Franklinothrips vespiformis* (vespiform thrips), *Scolothrips sexmaculatus* (sixspotted thrips), *Selenothrips rubrocinctus* (redbanded thrips), *Leptothrips mali* (black hunter thrips), and predatory phytoseiid mites, such as *Amblyseius* spp., *Euseius hibisci* and *Euseius tularensis* also effectively control field population of thrips.

Cultural Control

Cultural controls are prophylactic method to avoid or restrict the pest infestation. Because cultural controls are preventative rather than curative, they need long-term planning. Following are cultural practices for effective management of thrips.

- Avoid planting susceptible alternate hosts plants near the main crop.
- Control of weeds which act as alternate hosts.
- Use thrips resistant cultivars.
- Provide appropriate cultural care to keep plants vigorous and increase their tolerance to thrips damage.

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- Installation of blue and yellow sticky traps
- Keep plants well irrigated, and avoid excessive applications of nitrogen fertilizer, which may promote higher populations of thrips.
- Prune and destroy injured and infested terminal plant parts.

Reflective mulching

Mulch or mesh that reflects light interferes with certain flying insect's ability to locate plants. Reflective plastic mulch, or silver colored plastic mulch, significantly reduces arthropod pests such as thrips, spider mites, and whiteflies. Thrips locate suitable host plants part through visual cues in the UV spectrum, materials that reflect UV radiation could obscure host location cues used by thrips. The light reflection repels and confuses these pests, with often controlling pest more effectively than insecticides. In addition to repelling certain flying insects, mulch may improve growth of certain crops by increasing light levels, keeping soil warmer overnight, reducing weed growth, and conserving soil moisture. Organic mulch, such as wood chips, cover crop residues, or straw, can reduce thrips and leaf miner numbers significantly. Silver or gray is the most effective color for synthetic reflective mulch.

Insecticides compatible with thrips IPM

Contact insecticides that do not leave persistent residues can be effective for greenhouse thrips and other species that feed openly on plants. Contact insecticides include azadirachtin, insecticidal soaps, narrow-range oil, neem oil, and few pyrethrins combine with piperonyl butoxide are effective for thrips and safe for natural enemies and pollinators. To be effective, contact sprays must be applied to thoroughly cover buds, shoot tips, and other susceptible plant parts where thrips are present.

Spinosad is more effective against thrips due to its longer persistence and translaminar activity to reach thrips feeding site in protected plant parts. Adding horticultural oil to the spray mix can increase its persistence within plant tissue.

Insecticides to avoid for thrips IPM

Neonicotinoids have low, moderate, or severe adverse impact on natural enemies and pollinators varying with the product, situation, and the species and life stage of invertebrate. Imidacloprid commonly fails to provide satisfactory thrips control, and generally is not recommended for thrips. Neonicotinoid insecticides can translocate to flowers and may harm natural enemies and pollinators that feed on nectar and pollen.

Acephate can be highly toxic to natural enemies and pollinators and can cause spider mites to become abundant and damage plants after its application. Avoid foliar sprays of other organophosphate insecticides (e.g., malathion), carbamates (carbaryl), or pyrethroids (e.g., bifenthrin, cyfluthrin, fluvalinate, and permethrin). These materials are highly toxic to natural enemies and pollinators, can cause spider mite outbreaks, and are not particularly effective against most thrips.

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CONCLUSION

Thrips are hard to control pest and their management is difficult by traditional pesticides. Its successful management is only possible with early detection and immediate implementation of integrated pest management approach. Use of plastic ultraviolet (UV) reflective mulches is the promising cultural control method. Growing vegetables on plastic mulches is a standard cultural practice because these materials provide several benefits, including improved retention of irrigation water and soil moisture, conservation of soil applied fertilizers, modulation of soil temperatures, and weed suppression. Although thrips damage is unsightly, it does not usually warrant the use of insecticides in gardens and landscapes. Thrips can be difficult to control effectively with insecticides, partly because of their mobility, feeding behavior, and protected egg and pupal stages. If insecticides are used, combining their use with appropriate cultural practices and other methods usually improves the pest control.

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Major threat for onion growers - Purple Blotch and Stemphylium Leaf Blight

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Onions are a cold season crop that requires a long growing season to produce high quality bulbs and good yields. Medium to light loam soils with good drainage system are best suited for onion cultivation. Onions have limited root systems so irrigation is essential, especially in dry years. Weed control is also dangerous and complex, and on most farms is the most limiting factor in onion production. Onion can be a very easy-to-grow herb in the garden, though it is also prone to several diseases.

In a Survey and monitoring of major diseases of onion. The maximum intensity of stemphylium blight (6.40%) and purple blotch (1.80%) disease were recorded in onion crop during 2017 at Nashik. At Karnal, higher intensity of stemphylium blight (14.58%) was recorded in onion crop in 2017.

Major diseases this crop:

I. Purple Blotch
II. Stemphylium Leaf Blight

Purple blotch of onion is caused by the pathogen *Alternaria porri*. It is an important disease in warm, humid onion-growing regions throughout the world. Most long-day onion cultivars are susceptible, but sweet Spanish onions are generally more susceptible than common yellow cultivars. All short-day cultivars are susceptible.

Symptoms:

Purple Blotch disease of onion occurs mainly at the top of the leaves, the infection primarily starts with whitish minute dots on the leaves with irregular chlorotic areas on tip portion of the leaves. Circular to oblong concentric black velvety rings appear in the chlorotic lesion. The lesions of this disease develop towards the base of the leaf. The spots come together and spread rapidly to the entire leaf area. The leaves gradually die from the tip to downwards.

The disease frequently begins on older leaves as small, sunken, water soaked lesions with light centers. Lesions enlarge as disease progresses and turn purple to brown, often with yellow rings that produce a distinctive bull's-eye pattern. Leaves turn yellow/brown and wilt, and may be girdled. Younger leaves turn out to be more susceptible as the bulb matures. Onion bulbs may become infected through neck wounds. Yields may be reduced due to undersized bulbs and diseased bulbs may rot in storage. Bulb rot symptoms begin as soft, water-soaked areas, eventually; bulbs turn dark reddish to purple, and then convert in to brown to black. Pathogen of this disease *Alternaria porri* mycelium is branched, coloured and septate. Conidiophores arise singly or in groups. Conidiophores are straight or flexuous, sometimes geniculate.

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Purple Blotch

Stemphylium Leaf Blight

Disease cycle:

The pathogen overwinters in crop residue on or near the soil surface. Spores are produced and new plants infected during periods of warm (77-85°F) humid climate. Symptoms appear 1- 4 days after infection; black spores are produced by fresh lesions within 5 days. Spores of this pathogen produced at night and released in the morning as humidity decreases. The spores are disseminating by wind and splashing rain or irrigation. Typical lesions occur when the leaf wetness duration is ≥ 16 hours; flecking may occur at 12 hours. Purple blotch and Stemphilium leaf blight sometimes occur on the same plant. Microscopy is necessary to distinguish the two fungi; though, control measures for both species are the same.

CONTROL:

Cultural practices:

Management of disease starts with pathogen-free seed/bulbs. Proper spacing of plants and regular weeding will increase air circulation and decrease the duration of leaf wetness. Avoid excessive nitrogen. Rotate out of onions for at least three years. Field sanitation is important; remove or plow under plant debris, and cull volunteer plants. Infected plant material should be buried deeply. Harvest in dry weather and avoid injury to the necks. Allow onions to cure properly before leaf removal. Store at 34-38°F and humidity 65-70% in a well-aerated cooler. Control onion thrips if they are present, as plants weakened by thrips infestation are more susceptible to disease.

Chemical practices:

Seeds ought to be treated with Thiram @ 4 g/kg seed. The field should be well drained. Purple blotch and stemphylium blight are the major diseases. Three foliar sprayings with spray of Mancozeb @ 0.25% or Chlorothalonil @ 0.2% or Iprodione @ 0.2%, copper oxychloride 0.25 % or Chlorothalonil 0.2 % or Zineb 0.2 % or Mancozeb 0.2 %, is recommended. Colletotrichum blight is new disease in some pockets. Spray of Carbendazim @ 0.1% or Benlate @ 0.1% should be advocated. Mixing of sticker Triton @ 0.06% is must for effective control. Thrips is a major insect pest. Application of Cypermethrine 25 EL @ 0.01% or Deltamethrine @ 0.01% alongwith Triton should be advocated.

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Pest and Disease Management of Isabgol, *Plantago ovata*: A Medicinal Plant

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INTRODUCTION: India is a rich source of medicinal plant. Isabgol (*Plantago ovata* Forsk) is one of the most important medicinal plant in the Unani and Ayurvedic system of medicine. This plant belongs to family Plantaginaceae and consists of their genera and about 200 species. *P. ovata* is an annual and economically important crop, traditionally cultivated in Rajasthan, Gujarat and some part of Madhya Pradesh. In Gujarat, it is grown in North Gujarat, Saurashtra and Kachchh region. The medicinally important "husk" is derived from the seed coat of *Plantago ovata.* The milled seed mucilage is a white fibrous material that is hydrophilic (water loving). India is the sole supplier of seeds and husk in the international market, holding first ranks in production (98%) and fetching worth more than Rs 35 million annually. Isabgol contains a significant amount of proteins and husk yields colloidal mucilage which is valued for medicinal application and used in aryurvedic, Unani and allopathic systems of medicines. The mucilage has medicinal properties and used against constipation, irritation of digestive tract colon cleansing, controls acidity, checks cholesterol, improves digestion and having anti-diabetic property, etc. Isabgol cultivation requires cool and dry weather during the cropping season hence generally it is sown during winter months. The average yield of the seeds comes to 800-1000 kg/ha under the appropriate condition. Both biotic and abiotic factors significantly affect the production and yield of the crop. Rainfall at the flowering stage of the crop may cause 100% yield losses of the crop. But in recent years, the yield is also reduced due to some biotic factors (pest and diseases*).* The major pest is Aphid- *Aphis gossypii* Glover, White grub- *Holotrichia consanguinea,* Seed beetle – *lasiderma serricorne,* and minor significance are Hairy caterpillar (*Spilarctia oblique*), Looper (*Hyposidra successaria*), Tobacco caterpillar (*Spodoptera litura),* Gram pod borer (*Helicoverpa armigera*), whereas disease downy mildew, wilt and Leaf blight of Isabgol.

1. **Aphid** - *Aphis gossypii* (Homoptera: Aphididae): The crop is attacked by number of insect pest, out of which aphid, *Aphis gossypii* Glover is the major pest. Aphids are generally appeared 50-60 days after sowing or at the flowering stage. Both nymph and adults damage the crop in colonies as well as individually by piercing into cell sap. Consequently leaves become yellowish to brownish colour, curling of leaves started and plant gradually wilted. The aphid excreted honeydew like secretion on the plants and it will serve for black fungus growing and this will be interfering the photosynthesis activity of plants.

Management:

- Conservation of natural predators viz., coccinellid beetles, syphrid and chrysopids (*Coccinella transversalis, Coccinella septempunctata, Cheilomenes sexmaculata, Scymnus quadrellum, Chrysperla carnea, Ischiodon scutellaris*) suppress the population of aphids to great extent.
- Augmentation of coccinellids at 15 days interval during the crop season @ 4000 adults/ha suppress the population of aphids significantly.
- In severe infestation application, the neem-based formulation is preferred as a control measure like Neem oil 0.2% at weekly interval. However, two sprays of Oxydemeton methyl (Metasystox25 EC) is recommended to effective control of this pest.

2. **White grub** - *Holotrichia consanguinea: H. consanguinea* is pre-dominant in isabgol growing areas of Gujarat and Punjab region. These pests are commonly present throughout the year but their activity can see in only during the rainy season (May to December). Adults emerge large numbers in evening hours of the first monsoon in mid-May or

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June months. Once the mating process is completed again they enter into the soil and continue their life cycle in the soil itself. Normally these insects prefer the light clay soils and complete only one generation in a year. where grub is the damaging stage and cause significant loses to crop.

Management:

- Take up deep summer ploughing if irrigation facility is available to expose the pupa to sun radiation and predation by bird's species.
- Crop rotation with sorghum for reduces the infestation level.
- Incorporate carbofuran 3G or phorate 10G in soils before sowing.
- The fungus application of *Metarhizium anisopliae* or *Beauveria brongniartii* 2.5*1012 spores/ha is found effective for immature stages.
- Seed treatment with Chlorpyriphos 20EC @ 6.0-12.0 ml/kg seed.
- Place light traps @ 1 trap/ha between 7 PM to 10 PM after receipt of first monsoon rains.
- Spray insecticides such as imidacloprid 17.8SL @ 1.5 ml/lt during the evening hours on trees and shrubs of the surrounding areas.

3. **Downy mildew**- *Pseudoperonospora plantaginis*: Downy mildew of Isabgol is an important disease in isabgol growing area especially Gujarat and Rajasthan and causing considerable loss during last few years. The disease severity usually recorded more than 50 per cent and severely diseased plants showed a significant reduction of seed yield. Soil containing plant debris is the source of primary inoculum for the downy mildew disease. The flowering stage of plants is the highly susceptible stage compared to younger and older plants. Most congenial conditions for disease development are maximum temperature between 10-20ºC with due precipitations.

Management:

- Avoidance of late sowing, higher seed rate, the higher dose of nitrogen fertilizer and frequent irrigation application otherwise crop will more susceptible to diseases.
- Seed treatment of Metalaxyl @ 5g/kg seed was found effective in controlling the seedling infection.
- Seed treatment with Metalaxyl (Apron 35 SD @ 5 g/kg seed combined with three
- Foliar sprays of Ridomil MZ-72 WP 0.2 % at an interval of 15 days provide a good disease control.

4. **Fusarium wilt** - *Fusarium oxysporum*: Wilt is another economical important and widely spread disease in isabgol and cause a significant yield loses in the crop. The fungus may cause infection at any stage of the plant from the seedling to maturity. The infected plant produces two types of symptoms, under dry condition typical wilting symptom appears on the outer whorl, where leaves dried and turned silvery in colour, whereas in moist condition rotting symptoms on collar region and cortical roots of the plants.

Management:

- Seed dressing with carbendazim@ 3g kg-1 along with the *Trichoderma viridae* enriched neem cake mixture before sowing found the most effective control measure of wilt disease.
- Drenching the soil and spraying with 0.2% carbendazim solution and repeating the same solution after a week of the first application for mange and spread this disease.

CONCLUSION: *Plantago ovata* is one of the major medicinal crops commodities, having international value and industrial significance. Among the medicinal plants, Isabgol is the first ranking foreign exchange earner in India. But same time some of the biotic factor contributing for yield losses of this crop, in that *Aphis gossypii* and Downy mildew are the major constraints. Timely monitoring and effective eco-friendly management are necessary for control of this pest and diseases for good production of isabgol seed yield.

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Properties of Honey, Propolis, and Royal Jelly

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INTRODUCTION:

Apiculture is the science and art of prolonging, sustaining, and retaining health by using products obtained from honeybee hives, such as honey, bee bread, bee venom, bee pollen, propolis, and royal jelly.Recent years have seen growing interest on the part of consumers, the food industry, and researchers into food and the ways in which it may help maintain human health. The important role that diet plays in preventing and treating illness is widely accepted. Among foods that possess the characteristic of functionality, we may include all those originating in the beehive: honey, propolis, and royal jelly. Honey forms part of traditional medicine in many cultures, although it is most widely used ´ as sweetener. It is composed of at least 181 components and is basically a solution supersaturated in sugars, the fructose (38%) and glucose (31%) are the most important ; the moisture content is about 17.7%, total acidity 0.08%, and ashes constitute 0.18% (Nagai *et al*., 2006). In addition, there is a great variety of minor components, including phenolic acids and flavonoids, the enzymes glucose oxidase and catalase, ascorbic acid, carotenoids, organic acids, amino acids, proteins, and α-tocopherol. The actual composition of honey varies, depending on many factors such as the pollen source, climate, environmental conditions. Propolis is a resinous substance that bees collect from the exudates of plants and which they use to seal holes in the beehive. Propolis, too, forms part of traditional medicine, and chemical analysis has pointed to the presence of at least 300 compounds in its composition. It is mainly composed of resin (50%), wax (30%), essential oils(10%), pollen (5%), and other organic compounds (5%). Caffeic acid phenethyl ester (CAPE) is a biologically active ingredient of propolis with several interesting biological properties, including apoptosis, metastasis, and radiation sensitivity of cancer cells.Royal jelly is the exclusive food of the queen honeybee (*Apis millifera*) larva. Chemically royal jelly comprises water (50% to 60%), proteins (18%), carbohydrates (15%), lipids (3% to 6%), mineral salts (1.5%), and vitamins together with a large number of bioactive substances such as: 10-hydroxyl2-decenoic acid with immune modulating properties, antibacterial protein, fatty acids, and peptides. The royal jelly also demonstrated significantly improved the recovery from 5- fluorouracil-induced damage.

- **Properties:**
- **Phenolic Compounds :**

Phenolic compounds in their many forms are the main components responsible for the functional properties associated with many foods, such as antioxidant capacity, antibacterial capacity, antiviral capacity, anti-inflammatory capacity, cardio-protective effect, and the prevention of enzymatic browning. Among these foods, we may include honey, propolis, and royal jelly since they contain phenolic compounds collected by the bees from the plants where they gather nectar.The main groups of phenolic compounds present in plants, whether in free form or as glucosides, are derivatives of cinnamic acid, cumarins, and flavonoids. In honey, propolis, and royal jelly, most of the phenolic compounds are in the form of flavonoids, whose concentration depends on various factors, including plant species used by the bees, health of the plant, season, environmental factors, and so on.

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- **Antioxidant Capacity**

During recent years, functional foods have attracted growing attention because of consumers' increasing concerns about their health, which has spurred greater research effort into such foods. One of their most important properties is their antioxidant capacity, which contributes to the prevention of certain illnesses, including cardiovascular diseases, cancer, and diabetes. The importance of protecting cell defense systems against the damage caused by oxygen is well known. Free radicals and other oxidative agents are of great importance in the action mechanism of many toxins. These radicals induce oxidative damage in biomolecules, such as carbohydrates, proteins, lipids, and nucleic acids, which may alter the cell and provoke its death. The tissues of living organisms possess their own protective agents against oxidative damage, mainly ant oxidative enzymatic systems such as superoxide dismutase, catalase, peroxidase, and low molecular weight molecules such as tocopherol, ascorbic acid, and polyphenols. The undesirable effects of oxidation reactions in foods also have to be taken into account because of the resulting reduction in their shelf life. These effects include unpleasant odors and flavors, color loss, and the loss of nutritional values.

- **Anti-Inflammatory Capacity**

The inflammatory process is triggered by several chemicals and/or biologicals, including pro-inflammatory enzymes and cytokines, low molecular weight compounds such as eicosanoids or the enzymatic degradation of tissues. According to several studies, the enzyme most related with the inflammatory process is cyclooxygenase-2 (COX-2), an isoform of cyclooxygenase (COX), which catalyses the transformation of arachidonic acid to prostaglandin. The other isoform is cyclooxygenase-1 (COX-1), which regulates homeostasis processes (Dao *et al*., 2004). In the last 30 year, many studies have pointed out the anti-inflammatory properties of honey and propolis, properties due basically to the presence of flavonoids that inhibit the development of inflammation provoked by a variety of agents. Among these flavonoids, galangin is of particular interest. This compound is capable of inhibiting cyclooxygenase (COX) and lipo-oxygenase activity, limiting the action of polygalacturonase, and reducing the expression of the inducible isoform of COX-2. Another compound, caffeic acid phenethyl ester (CAPE), also present in propolis, shows anti-inflammatory activity through inhibiting the release of arachidonic acid from the cell membrane, which leads to the suppression of COX-1 and COX-2 activity and inhibits the activation of the genic expression of COX-2. These data were confirmed by the studies of Lee *et al*., 2004.

- **Inhibition of Enzymatic Browning in Fruits and Vegetables**

Enzymatic browning seriously affects the quality of foods. The action of polyphenol oxidase is responsible for this process in fruits and vegetables, while in crustaceans it prevents melanosis, provoking the appearance of brown colors, unpleasant smells, and generally unfavorable effects on the nutritional value of foods. The browning reactions induced by this enzyme have traditionally been countered by using chemical substances such as citric acid, ascorbic acid, and sulfites. However, the high cost, restricted action periods, and potential health hazards of some of these products limit their use in food. Sulfites are the most potent substances in preventing browning but their use may induce asthma attacks or anaphylactic reactions in susceptible subjects. For this reason, there is a search for natural substances that have the same effect, while not inducing harmful reactions

- **Antiviral Properties**

Propolis and its derivates have the capacity to inhibit virus propagation. Several in vitro studies have shown the effect of propolis on the DNA and RNA of different viruses, among them Herpes simplex type 1, Herpes simplex type 2, adenovirus type 2, vesicular estomatitis virus, and poliovirus type 2. The effects observed involve a reduction in viral multiplication and even a virucidal action. It has also been claimed that various propolis fractions affect the replication of viruses such as vaccinia virus and the virus responsible for Newcastle disease. Substances isolated from propolis have also been seen to have antiviral activity. For example, isopentyl ferulate inhibits the infectious activity of Hong Kong virusA . In studies by Critchfield *et al*., 1996, it was seen that characteristic honey flavonoids, like chrysin, acacetin, and apigenin, inhibit the activation of HIV-1 in latent models of infection through a mechanism that probably includes inhibition of viral transcription. Two of the flavonoids present in propolis (chrysin and campherol) have also been studied and were seen to be very active in the inhibition of replications of several herpes viruses, adenovirus, and rotavirus, while other flavonoids, which are responsible for antioxidant activity (galangin and acacentin) had no effect on these viruses (Amoros *et al*., 1992b).

- **Anti-Ulcerous Properties**

Another of the functional properties of both honey and propolis is their anti-ulcerous capacity. Several studies describe such activity in honey and, once again, this ability has been attributed to the presence of phenolic compounds, particularly the flavonoids (Gracioso *et al*., 2002). The action mechanism of these compounds varies: according to Speroni and Ferri (1993), flavonoids increase the mucosal content of prostaglandins, which enhances the protective effect on the gastric mucosa, thus preventing ulceration. Vilegas and others (1999) also mention how the flavonoids increase the mucosal content of prostglandins and have an important inhibitory effect on acid secretions, preventing the formaton of peptic ulcers. Other researchers (for example, Martin *etal.,* 1998) argue that ulcers are related with reactive oxygen species, flavonoids inhibiting lipid peroxidation, which considerably increases glutathione peroxidase activity.

CONCLUSION

Honey, propolis, and royal jelly are food products obtained from bees. All of them are important not only for their nutritional properties but also for their functional and biological properties. Antioxidant, anti-inflammatory, antibacterial, antiviral, and anti-ulcerous activities and also the capacity for the inhibition of enzymatic browning are some of these important properties. These activities are mainly attributed to the phenolic compounds such as flavonoids. Due to the large number of beneficial effects that honey, propolis, and royal jelly presented on the body, these products could be considered as potential ingredients for different foods. In any case, some precautions must be taken for their use in foods to avoid some problems in persons who suffer from allergy by beerelated allergens.

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Management of Potato Leafroll Virus

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INTRODUCTION:

Potato leaf roll virus is a member of genus polerovirus and family Luteoviridiae. It is a phloem limited positive sense RNA virus. A positive – sense single stranded RNA as its genetic material. The virus is spherical particle (its diameter is 0.000001 inch). The virus infects potatoes and other members of the family solanaceae. It is transmitted by Aphids, primarily the green peach aphids Myzus persicae. Responsible for an annual global yield loss of 20 million tons.

Virus Structure:

PLRV belongs to the polerovirus group of plant viruses. It 5.8 Kb single stranded positive sense genomic RNA (gRNA) contain 8 major open reading frames (ORFs) with a vpg bound at the 5̍ end.

- There is no poly (A) tail or tRNA like structure at the 3̍ end.
- CP-RTD (CP extended) the capsid subunit essential for aphid transmission.

Symptoms:

1. **Primary symptoms (primary infection) :-**

- Infection in the growing season occurs in the youngest leaves.
- Leaf margin becomes necrotic, turning brown and purplish and curl inwards and towards the center of the leaf.

2. **Secondary symptoms / infection**

- If the infected potatoes are grown more severe symptoms will be observed. Leaf rolling will be apparent and the entire leaf will become chlorotic and sometimes also has a purple discoloration.
- Infected potato plants exhibits stunted growth and produce smaller tubers.
- Infected tubers retain normal shape but experience necrosis of the vascular tissue. Necrosis of the tuber may not be apparent at harvest and can develop in storage. If you will cut the tubers you will be see brown to black flecks this is the indication of potato leaf roll virus.

Symptoms

Disease cycle:

- Potato leaf roll virus spread to the healthy potato field when infected seeds were grown or carried by insect vectors.
- Primary vector of PLRV is green peach aphid (Myzus persicae). Aphid takes the virus when they feed on infected plant. the phloem of plant is a reservoir of PLRV. The aphid feed phloem and carry virus through their stylet into the digestive system. After entering into digestive system the virus cross the gut membrane of aphid and enters into hemocoel and from there it reaches again to the salivary glands. This process take almost 12 hr after which the aphid will continue to transmit the virus for its remaining life this process known as persistent transmission. They remain laying eggs in the weeds or tree species in winter and when spring comes start to transmit virus. Winged aphid carry virus to long distances and cause widespread infection.

Vector- Green peach aphid

Management:

- Plant only certified seeds or virus tested tubers
- As virus persistently transmitted therefore easy to control because from acquisition to transmission aphid need much time
- Systemic and foliar insecticides can prevent aphids from feeding on potato plants.
- Insecticides such as Imidachloprid, Methamidophos commonly use to control aphid population.
- Remove solanaceae weeds or volunteer tuber because they are reservoir of virus
- Use hot water thermotherapy: treat the whole tubers at 55^0 c for 17 minutes.

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Sea food bioactives for health and wellness

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INTRODUCTION

The oceans occupy about 71% of the Earth's surface. The marine environment provides approximately 300 times more space for life than that provided by land and fresh water combined. About 80% of all life on earth is found under the ocean surface and two thirds of the phyla are exclusively marine. The marine environment is a rich source of both biological and chemical diversity. This diversity has been the source of unique chemical compounds with the potential for industrial development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, fine chemicals and agrochemicals (Maripandi*et al.,* 2010).

Bioactive compounds

The bioactive compounds refer to any chemical substances that affect a specific physiological function of any organisms. The invertebrate phyla as extensively studied are due to the abundance of innumerable bioactive compounds. The passion for the marine substances with biological activity was built in 1969 with the discovery of 15-ear-PGA2, a prostaglandin. The molecule was isolated from the *Caribbean gorgone, Plexaura homomalla* (Weinheimer and Spraggins, 1969).

Importance of Seafood

Seafood is any form of sea life regarded as food by humans. Seafood includes fish and shellfish. The latter includes molluscs: bivalves (mussel, oyster, and scallop), univalves (abalone, snail, and conch), and cephalopods (squid, cuttlefish, and octopus); crustaceans (crayfish, crab, shrimp, and lobster), and echinoderms. Most people would also include seaweeds and microalgae. Seafood is tasty, nutritious, and easily available worldwide. Marine products have been identified as being rich in proteins containing all the essential amino acids, polyunsaturated fatty acids (PUFAs), Ca, I, vitamins, and many other nutrients (Venugopal, 2005).

Seafood and Health Benefits

Seafood has an essential role in the human diet and is not only a reliable source of protein, but it also has a nutritional impact due to its lipids and vitamin and mineral constituents. Seafood proteins are highly digestible, and easily absorbed by the body. Lysand Met are 2 of the most important essential amino acids. These are generally found in high concentrations in fish proteins.

Health benefits of seafood as a source of antioxidants

Synthetic antioxidants such as butylated hydroxyl anisole, butylated hydroxyl toluene, tertiary-butylhydroquinone, and propyl gallate have been widely used to retard lipid oxidation. However, those synthetic compounds are under strict regulation in most countries owing to their potential health hazards (Park *et al.,*2001).

Anti-cardio vascular effects

Fish consumption is known to have a beneficial effect on CDV and CHD mainly due the PUFAs in fatty fish. Many studies have been conducted to prove the relation between fish consumption anddecreasingCDVandCHD.Ithasbeenshownthatpopulations that consume the most marine products like Alaskans and the Japanese suffer less from heart diseases (Kinsella, 1989).

Impact on prebiotics

Macroalgae contain various polysaccharides that could be used as prebiotic compounds for health applications. Different polysaccharides are found in all the species. Chlorophyta contains highlycomplex sulfated heteropolysaccharides. Alginates, fucans, and laminarin are found in brown algae. Agar and carrageenans are also extracted from red algae. The benefits of macroalgal polysaccharides have been shown in vitro and in vivo.The results were promising as laboratoryanimals h ave been shown to have increased numbersof*Bifidobacterium*and*Lactobacillus* (Kuda*et al.,* 2005; Hu *et al.,* 2006; Wang *et al.,* 2006).

Influences on anti-inflammatory activity

The anti-inflammatory effects of seafood are due to the fact that the PUFAs, especially omega-3, are able to inhibit certain inflammation mediators (Calder, 2009).

Health benefits related to preventing obesity

Obesity is a chronic metabolic disorder caused by an imbalance between energy intake and expenditure. Excessive fat accumulation leads too many health problems such as high blood pressure, type 2 diabetes mellitus, high blood cholesterol levels, CHD, and sleep apnea (Must *et al.,*1999).

Neuro-protective effects of seafood

Neurodegenerative diseases are considered to be one of the most common causes of death among the elderly (Bjarkam *et al.,*2001). For this reason, scientists have been looking for novel neuroprotective agents to prevent apoptosis, neuronal cells damage, dysfunction, and deterioration of the central nervous system (CNS) (Zarros, 2009).

Health benefits for preventing cancer

Cancers can be defined as diseases where cells stop responding normally to chemical signals from other cells. Instead of stopping, they continue to grow and divide. Those abnormal cells may kill by invading and subverting normal tissues (Silverstein *et al.,*2006).

Major bioactive compounds in fish

1) Proteins.

Seafood is an excellent source of proteins and contains all the essential amino acids in close to the right proportions for humans. The essential amino acids for humans are His, Phe, Val, Thr, Trp, Leu, Ile, Met, and Lys (Driskell, 1999).

2. Peptides

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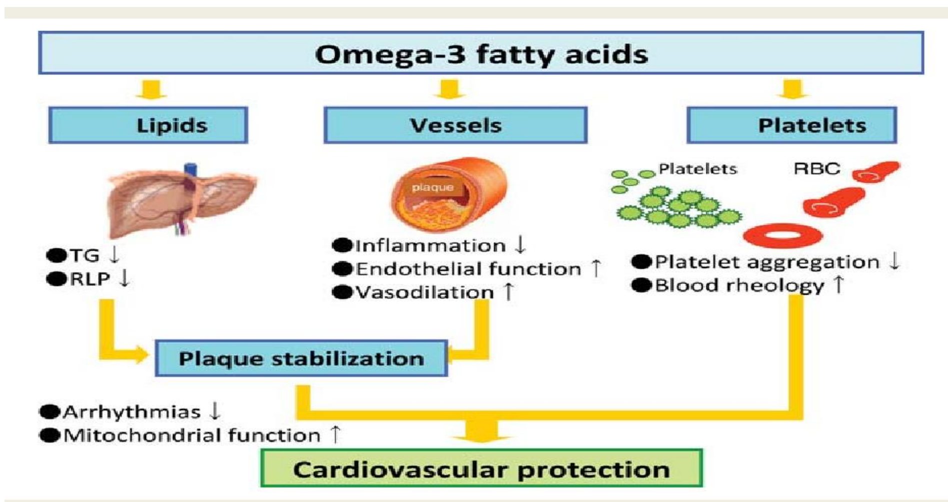
The hydrolysis of proteins leading to bioactive peptides has been receiving intensive investigation including those peptides derived from marine proteins. These peptides have beenisolated from marine sources, for example, algae, crustaceans, and fish species. Bioactive peptides often have 3 to 20 amino acid residues depending on amino acid composition and sequence (Ibanez *et al.,*2011).

3. Amino acids

Among the water-soluble components, sea food muscles are rich in amino acids, mainly taurine, Gln, Pro, Gly, Ala, and Arg. Cooking or thermal processing causes the loss of water soluble components and so their positive properties are likely to be greater when seafood is minimally processed (Luten, 2009).

4. Lipids and fatty acids

The fatty acid composition of seafood is generally characterized by a relatively low content of saturated fatty acids (SFA). A low intake of SFA is recommended since a link between SFA consumption and the development of cardiovascular disease (CVD) has generally been assumed. However, recent research is questioning this assumption as carbohydrates are being considered a likely culprit. Seafood also contains PUFAs and substantial amounts of monounsaturated fatty acids (Larsen *et al.,* 2011)



5. Sterols

Another class of lipids from marine sources is the sterol compounds. They are membrane lipids produced by eukaryotes as well as by some bacteria (Lewis *et al.,*2001)

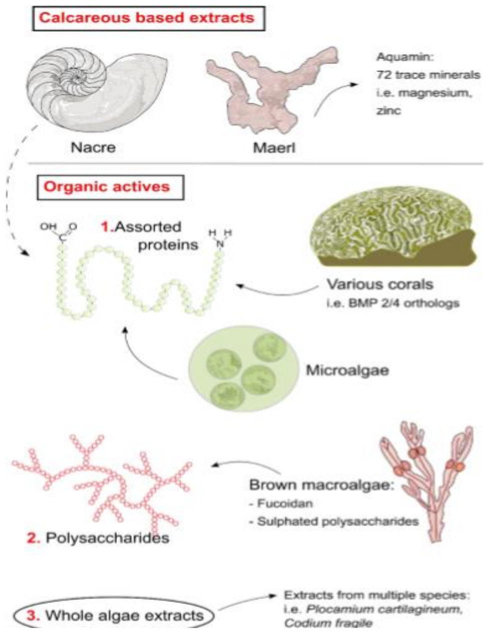
6. **Vitamins**

Vitamins are required for the human body for various chemical and physiological functions. Seaweeds are generally a good source of Bgroupvitamins(B1,B 2,andB12) (KimandTaylor, 2011)

7. Minerals

Seaweeds are also very rich in essential minerals and trace elements. This is associated with their ability to maintain inorganic atoms from seawater. Most of these essential minerals are found in high level in seaweeds compared to terrestrial foods. All of the essential minerals and trace elements required for human diet exist in macroalgae (Ito and Hori, 1989

2. Major bioactive compounds in mussels



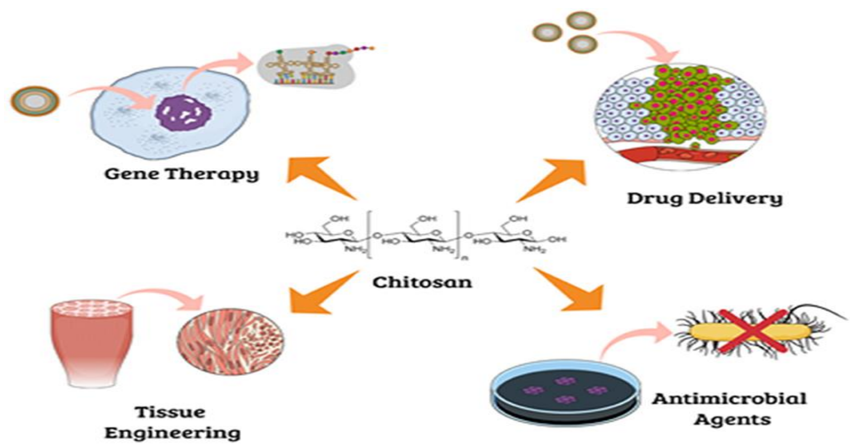
Mollusca

The phylum Mollusca is made up of eight distinct classes and is highly diverse, though as of yet <1% of species have seen secondary metabolite investigation—whilst testing of other compounds/molecules is similarly limited. Within this, proteins, lipids, and carbohydrates have seen particular research focus, with mussel lipids a well-established treatment for rheumatoid arthritis. In terms of osteogenic bioactives, novel activity has been found—such as from abalone gastro-intestinal digests of Haliotis discus hannai (Benkendorff et al., 2010).

Nacre

Nacre, often in its powdered form, features in a considerable body of research. Also known as mother of pearl, nacre is the lustrous aragonitic inner layer found on molluscan shells in taxa such as mussels and abalone. Like bone, nacre has both inorganic and organic components, with an organic shell matrix comprised of proteins, glycoproteins and polysaccharides which then serve as a template for calcium carbonate mineralisation. It is this similarity that fuelled the idea that factor able to stimulate mineralisation and support healthy human bone may be contained within nacre. Research on nacre has been conducted since the early 1990s, with initial in vitro work demonstrating its capacity to stimulate the mineralisation of human osteoblasts (Marie *et al.,* 2009).

3. **Major bioactive compounds in crustaceans**
   1. **Chitin and Chitosan**



Risk associated with Fish Consumption

The health benefits related to the reduction in risk of CVD have triggered the mass consumption of fish (FAO 2010). Fish consumption, however, also carries certain risks associated with exposure to environmental toxicants. For instance, the only exposure to methylmercury is through edible marine products. Free mercury easily metabolizes methylmercury by microorganisms and is accumulated in the fish at the top of the food chain. Methylmercury exposure affects the highly sensitive nervous system. The developing fetal and infant nervous systems are also highly sensitive to methylmercury. Methylmercury induces central nervous system damage that depends on the amount ingested (Clarkson *et al.,* 2003).

CONCLUSION

People have come to realize the importance of seafood in our diet. Numerous studies have proved that some of the best sources of excellent fats, protein, vitamins, and minerals that promote health can be found in seafood. It is unfortunate that it took so many years for the health benefits of seafood to be realized. In the future, an increase in lifestyle-related diseases, the majority of which are a result of dietary habits, is expected in both developed and developing countries (Daar *et al.,* 2007).

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Ethno botanical importance and medicinal value of fruits grown in Uttar Pradesh, India

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Plants have an immense role in the sustainability of human life and being used since ancient times to fulfil their needs. The complex relationship between the plants, humans and cultures is studied with the help of ethno botany. Uttar Pradesh has the natural advantage of diverse agro climate condition, which enables production of wide range of fruit crops. It is bestowed with rich bio diversity and varied agro-climatic condition ideal for growing a large variety of fruit crops. There are vast untapped lands of different kinds, which are fit for supporting cultivation of major fruit crops. Such lands can easily be put to use for growing such crops in order to diversify the present day agriculture. The increase in area and production of these fruit crops will not only provide nutritional security, it can provide many fold employment.

INTRODUCTION

Uttar Pradesh is India's fifth largest and most populous state, located in the northwestern part of the country. It is situated between 23°52 and 31°28'N latitudes and 77°3' and 84°39'E longitudes, this is the fifth largest state in the country in terms of area, and the first in terms of population. It spreads over a large area, and the plains of the state are quite distinctly different from the high mountains in the north. The climate of Uttar Pradesh can also vary widely, with temperatures as high as 47°C in summer, and as low as -1°C in winter.

Uttar Pradesh is rich in diversity of fruits in wild and semi wild condition, which are yet to be exploited. These fruit crops play a major role in meeting the nutritional and ethno medicinal need of the population of Uttar Pradesh since time immemorial. In addition, they are also used for flavour, colour and other health benefits. However, the lack of awareness averted the proper utilization of these potential fruit crops. These fruits have medicinal properties to cure various gastrointestinal disorders, respiratory problems; cardiovascular compliance, muscular illness, bone diseases, gynaecological problem, cancers, allergy and malaria. This indigenous system of treatment based on such fruits is still an integral part of social and cultural ethnic of the people. The traditional knowledge of the local people has been transferred from generation to generation without proper technological interventions. Therefore, there are chances of eroding of knowledge unless documentation is carried out. Thus, the main objective of this work is to highlight the diversity of fruits and their ethno medicinal uses.

Due to physical diversity, different varieties of fruits are produced in Uttar Pradesh. On regional basis,three horticultural zones may be identified in the state.

1. Sub-Tropical Zone

This incorporates Tarai region of the state covering the parts of Saharanpur, Rampur, Bijnor, Bareilly, Pilibhit, Kheri, Bahraich, Gonda, Basti, Gorakhpur and Deoria districts. The region is characterised by hot summer and 90 -125 cm of annual rainfall. It has two sub-regions: (a) northwestern zone,where litchi, peaches, plums and grafted mango are commonly grown and (b) north-eastern zone with higher rainfall and producing fruits like mango, banana, pineapple and jackfruit.

2. Plain Region or Sub-tropical Region

The region enjoys unfair heat during summer and cold winter. The average annual rainfall ranges between 100-125 cm. It is divided into three sub-regions: (a) Central zone growing grafted mango, jackfruit, loquat, citrus fruits, and papaya (b) Eastern zone producing bale, jackfruit,mango, and aonlaetc; and (c) Western zone supplying guava, malta, papaya, mango, ber etc.

3. Bundelkhand Zone

In this zone jujube, guava, bale, lemon, custard apple, papaya etc are the main fruits.

The state has rich diversity of different fruit crops. Some important fruits are mango, guava,aonla, papaya, jackfruit ber,bael, jamun, tamarind,phalsa,karondaetc and their potentialities are discussed below.

Mango (*Mangifera indica*L.):Itis a juicy stone fruit belongs to family Anacardiaceae. Fruit of mango contain Gallic acid, gallotanin, mangiferin,elagicacidgiucansolubal sugar acid, protein, carotene xanthophylls, vitamin A and C. Seed contain gallotanin stearic acid, methyl alcohol. Leaves contain mangiferin, glucose, galactose, xylose, gallic acid, glycoside and several other secondary metabolieds Shah *et.al.,* (2010). The young leaves can be eaten row and used in several diseases such as burning sensation, diarrhoea, dysentery haemorrhoids, hiccough hyperdipsia, ulcer, kidney stone and wound. Leaves pest used for hair blackening, jaundice, piles, vomiting, urinary diseases, liver disorder, constipation, it is also used as anti-microbial, liver disorder and in bloody dysentery. Root of plant can be used against diarrhoea, leucorrhoea, pneumonia, rheumatism. Inner bark and young leaves used by tribals against diabetes. Flowers of plant used as anorexia, dyspepsia, ulcer and blood purification. Fruits raw as well as mature can be used in sunstroke, opthalmia, eruption, intestinal disorder, in fertility, night blindness, the oil used in eczema. Seed used in heart problem, amebiosis, carminative, nasal bleeding. It is also used in liver disorder, teeth diseases, acidity, uterus problem, and fistula it used against poisonous biting such as scorpion, makadi, honeybee etc.Khandare, (2016).

Papaya (*Carica papaya* Linn): An evergreen flowering treebelongs to family Caricaceae valued for its buttery fruit that is believed to offer many health benefits. It is well known for its exceptional nutritional and medicinal properties throughout the world. From the times immemorial, the whole Papaya plant including its leaves, seeds, ripe and unripe fruits and their juice is used as traditional medicine. The many benefits of papaya are owed due to high content of vitamin A, B and C, proteolytic enzymes like papain and chymopapain, which have antiviral, antifungal and antibacterial properties. Nowadays, Papaya is considered as nutraceutical fruit due to its multifaceted medicinal properties.Fruit, leaves, latex and stem are used to treat indigestion, diarrhoea, swelling of the lungs, stoppage of urination, blindness, tachycardia, ringworm and alopecia. The seeds of Papaya have been reported to have both antimicrobial and antihelmintic activities. The latex of Papaya and fluconazole has synergistic action on the inhibition of the growth of Candida albicans. The molluscicidal activity of papaya seed and latex may be due to the existence of papain. This significantnutritious fruits feed the body and immune system. Vijay *et. al*., (2014).

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Aonla (*Emblica officinalis* Gaertn. Syn. *Phyllanthus emblica* L.): It belongs to family Euphorbiaceae and considered as one of the oldest minor fruits of India. Fruit of aonlais a rich source of vitamin C (500-600 mg/100 g). It also contains proteins and different minerals like phosphorus, calcium and iron. The high vitamin C concentration of fruit makes its wide use in Ayurvedic medicine. The fruit contains quercetin, kaempferol and rutin. The fruits are diuretic and laxative. They are useful in the disorders associated with the digestive system and are prescribed in the treatment of coughs and jaundice. Aonla is one of the three ingredients of the famous ayurvedic preparation, triphala, which is given to treat chronic dysentery, biliousness and other disorders. The plant is considered an effective antiseptic for cleaning wounds and it is one of the many plant palliatives for snakebite and scorpion stinging. Pareek and Kaushik (2012)

Ber (*Ziziphus mauritiana* Lam.): The Indian jujube or ber, known as king of arid zone fruits is belongs to family Rhamnaceae. It is an ideal fruit tree for arid and semi-arid regions in tropical and subtropical climate where most of the fruit crops cannot be grown either due to lack of irrigation facilities or adverse climate and soil condition. Fruits are used as an ingredient in the preparation of "Joshanda" (An Ayurvedic medicine used in chest trouble). The fruits are laxative and invigorating. The leaves are used to treat conjunctivitis. The bark is used for the treatment of diarrhea. Root decoction is used in fever and its powder is applied to ulcers and old wounds. Nair and Agrawal (2017)

Jamun (*Syzygiumcuminii*): Itbelongs to Myrtaceae family and found abundance in Uttar Pradesh.Ripe fruit of jamunis delicious as dessert. The ripe fruit is very useful in curing diabetes and diarrhoea. It is stomachie, carminative and diuretic, apart from having cooling and digestive properties, which help to cure diarrhoea, diabetes, and dysentery. Recent studies have shown that it noticeably lowers blood pressure. The seed powder of jamun reduces the magnitude of sugar in urine very rapidly and permanently. The berry is known for its hypoglycemic (lowering blood sugar) properties. The seed is used in various alternative healing methods in Unani, Ayurveda and Chinese medicine for digestive ailments. The leaves and bark are used for gingivitis and controlling blood pressure. (Swami *et.al*., 2012)

Bael (*Aegle marmelos* Correa): Bale belonging to family Rutaceae. It has tolerance to arid conditions (Chundawat, 1990) as well ashigh rainfall. It is known for its high medicinal and nutritional properties. Almost every part of the bale tree is used. The fruit is very rich in sugar, riboflavin (Vitamin B_2) and minerals. The ripe fruit is a tonic, restorative, laxative and good for brain and heart. The mature fruit is astringent, digestive and stomachic, and is usually prescribed for diarrhoea and dysentery (Sharma *et al.,* 2011). The ripe fruit is a good and simple cure for dyspepsia (Parichha, 2004; Chowdhury*et al.,* 2008).A decoction made out of the root and bark of bale tree is used in treating fever. The bale root could also prove a useful home remedy for getting rid of ear problems. The oil obtained from unripe fruits is said to be useful in removing the peculiar burning sensation in the soles.

Phalsa (*Grewia subinaequalis* D.C.): The Phalsa plant belongs to the family Tiliaceae. The edible part of fruit varies from 69 to 93% of its fresh weight. Ripe phalsa fruits are sub-acidic and good source of vitamin A and C and are fair sources of phosphorus and iron. The popularity of phalsa fruit is due to its attractive colour ranging from crimson-red to dark purple and its pleasing taste. The ripe fruits are used for making refreshing drink in summer having cooling effect. Several beverage like nectar, concentrate, squash and crushed phalsa are packed in glass bottles remain acceptable for up to 8 months in cool storage. The shoots of the plants after pruning can be utilized for either making baskets or supporting vegetable crops.

Karonda (*Carissa carandas* L.): It is an evergreen, spiny small tree belongs to Apocynaceae family. The karonda is a non-traditional fruit crop. In India, it is cultivated in a limited way in the tropical and subtropical Mediterranean region (Bankar*et al.,* 1994). Ripe fruits are sub-acidic to sweet in taste with peculiar aroma. The fruits may be eaten as a dessert when ripe or used in the preparation of fruit products such as jelly, squash and chutney. The dried fruits may become a substitute for raisins. The unripe fruits yield milky white latex, which can also be used in preparing rubber and chewing gum. Fruits can also be used in tanning and dyeing industries. Karonda fruit is considered to be antiscorbutic. Root extracts are used in lumbago, chest complains and venereal diseases.

Guava (*Psidium guajava* Linn.): Guavabelongsto family Myrtaceae.*Psidiumguajava* L. is consumed not only as food but also as folk medicine in subtropical areas all over the world due to its pharmacologic activities (Deguchi and Miyazaki, 2010). It is well known that guava is frequently employed in numerous parts of the world for the cure of a lot of sickness like diarrhea reducing fever, dysentery, gastroenteritis, hypertension, diabetes, caries, pain relief and wounds. The countries, which have a long history of using medicinal plants are also using guava at big level like Africa, Mexico, Asia and Central America. With its medicinal uses it is also used as food and in the preparation of food products. Guava contains high content of organic and inorganic compounds like secondary metabolites e.g. antioxidant, polyphenols, antiviral compounds and anti-inflammatory compounds. Guava has a lot of compounds which have anti cancerous activities. It has a higher number of vitamins and minerals. Phenolic compounds like flavonoids also find an important place in the guava. Lycopene and flavonoids are important antioxidants. They help in the cure of cancerous cells and help to prevent skin aging before time [Anand*et al.* 2016]. Guava can affect the myocardium inotropism(Conde Garcia *et al.* 2003). Guava skin extract can control level of diabetes after 21 days treatment [Rai*et al.* 2010].Guava leaf extract has analgesic, anti-inflammatory, antimicrobial, hepatoprotective and antioxidant activities. Its pulp reduces the body weight, glycemia and cholesterol levels.

Jackfruit (*Artocarpus heterphyllus*): The Jackfruit belongs to family Moraceaeand can be usedraw as vegetable and ripe as fruit. The Jackfruit is an extremely versatile and sweet tasting fruit that possesses high nutritional value. From the timeimmemorial, the whole jackfruit tree is used as a traditional medicine. Jackfruithas multifaceted medicinal properties. The medicinalproperties of Jackfruit include antioxidant, anti-asthmatic, antibacterial, antifungal, anticancer, hypoglycemic, anti-diarrhoeal, antimalarial, antiarthritic,anti helmintic, anti-inflammatory, ant carcinogenic, anti platelet, antiviral, anti atherosclerotic, anti tubercular activities. Studies showed that it has valuable pharmacological properties and used as many medicinal products. The bark of the tree exhibit methanolic extracts that have strong antioxidant activity. Moreover, heartwood extract also have potential skinwhitening properties. It has also shownwound healing effect and causes decrease in the sexual arousal, libido, performance and vigor in men.

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Dairy & Food Sector: A Potential Sector for Entrepreneurs in India

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INTRODUCTION

India is the world's second largest producer of food next to China, and has the potential of being the biggest with the food and agricultural sector. The food processing industry is one of the largest industries in India-it is ranked fifth in terms of production, consumption, export and expected growth. The food industry is on a high as Indians continue to have a feast. Fuelled by what can be termed as a perfect ingredient for any industry - large disposable incomes - the food sector has been witnessing a marked change in consumption patterns, especially in terms of food. Increasing incomes are always accompanied by a change in the food basket. The proportionate expenditure on pulses, cereals, edible oil, sugar, salt and spices declines as households climb the expenditure classes in urban India while the opposite happens in the case of milk and milk products, meat, egg and fish, fruits and beverages. Food Processing Sector has emerged as an important segment of the Indian economy in terms of its contribution to GDP, employment and investment.

Entrepreneurship Opportunities in Dairy & Food sector

By 2022, the food processing related industries is expected to generate about 4.4 million new jobs at entry level as well as supervisory level. The man power requirement in the dairy industry would be around 2.3 lacs. As per Census of 2011 agriculture sector engaged 263 million people out of them more than 50% is agriculture laborers. In future there will be massive increase of jobs in horticulture, dairy, fishery, poultry, floriculture and post-harvest supply chain and consequently there is need to upgrade skills of farmers, wage workers and entrepreneurs.

The various agencies reported that there is a huge demand potential in several agriculture sectors where new entrepreneurs can invest and earn. The emerging potential sectors are :Dairy, Poultry, Meat, Fisheries, Horticulture, Farm Mechanization, Micro irrigation etc., Proposed cultivation (green House, Hydroponics etc), plant tissue culture, Bamboo, Honey, Medicinal & Herbal, Organic etc., Agri warehousing, cold chain, logistics & supply chain, Commodity & Financial markets, Digital & Agriculture technology, weather forecasting, Alternate energy (Solar, Biomass etc) and New requirement in seeds, pesticides, fertilizers etc.

Growth Potential of Food processing sector

The food processing sector has tremendous growth potential due to following reasons:

- Increased urbanization, change in life style and aspirations
- Changing demographics- rise in disposable incomes
- Increasing spending capacity of consumer on food products
- Increasing nuclear families and working women
- Demand for functional foods/neutraceuticals

Source of Knowledge for Entrepreneurs

The table given below shows various sources of information for the budding entrepreneur. They can contact concerned agencies/departmentsfor the relevant information. However, theymust contact at least the following agencies to have knowledge about small-scale industries and the procedures:

- District Industries Centre

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- ❖ Directorate/Commissioner of Industries Office
- ❖ State Financial Corporation
- ❖ Technical Consultancy Organisation and
- ❖ Agencies Conducting Entrepreneurship Development Programmes

Table-: Knowledge Centres for Entrepreneurship related Informations

S.No.	Area of Assistance	Sources
1.	For Selection of a Project	SISI, DIC, TCOs, SFCs
2	Registration	DIC (District Industries Centre)
3	Knowledge to get loans	SFCs, NSIC
4	Technical Information/Guidance	DIC, TCOs, CFTRI,SISI, NSIC, DFRI
5	Skill & Vocational Training	ED Inst., SISI, TCOs,DICs, CFTRI, NGOs
6	Infrastructure	DIC, IDCs, LA
7	Raw Materials	DIC
8	Plant & Machinery	DIC, NSIC, SISI
9	Marketing Information	DIC, TCOs, EPC(APEDA, MPEDA)

DIC = District Industries Centre, SISI = Small Industries Service Institute
TCOs = Technical Consultancy Organisations, SFCs = State Financial Corporations
NSIC = National Small Industries Corporation, DFRI = Defence Food Research Laboratory
ED Inst. = Entrepreneurship Development Organisations, CFTRI = Central Food Technology Research Institute, IDCs = Infrastructure Development Corporations
LA = Local Authorities like Municipalities
EPC (APEDA, MPEDA) = Export Promotion Council (Agriculture andProcessed Food Export Development Authority, Marine ProductsExport Development Authority)

Knowledge of Legal Requirements

All industries and its activities are governed by certain legal provisions that come in force from time to time. Some of them are given below for their ready reference. These could be divided into 'general' and 'Food Processing Industry specific'.

General Legal Acts

- ❖ Factories Act, 1948
- ❖ Employees' State Insurance Act
- ❖ Payment of Wages Act, 1936
- ❖ Employees Provident Fund & Miscellaneous Provisions Act, 1952
- ❖ Minimum Wages Act, 1948
- ❖ The Indian Partnership Act, 1932
- ❖ Central Goods and Services Tax Act, 2017
- ❖ The Income Tax Act, 1911
- ❖ Pollution Control Act

Specific Legal Acts for Food Processing

- ❖ FSSAI, 2006

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Support Institutions for Promotion of Food Processing Sector

(i) **Ministry of Food Processing Industries:** The Ministry of Food Processing Industries is the key central agency of theGovernment responsible for developing a strong and vibrant food processingsector with a view to creating increased job opportunities in the rural areas,enabling the farmers to reap benefit of modern technology, creating surplusfor exports and stimulating demand for processed food. Italso provides technical assistance and advice to food processing industry.Information on schemes of the ministry is available on the websitewww.mofpi.nic.in.

(ii) **Central Food Technological Research Institute** – CFTRI (www.cftri.com):The institute gives recent and updated technologies for food processing enterprises.

(iii) **National Small Industries Corporation Ltd**– NSIC (www.nsicindia.com):The agency is knowledge center for integrated technology, marketing and financialsupport to small scale enterprises.

(iv) **Small Industries Development Organization**– SIDO (www.laghu-udyog.com): It is the Nodal Development Agency for small scale industries.

(v) **Export Credit Guarantee Corporation of India Limited**– ECGC (www.ecgcindia.com) : Itshelters the risk of exporting on credit. Being essentiallyan export promotion organization, it functions under the administrativecontrol of the Ministry of Commerce, Government of India. It provides arange of credit risk insurance covers to exporters against loss in export ofgoods and services. It also provides information on creditworthiness/credit ratings of overseas buyers and various countries.

Credit Status Information Agencies

- India Trade Promotion Organization – ITPO (www.indiatradepromotion.Org).
- Dun & Bradstreet – (www.dnb.co.in)
- Small Industries Development Bank of India – SIDBI (www.sidbi.com)
- Federation of Indian Export Organizations – FIEO (www.fieo.com)
- Export-Import Bank of India – EXIM Bank (www.eximbankindia.com)

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Care for a Lawn

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INTRODUCTION

A lawn can be defined as the natural green carpet for a landscape. It is a basic feature for home ground development and an essential feature for any other type of garden. A garden without a lawn is not considered complete. It is also known as the heart of a garden.75% of beauty of garden depends on a properly maintained lawn.

Starting the lawn

Lawn is started in one of two ways: 1. seeding, 2. vegetative planting

Seeding:-

Sowing the seed:

Seed may be planted by hand or with a mechanical seeder.to obtain uniform distribution seed may be mixed with small amount of career such as sand.The mixed material is divided in two parts; one is sown in one direction and the other part crosswise to the first sowing.

Vegetative planting:

There are some grasses for which seed is not available,or the seed available does not produce plants that are true to type.These grasses must be planted by one of several vegetative methods, such as Dibbling, Turfing, Bricking, Planting in polythene.

Selection of grasses

1) Bermuda grass or Bahama Grass or Calcutta Grass (*Cynodon dactylon*): It is commonly known as “doob” or “Hariyali”.
2) Korean Grass (*Zoysia japonica*): It is known as Japan or Korean grass.This is highly suitable for smaller areas and home lawns. Manila Grass *(Zoysia matrella*):
3) Korean Velvet Grass (*Zoysia tenuifolia*): This grass forms a thick mat and is used in the form of carpet grass.
4) Annual blue grass (*Poa annua*);Canada blue grass (*Poa compressa*); Kentucky blue grass (*Poa pratensis*);Rough blue grass (*Poa trivialis*).
5) Red top (*Agrostis alba*), Velvet bent grass (*Agrostis canina*), Creeping bent grass (*Agrostis palustris*)
6) Tall fescue (*Festuca arundinacea*), Sheep fescue (*Festuca ovina*), Red creepimg fescue (*Festuca rubra*)
7) Carpet grass (*Axono pusaffinis*), Centipede grass (*Eremochola ophiuroides*)

Planting techniques

Dibbling: (Use of cuttings, and underground stem).Well-matured un-rooted or rooted “doob” grass cutting obtained from a close cut lawn or a nursery or from a lawn scarping are used for dibbling. Dibbling results in making a lawn in about 4 months.

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Turfing: The quickest method of developing a lawn,though costly, is by turfing. Turf is a piece of earth about 5 cm thicknesses with grass thickly grown over it.

Turf plastering: A pest is prepared by mixing garden soil, fresh cow dung, and water. Bits of chopped-up fresh roots and stem or rhizomes of "doob"grass are mixed with the paste and this paste is spread evenly on the surface of moistening ground.

Planting on polythene: In this method lawn is grown on thick polythene (800 gauge thickness). First polythene is cut into suitable pieces of desirable dimension. Mixture of soil (3-4cm.) is spread over it. It can be rolled and taken to place and rolled out where temporary effect is created.

Cultural practices

Rolling: The object of rolling grass anchor itself securely and also to keep surface levelled. In light sandy soils rolling after each weeding will be helpful to keep the surface levelled.

Mowing: The frequency of mowing is determined by the amount of growth and will vary from season to season. But grass should not be allowed to more than 5 to 6 cm in length in any season.

Sweeping: Sweeping is essential to clean the cut grasses and fallen leaves and other debris.

Fertilization: Top dressing of Compost @100 kg/100 m² consisting of good garden soil, coarse sand, and leaf mould in the proportion of 1:2:1 is spread over the lawn to a depth of 3-5 cm. Bone meal also applied at the rate of 1 kg per 10 square meters.The ammonium sulphate is applied once every month at the rate of 1 kg per 50 square meters area followed by watering.

Irrigation: "Doob" grass is a shallow rooted therefore, frequent light irrigation is better than copious flooding after long intervals. Stagnation of water should not be allowed as it may kill the grass.

Weeding: Weeding is common in both new and old lawns. Weeding should start as soon as the lawn established and continue at regular intervals or whenever the weeds come out. The *Cyperus rotundus* is the most difficult weed to eradicate,because of its deep root system. A red creeping weed, "Dudi"*Euphorbia thymefolia* often invades the lawn and is not difficult to eradicate if controlled in initial stages.The most commonly weedicide is 2,4-D which is effective in selective killing the broad leafed weeds. Glyphosate is most widely used herbicide in the lawn.

Liming: Application of lime followed by watering should be done once a year. Powdered chalk or lime should be applied at the rate of 250 g per square meter area.

Scarping and Raking: Excessive rolling, treading, and mowing may result in the formation of hard crust and the lower part of the lawn may get matted and woody. For such lawns, the grass is scraped at the ground level with the help of a khurpi in the month of April- May.

Renovation and Replanting of old lawn

Aeration: Small holes,about 10 cm deep and 10-15cm apart may be made to facilitate proper aeration of the soil, especially in a heavy clayed soil.

Weeding: A lawn which is badly infested with weed should be remade.

Replanting: If there small patches of grass are shown poor growth these may be replanted and manured.

Mixing Lawns with Other Landscape Component

If the lawn is spacious, seasonal beds, herbaceous borders, beds of canna, attractive specimen trees or shrubs etc.may be planted. Sometimes mound are created in the spacious lawn to break the monotony. Some bulbous plants may be planted in groups in the lawn.

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Plants suitable for planting in Lawn

Trees	Shrubs and Creepers
Amhersita nobilis	*Agave americana*
Callistemon lanceolatus,	*Furcreaea gigantia*
Magnolia grandiflora	*Musa superba*
Cupressus macrocarpa	*Bougainvillea spectabilis*
Pinus longifolia	*Dombeya spectabilis*
Thujaorientalis	*Cestrum nocturnum*
Araucaria excels	*Hibiscus spp.*

Astroturf

It refers to a synthetic lawn popularly used in developed countries in roof garden and stadium. It dispenses the normal maintenance usually required for normal lawns. However it requires constant water sprinkling to bind the synthetic fibre to provide a surface akin to a lawn carpet.

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Climate change adaptations and pest management strategies

Article id: 22442

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Introduction - Climate change and Agriculture

Being a tropical country, India is more challenged with impacts of looming climate change. Over past hundred years, the global temperature has increased by 0.8ºC and is expected to reach 1.1-5.4 ºC by the end of next century. On the other hand, CO_2 concentration in the atmosphere has increased drastically from 280 ppm to 370 ppm and is likely to be doubled in. There has been a lot of discussion on the effects of climate change on plant productivity and experiments indicate that higher levels of CO_2 generally increase productivity of plants. However this can be countered by effects mediated through high temperatures and reduced water availability. There is already evidence that these factors are having a negative impact on productivity of grains and other rather than a positive effect.

Apart from having direct effects on plant productivity, climate change can also influence productivity through indirect effects mediated by changes in pests and diseases. Insect-pests of crop plants are the real candidates most affected by global climate change. Complex physiological effects exerted by the increasing temperature and CO_2 may affect profoundly, the interactions between crop plants and insect-pests.

Impacts of climate change on pest scenario

Climate change driven global warming is affecting the distribution, demography and life history of many species, particularly insects. It is also influencing the phenology of insects including arrival times and emergence time of a range of insects. These changes are having, and will have, consequences for human livelihoods, including an increased spread of pest and diseases of important crops. Following are the notable effects of climate change on insect pest scenario and pest population dynamics.

1. Expansion of geographic ranges

Altered temperature and rainfall regimes with the predictable changes in climate will determine the future distribution, survival and reproduction of the species. With rise in temperature, the insect-pests are expected to extend their geographic range from tropics and subtropics to temperate regions at higher altitudes along with shifts in cultivation areas of their host plants. This may lead to increased abundance of tropical insect species and sudden outbreaks of insect-pests can wipe out certain crop species, entirely. At the same time; warming in temperate region may lead to decrease in relative abundance of temperature sensitive insect population. In future, projected climate warming and increased drought incidence is expected to cause more frequent insect outbreaks in temperate regions also.

Range extension in migratory species like *Helicoverpa armigera* (Hubner), a major pest of cotton, pulses and vegetables in North India is predicted with global climate warming. Subsequently, these ongoing shifts in insect-pest distribution and range due to changing climate may alter regional structure, diversity and functioning of ecosystems.

2. Increase in number of generations

As temperature being the single most important regulating factor for insects. Global increase in temperature within certain favourable range may accelerate the rates of development, reproduction and survival in tropical and subtropical insects. Consequently, insects will be capable of completing more number of generations per year and ultimately it will result in more crop damage.

3. Risk of introducing invasive alien species

According to the Convention on Biological Diversity (CBD), invasive alien species are the greatest threat to loss of biodiversity in the world and impose high costs to agriculture, forestry and aquatic ecosystems by altering their regional structure, diversity and functioning.

It is expected that global warming may exacerbate ecological consequences like introduction of new pests by altering phenological events like flowering times especially in temperate plant species as several tropical plants can withstand the phenological changes. Invasion of new insect-pests will be the major problem with changing climate favouring the introduction of insect susceptible cultivars or crops.

4. Impact on pest population dynamics and outbreaks

Changes in climatic variables have led to increased frequency and intensity of outbreaks of insect-pests. It may result in upsetting ecological balance because of unpredictable changes in the population of insect-pests along with their existing and potential natural enemies. Outbreak of sugarcane woolly aphid *Ceratovacuna lanigera* Zehntner in sugarcane belt of Karnataka and Maharashtra states during 2002-03 resulted in 30% yield losses. These situations of increased and frequent pest damage to the crops have made another big hole in the pockets of already distressed farmers by increasing the cost of plant protection and reducing the margin of profit.

5. Breakdown of host plant resistance

Expression of the host plant resistance is greatly influenced by environmental factors like temperature, sunlight, soil moisture, air pollution, etc. Under stressful environment, plant becomes more susceptible to attack by insect-pests because of weakening of their own defensive system resulting in pest outbreaks and more crop damage. Thermal and drought stress associated breakdown of plant resistance have been widely reported. With global temperature rise and increased water stress, tropical countries like India may face the problem of severe yield loss in sorghum due to breakdown of resistance against midge *Stenodiplosis sorghicola* (Coq.) and spotted stem borer *Chilo partellus* Swinhoe.

The environmental factors like high temperature have been found affecting transgene expression in Bt cotton resulting in reduced production of Bt toxins, this lead to enhanced susceptibility of the crops to insect-pests like bollworms viz., *Heliothis virescens* (F.), *Helicoverpa armigera* (Hubner) and *Helicoverpa punctigera* (Wallen).

6. Increased incidence of insect vectored plant diseases

Climate change may lead to more incidence of insect transmitted plant diseases through range expansion and rapid multiplication of insect vectors. Increased temperatures, particularly in early season, have been reported to increase the incidence of viral diseases in potato due to early colonization of virus-bearing aphids, the major vectors for potato viruses in Northern Europe.

Pest Management Adaptations to Changing Pest Scenario Due to Climate change

1. Breeding climate-resilient varieties

To minimize the impacts of climate and other environmental changes, it will be crucial to breed new varieties for improved resistance to abiotic and biotic stresses. Considering late onset and/ or shorter duration of winter, there is chance of delaying and shortening the growing seasons for certain Rabi/ cold season crops.

Hence we should concentrate on breeding varieties suitable for late planting and those can sustain adverse climatic conditions and pest and disease incidences.

2. Alternation in sowing dates of crops

Global climate change would cause alternation in sowing dates of crops which alter host-pest synchrony. There is need to explore changes in host plant interaction under early, normal and late sown conditions in order to recommend optimum sowing dates for reduced pest pressure and increased yield.

3. Rescheduling of crop calendars

As such, certain effective cultural practices like crop rotation and planting dates will be less or non effective in controlling crop pests with changed climate. Hence there is need to change the crop calendars according to the changing crop environment. The growers of the crops have to change insect management strategies in accordance with the projected changes in pest incidence and extent of crop losses in view of the changing climate.

4. GIS based risk mapping of crop pests

Geographic Information System (GIS) is an enabling technology for entomologists, which help in relating insect-pest outbreaks to biographic and physiographic features of the landscape, hence can best be utilized in area wide pest management programmes. How climatic changes will affect development, incidence, and population dynamics of insect-pests can be studied through GIS by predicting and mapping trends of potential changes in geographical distribution of agro-ecological hotspots and future areas of pest risk.

5. Screening of pesticides with novel mode of actions

It has been reported that, application of neonicotinoid insecticides for controlling sucking pests induces salicylic acid associated plant defense responses which enhance plant vigour and abiotic stress tolerance, independent of their insecticidal action. This gives an insight into investigating role of insecticides in enhancing stress tolerance in plants. Such more compounds needs to be identified for use in future crop pest management.

In addition to the strategies discussed above, we need to decide the future line of research and devise policies for combating the pest problems under climate change regimes. Some of these are

- Evolve temperature tolerance strains of natural enemies
- Development of Weather and pest forecasting models
- Developing early warning systems/decision support systems
- Awareness regarding impacts of climate change
- Adoption of mitigation and adaptation measures
- Sensitization of stakeholders about climate change and its impacts
- Farmers' participatory research for enhancing adaptive capacity
- Promotion of resource conservation technologies

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CONCLUSION

In India, pest damage varies in different agro-climatic regions across the country mainly due to differential impacts of abiotic factors such as temperature, humidity and rainfall. This entails the intensification of yield losses due to potential changes in crop diversity and increased incidence of insect-pests due to changing climate. It will have serious environmental and socio-economic impacts on rural farmers whose livelihoods depend directly on the agriculture and other climate sensitive sectors.

Dealing with the climate change is really tedious task owing to its complexity, uncertainty, unpredictability and differential impacts over time and place. Understanding abiotic stress responses in crop plants, insect-pests and their natural enemies is an important and challenging topic ahead in agricultural research. Impacts of climate change on crop production mediated through changes in populations of serious insect-pests need to be given careful attention for planning and devising adaptation and mitigation strategies for future pest management programmes.

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IDM strategies for Bacterial blight of Pomegranate

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INTRODUCTION:

Pomegranate, *Punica granatum*, is a deciduous or evergreen tree or shrub in the family Punicaceae grown for its edible fruits. The pomegranate tree is branched and spiny with glossy, leathery, oval to oblong leaves that grow in whorls of five or more on the branches**.** The cultivation of pomegranate is are taken by many states. Maharashtra, Karnataka are leading states in pomegranate cultivation. Bacterial leaf spot of pomegranate Caused by *Xanthomonas axonopodis* pv. *Punicae.* Important weather related disease. The increase in day temperature (38.6°C) and afternoon relative humidity of 30.4% along with cloudy weather and intermittent rainfall favored the disease initiation and further spread of the disease.

Disease symptoms:

- Small irregular water soaked spots appear on the leaves.
- Small, deep red spots of 2-5 mm dia. with indefinite margins on leaf blade
- Leaves distorted and malformed
- Severely infected young leaves shed
- The bacterium attacks stem, branches and fruits also.
- On the stem, the disease starts as brown to black spots around the nodes.
- Girdling and cracking of nodes
- Branches break down
- Brown to black spots on the pericarp of fruit with L or Y shaped cracks
- Spots on fruits are raised with dark brown lesions of indefinite margins on the surface


Symptoms

Survival and spread:

- Primary source of inoculum is Infected cuttings
- Secondary source of inoculum spreads through Wind splashed rains.
- The bacteria infect through wounds and stomatal openings.

Favourable conditions:

- The increase in day temperature (38.6°C) and afternoon relative humidity of 30.4% along with cloudy weather and intermittent rainfall favored the disease initiation and further spread of the disease.

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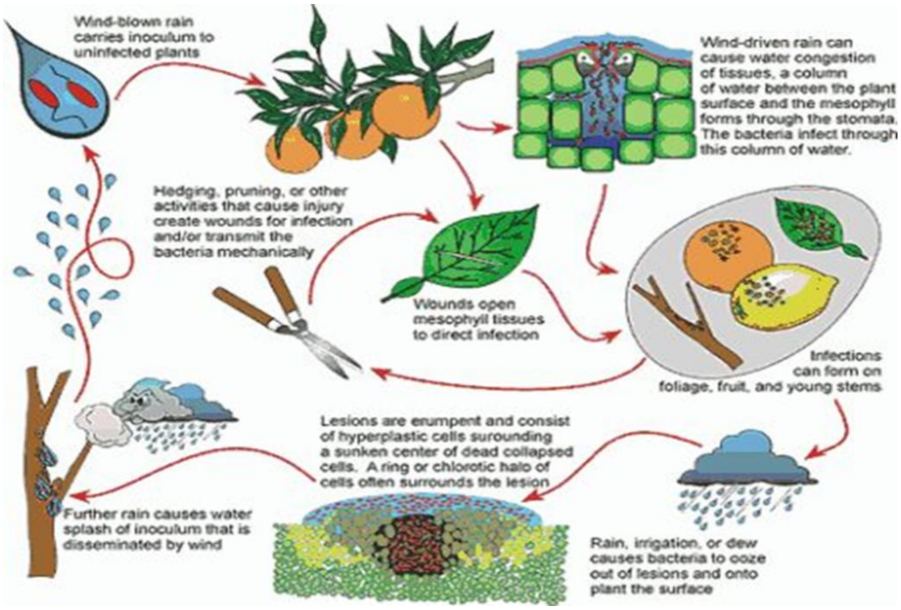

Disease cycle

Characteristics of bacteria

X. axonopodis pv. *punicae*

- It is a gram negative bacteria.
- Aerobic
- Rod shaped
- Non spore farming
- Motile with single flagellum
- The size of bacterium is 1.0-3.0 µm× 0.4- 0.75µm
- Colonies on NA media are
- yellowish in colour

Management:-

- **Cultural method**
  - Following stringent sanitation measures
  - Using healthy and disease-free planting material
  - Applying balanced nutrition to plant
  - Use of resistance varieties like Bhagwa, NRCP Hybrid 4 and NRCP Hybrid 12
  - Use disease free planting material
- **Chemical method**
  - spraying the crop with streptocycline (250 ppm) 2.5gm/10lit of water
  - bronopol (500 ppm) + copper oxychloride (0.2 %)

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It is proved that insects like anar butterfly, ants, aphids, blister beetle, and larvae of fruit borer can disseminate.

- **Biological method**

  Use of a talc based formulation of *Pseudomonas fluorescens* at 10 g/l of water as a spray.

CONCLUSION

- Disease cause by *Xanthomonas* are major constrains in the cultivation of pomegranate.
- Epidemiological studies of important diseases in the Maharashtra region will help to formulate effective cultural, chemical and biological practices.
- Use of resistant varieties or resistant rootstocks is important tool in the management of bacterial diseases of fruit crops.
- Use of antagonist is effective eco-friendly control measure to cure disease cause by xanthomonas.

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SMART FARMING: A future key Technology for Sustainable Agriculture.

Article id: 22444

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INTRODUCTION:

In future agricultural sector is about to face wide range challenges in pursuance to feed the 9.6 billion people that the FAO estimates food production may increase by 70% by 2050, and will be achieved by limited availability of arable lands, the increasing need for fresh water and other, such as the effect of climate change and also changes to seasonal occurrences in the life cycle of plant and animals.

To expand or maintain its current and future food output it needs to increase its productivity - without imposing an additional burden on the environment. To overcome from these problems and increase the quality and quantity of agricultural production is using latest smart sensing technology to develop farms grow perceptive for expand connective and the application of information and data technologies in optimizing complex farming systems is called as 'smart farming'.

What is smart farming?

Smart Farming is a farming management concept by implementing the modern technology to increase the quantity and quality of agricultural products. Smart farming (SF), based on the incorporation of information and communication technologies into machinery, equipment, and sensors in agricultural production systems, allows a plenty of data and information to be generated with continuous insertion of automation into the process. Smart farming depends on data transmission and the concentration of data in remote storage systems to enable the combination and analysis of various farm data for decision making. New technologies such as the internet of things and cloud computing are expected to advance this development, introducing more robots and artificial intelligence into farming. Absolutely measuring variations within a field and reorganise the programme accordingly, farmers can substantially improve the effectiveness of pesticides and fertilizers, and use them more carefully. Smart Farming technologies that help farmers can superiorly observe the needs of individual animals and alter their nutrition balancingly, therefore preventing disease and maintaining good health.

Smart farming involve emerging technologies into existing farming practices that pursuance to increase production efficiency, quality of agricultural products and they also improve the quality of life for farm workers by reducing massive labour and unexciting tasks.

What do you need for smart farming?

Knowledge and wealth are essential for any innovation. Latest farming technologies require additional professional skills. Presently farmer is not only a person with a agony for agriculture, he or she is also a lawful socialist and a part-time data analyst, economist and accountant.

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Furthermore, Smart Farming requires capital. Thankfully, there are a wide range of options available. From using low capital investment smart phone applications that track your livestock to a capital-intensive automated combine. In truth, adopting Smart Farming technologies can be easily lavished.

The main aim of the agriculture sector is to optimize processes and uses of resources and efficient use of existing arable land. The Internet of Things can enable all that. It can increase production, but it can also increase the level of quality of agriculture. That is to say that smart rural areas should not come out of the melancholy and live in a blank, but be connected with smart agri-food industry, smart tourism that move around the other agriculture activities in rural areas.

Applications of smart farming:

1. Automatic Connected Farm with Sensors and the Internet of Things (IoT)
2. Real-Time Monitoring and Analysis through Drones
3. Using Crop Spraying Drones
4. Planting from the Air
5. Drones for Imaging, Planting and More
6. Reducing Labor, Increasing Yield and Efficiency
7. Harvesting from Field, Tree and Vine
8. Weeding and Crop Maintenance
9. Automatic Watering and Irrigation
10. Precision Seeding and Planting
11. Autonomous and Robotic Labour
12. Driverless Tractors

Benefits of smart farming:

- ✓ SmartFarming develops smartphone applications (‘apps’) that provide farmers with practical agricultural knowledge and advice. These apps support organisations to increase their impact.
- ✓ Smart Farming: Improving Produce Quality and Quantity.
- ✓ Smart farming is key to developing sustainable agriculture
- ✓ Smart farming reduces the ecological footprint of farming. Optimising resources such as site-specific application of inputs, such as fertilizers and pesticides, in precision agriculture systems will mitigate greenhouse gases (GHG) emission and leaching problems.
- ✓ Smart farming can make farmers more profitable in agriculture sector. Reducing resource inputs will help the farmers money and labour, and increased effectiveness of spatially clear cut data will mimimum risks.
- ✓ Smart farming has the potential to improve consumer adoption. In truth, optimizing management also enable increased product quality (e.g., higher amounts of antioxidants and other secondary metabolites.
- ✓ Smart farming can contribute a interactive path out of locked-in technologies and practices distinguished by strong polarization and market segmentation.

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CONCLUSION:

Smart farming and precision agriculture play an important role in sustainable agriculture, using big data and new technologies such as IoT, drone imagery and smartphone apps to harvest as much matter and products as possible, while consuming less energy and inputs (fertilizers and pesticides, phytosanitary products, water) that will help farmers to increase the quantity and quality of agricultural produce and improve the health related quality of life.

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Synthetic Seeds: a panacea for seed industry

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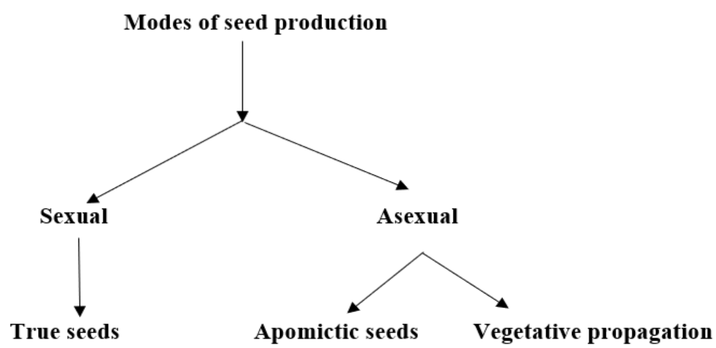
INTRODUCTION

Agriculture is the mother of all cultures. It is the backbone of Indian Economy. About 65per cent of the Indian population depends directly on agriculture and accounts for around 22per cent of the GDP. Agriculture has vital supply and demand links with the manufacturing sector. During the past five years, theagriculture sector has witnessed spectacular advances in the production and productivity of food grains, oilseeds, commercial crops, fruits, vegetables, poultry and dairy. India has emerged as the second largest producer of fruits and vegetables in the world. The major reason for this increased food production is the use of quality seeds of hybrids and improved varieties. It has been estimated that the use of quality seeds alone will increase the yield by 20 per cent, but the availability of such quality seeds to all farmers is yet to be accomplished. Seeds are the basic input in agriculture. Seed is defined as the mature fertilized ovule (true seed). However, according to the Indian minimum seed certification standards (2013), seeds shall include both true seeds and vegetative propagules as discussed in detail below.Based on Indian minimum seed certification standards definition, seed production can be classified as below



There are two modes of producing seeds- sexual and Asexual. True seeds are produced from thesexual mode, whereas apomixes and vegetative propagation are Asexual modes. Vegetative propagation is further divided into natural and artificial vegetative propagation. The natural method of propagation includes root, stem and leaf modifications like bulbs, tubers, corms, rhizomes, suckers, runners and others. The artificial method includes conventional approaches like stem cutting, grafting, budding and innovative approaches like tissue culture. The product of this tissue culture or tissue culture propagules is used for theproduction of encapsulated embryo or synthetic seeds.

Synthetic seeds

Synthetic seeds are encapsulated somatic embryos, shoot buds, cell aggregates or any tissue, that can be used for sowing, which possesses the ability to be converted into a plant under *in vitro* or *ex vitro* conditions, as well as retains its potential to germinate even after storage.The several plant propagule has been tried for production. However, somatic embryos were found to be the best candidates for production of encapsulated embryos. These encapsulated embryos are known by different names like synthetic seeds, synseeds, artificial seeds and manufactured seeds.

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In vitro propagules	Crop
Somatic embryos	Papaya, Mango, Carrot, Sandalwood, Rice, Maize, Wheat, Soybean, Finger millet and Brinjal
Axillary buds	Eucalyptus, Citrus and Pineapple
Shoot tips	Cardamom and Apple

(Singhal, 2011)

Table 1- Difference between true seed and synthetic seed

Particulars	True seed	Synthetic seed
Develop from fertilized egg cell	✓	✗
Low moisture drying	✓	✗
Endosperm	✓	✓/ ✗
Labour intensive	✓	✗
Dormancy and vivipary	✓ / ✗	✗

(Singhal, 2011)

Genesis of synthetic seed technology

Embryo encapsulation is based on the principle of totipotency. The technology started when Murashige (1977) presented the concept of using somatic embryo as a substitute for natural seed or true seed but Steward *et al*. (1958) first identified somatic embryogenesis in carrot. Later desiccated synthetic seed was produced by Kitto and Janick (1982) but due to dessication of plant propagule, the technique failed. Redenbaugh*et al*. (1986) suggested calcium alginate as coating agent as suitable for celary and alfa-alfa. However, the technology was standardized by Sakamoto *et al*. (1992). In about a decade, synthetic seeds of several crops were developed.

Components of synthetic seeds

It consists of mainly two components plant propagule and the artificial seed coat. The plant propagule used are somatic embryos, shoot tips, nodal segments and Protocorm-like bodiesprotocorm. The artificial seed coat consists of either one chemical or combination of two chemicals like gelling agent and complexing material. Gelling agents are used for covering the plant propagule whereas complexing material is used mainly to harden the gelling agent and keep it firm.

Table 2- Commonly used gelling agent and complexing material

Gelling agent	Complexing material
Sodium alginate	Calcium salt
Sodium alginate with gelatin	Calcium chloride
Carrageenan	Potassium chloride
Locust bean gum	Ammonium chloride
Gerlite (Low temperature)	
Agar (Low temperature)	
Polyoxyethylene (Drying)	

It is not necessary that every gelling agent should have a complexing agent some gelling agents like gerlite and agra can be hardened by altering the temperature. Whereas polyoxyethylene can be hardened by desiccation. Based on whether complexing agent is usedfor hardening or not the synthetic seeds are classified into two types.

Desiccated synthetic seeds

Polyoxyethylene, which is readily soluble in water, dries to form a thin film and does not support the growth of microorganisms and is non-toxic to the embryo, is used for the production of desiccated synthetic seed. Desiccation can be achieved either slowly over a period of one or two weeks or overnight.

Hydrated synthetic seed

Hydrated seeds are produced in those plant species where the somatic embryos are sensitive to desiccation. Encapsulation of somatic embryos in hydrogel capsules produces hydrated synthetic seeds.

Procedure for production of Hydrated synthetic seeds

Success of synthetic seeds depends on the selection of suitable planting material and standardization of protocol for production of that desired plant propagule

1. Selection of plant propagule:- suitable explant must be selected for development of a good quality synthetic seeds
2. Selection of coating material:-Since the coating material of capsules is largely accountable for the direct surroundings of the plant material, thus proves that it has a significant impact on the eventual sustainability of the synthetic seed.
3. Encapsulation:-Plant propagule is mixed with the gelling agent and this individual plant propagule along with the gelling agent are dropped into the complexing material using a pipette. As soon as the mixture is dropped the complexing begins leading to ion exchange between the gelling agent and complexing material. The time for which this ion exchange is allowed to take place is called exposure time.
4. Drying and storage:-The synthetic seeds are removed from the complexing material and dried for short time and stored at room temperature or cold storage.
5. Green house or field planting:-Once the synthetic seeds beads are ready they are planted in the green house or field for evaluating their regeneration.

Factors affecting germination and storability of synthetic seeds

1. Concentration of coating material
2. Exposure time
3. Size of somatic embryo
4. Storage temperature
5. Substrate used for regeneration

Seed quality problems mitigation by synthetic seeds

Genetic purity maintenance:- Genetic purity is defined asthe percentage of contamination by seeds or genetic material of other varieties or species. The genetic purity of any commercial agricultural product propagated by seed begins with the purity of the seed planted.Where as in thecase of synthetic seeds the demand of maintaining the genetic purity dose not arise because all the seeds that are produced are from the single callus so they are 100 percent true to type.

Generation system:-In true seed production, we follow generation system *i.e*., breeder seed, foundation seed, and certified seed. Production of a different class of seeds is tedious,time-consuming and a high cost involving process but synseeds are a viable option because there is no such class followed, less cost is involved and not time-consuming.

Low Seed Multiplication Ratio:- Seed multiplication ratio is the number of seeds that can be produced from a single seed when it is sown and harvested. Seed multiplication ratio of few crops are as high as 1: 80 in paddy, 1:100 in maize and 1: 200in bajra. But, it is low as 1:4 and 1: 8in case potato and groundnut respectively. Due to low seed multiplication ratio, the area required for theproduction of these crops will be more. In thecase of synthetic seed technology seeds of this low seed multiplication ratio, crops can be produced in less time and more number because numerous somatic embryos can be produced from a single callus.

Seasonal bearing:- In some vegetable crops seeds can only be produced in a particular season like in case of seedproductionof cole crops can be done only in rabi season where the plants need to be over wintered to produced seeds. But in thecase of synthetic seeds, such a problem does not arise because they can be produced *in vitro* condition so they can be produced throughout the year.

Weeds and off types:- Maintenance of physical purity is of prime importance because it tells us the proportion of pure seed component in the seed lot as well as the proportion of other crop seed, weed seed, and innert matter. So maintainance of physical purity is of prime importance. In order to maintain the physical purity,rouging is followed which is also a skillful task and labour concentrated process. In case of synthetic seeds technology such problem of diseased seeds, off types does not arise because all seeds that are derived are from single callus or few identicalcallus and in *invitro* condition.

Cost of Hybrid seed production:- At present hybrid seeds of different crops are produced using CGMS, GMS and hand emasculation and pollination system that requires maintenance of three line or two lines system respectively and there is always achance for presence pollen shedder selfed seeds in the hybrid seeds lots. By applying the synthetic seed technology for the hybrid seed production, the problem of maintaining parental lines, the chance of admixture in can be overcome. In addition, the area devoted to seed production could be diverted for the crop production and also the cost of hybrid seeds could be reduced.

Seed health:- Indian agriculture has witnessed several disease outbreak of seed borne nature during part decades. Some disease also lead to famine like thelate blight of potato caused by *Phytophthora infestans* andbrown spot of rice*Cochliobolusmiyabeanus.* Due to infection by such seed borne pathogen there will be loss of germination and vigour, development of plant disease, discolouration and shriveling, biochemical changes and poor plant population leading to low yield. As synthetic seeds are produced under aseptic condition, the resulting seeds will be free from any seed borne pathogens provided explant used must be disease free.

CONCLUSION: Synthetic seeds technology offer some unique advantages in agriculture. However, commercial application of synthetic seeds was hampered due to technological components. With the advancement of technologies in the recent decades, many of these technological limitations are being overcome. Although thesuccessful application of synthetic seed technology is limited to only a handful of crops, it is expected that this technology will be increasingly extended to a wider range of crop plants.

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Green pesticides: A Potential source of Integrated Pest Management

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INTRODUCTION: Insects are most diverse and largest class of the animal kingdom, it includes nearly 80% of the known animal species among them most of the insects are beneficial to human beings in one or the other way likely some of the insects performs predators and parasitoids against the pest and some insects play an ecological role like scavengers, pollinators, etc and direct benefit to human kinds in production of silk and honey. Apart from some insects act as pests, directly damage to the plants and indirectly transmit some viral disease to plants and as well as human beings. From way back to till date use one or the other chemicals to manage this pest in the name of pesticides. Normally pesticides are the chemical substances or poisons, target to harmful insect pests. By usage of various chemicals to plant ecosystem and public places, certainly, we got good insect control and enhance the crop yield and reduce the vector born disease problem in human beings. However indiscriminate usage of pesticides causes a serious negative impact on the environment as well as a public concern. For this instance development and use of harmless pesticides is necessary. Therefore, looking for alternative possible and viable solution to address this issue, green pesticides are the best approach for the present situation.

Concept of Green pesticides:

Green pesticides are normally called as an ecological pesticide because pesticides are obtained from organic sources, which consider as an environment-friendly nature and reduce the pest population problem. Simentaniouly, green pesticides can reduce the pests problem as well as increase food production and also more compatible with the environment components than synthetic pesticides. present concept of green pesticides include substances such as plant extracts, hormones, pheromones and toxin obtained from organic origin and also many aspects of pest control agents such as microbial, entomophagous nematodes, plant-derived pesticides, secondary metabolites from the microorganisms, pheromones and genes used to transform crops for resistance to pests and even biodegradable synthetic and semisynthetic products are considered as umbrella of green pesticides.

Significance and advantages of Green Pesticides

Nearly past 50 years, more than 2000 plants belonging to different families have been reported to potential toxic principles. The botanicals are normally broad-spectrum, safe to the environment, unique in action, and it can be easily processed and applied. Plants contain secondary metabolites like terpenoids, alkaloids, glycosides, phenols; tannins etc. play a major role in behavioural and physiological effects on insects. Apart from many plants essential oil shows a broad spectrum of activity like antifeedant, repellent, oviposition deterrent, growth regulatory and antivector activities. Green pesticides prove effective organic food production as well as solve the resistance problem in insects, ultimately greatest impact on integrated pest programme because of their low mammalian toxicity, no health hazards, no environmental pollution, no risk of developing pest resistance, no adverse effect on plant growth, seed viability and cooking quality of grains and Less expensive and easily available. Due to these various advantages of green pesticides, it can be considered an important alternative source for synthetic chemical pesticides. For considering the importance of the less

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harmful effect of environment and public health, compounds such as pyrethroids, neonicotinoids or insect growth regulators and biological insecticides such as spinosyns, azadirachtin and *Bacillus thuringiensis* as green alternatives for chemical pesticides.

Plant-based pesticides: These pesticides are normally mixture of chemical substances obtained from purely different parts of the plants, it may be leaf, stem, shoot, bark, flower and fruits etc They comprise, normally rotenone, d-limonene, sabadilla and ryania, besides pyrethrum and nicotine, However, the most promising botanical insecticide is azadirachtin (Katsuda, 1999), triterpenoid isolated from the seeds of the Indian neem tree (Brahmachari, 2004). Neem products are extracted from *Azadirachta indica* and Main active ingredients of neem are azadirachtin, meliantriol, salannin, nimbin, desacetylnimbin, and nimbidin. Azadirachtin concentration from 0.2 to 0.6% in seeds compared to other plant parts. Azadirachtin possesess a broad range of mode of actions on various insect pests such as repellents, antifeedant, insect growth regulatory and anti-ovipositional properties have unique among all currently available insecticides. Azadirachtin is most effective against nearly 550 insect species, mostly on Dictyoptera, Orthoptera, Heteroptera, Isoptera, Lepidoptera, Diptera, Coleoptera, Homoptera, Siphonaptera and Hemipteran orders. Although, Neem extract is the most effective insecticide against various sucking insect pests, like, whitefly, jassid, and mites (Ishaaya, 2003).

Pyrethrum is one of the most important botanical pesticides used in India, which is extracted from the flowers of *Chrysanthemum cinerariaefolium.* The highest concentration of pyrethrum is found mainly in the flowers compared to other parts of the plant. Normally Pyrethrum is the mixture of six active ingredients, namely, pyrethrin I, pyrethrin II, cinerin I, cinerin II, jasmolin I, and jasmolinII. Pyrethrin I, cinerin I, and jasmolin I are the esters of chrysanthemic acid, whereas pyrethrin II, cinerin II, and jasmolin II are the esters of pyrethric acid. Pyrethrins are the most dominant form of active ingredients compared to cinerins and jasmines in terms of concentrations.

Neonicotinoids: Nicotine and nicotinoids have normally tested and used against the various insect pests. Nicotine is obtained from extract of tobacco plants which is used for control of sucking pests, although it has narrow spectrum and high mammalian toxicity. Furthermore, synthetic nicotinoids have been developed and used, but it has fewer features to full fill the commercialization aspects. Subsequently, researchers have been developed a novel class of synthetic compounds called neonicotinoids. Usually, neonicotinoids possess an electron-withdrawing group, either a nitroimino, cyanoimino or nitromethylene moiety (Tomizawa & Casida 2003). Neonicotinoids have unique properties and broad-spectrum of insecticidal activity (sucking and chewing insects), low application rates, as well as lacking cross-resistance to other insecticides. Because of this nature, neonicotinoids are increasingly used in crop protection as well as animal health care. The first successfully used neonicotinoid insecticide was imidacloprid and this is the first generation Neonicotinoids. Many other neonicotinoids, imidacloprid is efficient at low rates and is safe for both human beings and the environment. Another second-generation neonicotinoids are Thiamethoxam, these chemicals are mainly used for foliar or soil treatment and seed protection against the various homopteran, coleopteran and some lepidopteran pests. This compound and related structures have low acute dermal and inhalation toxicities.

Spinosyns and spinosoids: Spinosyns are a new class of lactone-derived macrolides of *Saccharopolyspora spinose*. Spinosad is a commercially available formulation and the mixture of natural spinosyns A and D in a ratio of about 85 to 15. Spinosad has broad spectram of action against the various insect pests, especially against lepidopterans and dipterans (Sparks et al., 1998). Besides, a variety of pests, spinosyns is more active than organophosphorus and carbamate insecticides. Furthermore, spinosyns have a unique mode of action and they show both rapid contact and ingestion activity in insects. Several studies suggest that insecticidal compounds alter both nicotinic and gamma-aminobutyric acid (GABA) receptors. The existence of a novel mode of action is quite important to minimize the potential cross-resistance, as compared with classical synthetic insecticides.

Insect growth regulators (IGRs)

Insect growth regulators (IGRs) are the compounds that alter the normal growth of insects and these compounds interfere with insect metamorphosis, embryogenesis or reproduction. Among the IGRs, Juvenile hormone and chitin synthesis inhibitors are the majors. The main advantages of these compounds are low mammalian toxicity and species-specific. Juvenile hormones have taken part in two important processes like regulating the metamorphosis and production of eggs in female insects and due to its specificity of these function juvenile hormone have attracted attention towards the development of biorational insecticides. Apart from juvenile hormones (JHs) are usually too unstable to use as practical insecticides, this features provoked intense research in the field of development of juvenile hormone analogues (JHAs), normally called as juvenoides, either naturally occurring or synthetic one. These juvenoides acting by inhibit the developmental process associated with embryogenesis, morphogenesis and reproduction. Methoprene and hydroprene are commercially used insecticides in the household situation. However agricultural use of JHAs has been scanty, because of their lack of outdoor stability and limited insect control and their slow toxic action nature.

Chitin synthesis inhibitors are another major source of insect growth regulators and Chitin is a homobiopolymer of N-acetylglucosamine found in invertebrates, especially in insects and crustaceans, to provide rigidity and serves as a mechanical and protective barrier for thenatural condition. Several natural compounds have found to inhibit the biosynthesis of chitin in insects and also considered as potential insecticides. For instance, natural trehazolin, allosamidin, to till date, two different groups of compounds interfering the chitin biosynthesis against insects namely, the first group consists nucleoside peptides, such as Nikkomycin-Z, obtained from the culture of *Streptomyces tendae* and second group consists of N-acyl urea derivatives, such as diflubenzuron. Some other compounds like pyridazinone-substituted 1,3,4-oxadiazoles compounds exhibit insecticidal activity. Thus, compounds seems to block the incorporation of N-acetylglucosamine into chitin biosynthesis, whereas pyridazinone-derived insecticides are found to show juvenile hormone effects and potent antifeedant activity against larvae of some insects, such as *Pseudaletia separata, Pieris rapae and Plutella xylostella* (Huang et al., 2003).

Microbial insecticides: Microbial insecticides are contained microorganisms and their by-products, usually; microbial insecticides are commonly called as biological pathogens. Normally these pathogens comprised of Virus, bacteria, fungi, protozoa and nematodes and these microbial insecticides are commonly available in dusts, liquids, wettable powders and granules to form for application. Microbial insecticides are nontoxic and non-pathogenic to non-target organisms and it will work based on species specific and it will not cause any harmful effect to beneficial insects, this is the biggest strength in microbial insecticides. *Bacillus thuingiensis* var. *kurstaki* and *Bacillus papillae* (milky spore disease) can kill a wide range of lepidopterans and Japanese beetle larvae respectively. Most of the viruses are nuclear polyhedrosis viruses (NPV's), in that numerous virus particles are packaged together in a crystalline form within insect cell nuclei or granulosis viruses (GV's), in that one or two virus particles are surrounded by a granular or capsule-like protein crystal found in the host cell nucleus. These groups are normally infected to caterpillars and the larval stages of sawflies. Fungal pathogens are another important microbial pathogens, it can infect eggs, immatures and adults of a variety of insect species. *Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi, Vericillium lecanii, Lagenidium giganteum* and *Hirsutella thompsonii* are important fungal pathogens for various insect species. *Nosema* and *Vairimorpha* are important protozoan pathogens. The entomogenous nematodes are *Steinernema feltiae* (*Neoaplectana carpocapsae*), *S. scapteriscae*, *S. riobravis, S.carpocapsae* and *Heterorhabditis heliothidis* are the most commonly used entomopathogenic nematodes.

CONCLUSION: Green pesticides are important pest control agents, in the context of normally wide range of action, economically viable, environmentally safer and easily biodegradable nature than any other synthetic pesticides because of their natural origin. Naturally occurring compounds such as plant-based chemicals, neonicotinoids, spinosyns and spinosoids, Insect growth regulators (IGRs) and Microbial insecticides are proved efficient insecticides against some insect pest species. Although green pesticides are a slow mode of action, not produce the immediate Knockdown effect and lack of residual action. Because of this nature, farmers are normally won't prefer green pesticides than any other synthetic pesticides. Scientists and researchers should have concentrate and solve this issue and increase the production and usage of green pesticides in the global market for better and organically productions of food crops for sustainable development.

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IPM approach for thrips management in vegetable and ornamental crops

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INTRODUCTION

Thrips are among the most important pests of horticultural and ornamental crops globally. Thrips reduces yield and value of the crop directly by using them as food and oviposition site and indirectly by transmitting viral diseases. Their infestation can negatively impact global trade due to the quarantine risks associated with several species in the order. Thrips are tiny slender insects with fringed wings comes under the order Thysanoptera. The majority of scientific literature related to economics of thrips deals with four globally important thrips species. Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande), is one of the most destructive insect pests of commercial greenhouses worldwide, feeding on a wide variety of horticultural crops. The chilli thrips, *Scirtothrips dorsalis* Hood, is an important pest of various vegetable, ornamental and fruit crops in southern and eastern Asia, Africa, and Oceania and is one of the limiting factors for chili production in India. Onion thrips, *Thrips tabaci* Lindeman, is a major pest of importance in commercial onion production in India and Asian countries with significant yield losses. Melon thrips, *Thrips palmi* Karny is a polyphagous species, but is best known as a pest of *Cucurbitaceae* and *Solanaceae*.

Damage caused and symptoms of thrips infestation

The pest status of thrips can be attributed to its polyphagous nature, high reproductive rate, short generation time, high survival of cryptic (nonfeeding prepupa and pupa) instars, ability to reproduce without mating (parthenogenesis), ability to transmit plant pathogens, and development of resistance to insecticides. They feed by puncturing the epidermal (outer) layer of host tissue and sucking out the cell contents, which results in stippling, discoloured flecking, or silvering of the leaf surface. Thrips feeding on plants can damage fruit, leaves, and shoots and very noticeably affect plants cosmetic appearance. Extensive feeding can stunt plant growth and causes damaged leaves to become papery and distorted, develop tiny pale spots and drop prematurely.

Apart from causing direct damage by feeding on its host, several thrips also transmits a number of deadly viral diseases to plant. Chilli thrips, *S. dorsalis* vectors seven plant viruses including chilli leaf curl virus (CLC), peanut necrosis virus (PBNV), peanut yellow spot virus (PYSV), tobacco streak virus (TSV), watermelon silver mottle virus (WSMoV), capsicum chlorosis virus (CaCV) and melon yellow spot virus (MYSV). Western flower thrips also transmits Tomato spotted wilt virus (TSWV), which can severely damage or kill certain vegetable crops. Onion thrips is known to transmit (TSWV), tomato yellow fruit ring virus (TYFRV), and impatiens necrotic spot virus (INSV) in other crops.

Thrips management - An integrated approach

Incursions of thrips are difficult to control due to their inconspicuous nature. IPM is an approach that aims to reduce pest status to tolerable levels by using methods that are effective, economically sound while minimizing environmental impact. Effective management of thrips can be achieved through integrated program that combines the regular pest monitoring, use of natural enemies, good cultural practices, and the use of most selective and least-toxic insecticides.

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Monitoring of thrips infestation

Early detection and regular monitoring of insect pest infestation in field is the key to implement integrated pest management tactics. One essential component of IPM is field monitoring/scouting and growers use information gathered from scouting to select and schedule appropriate control tactics.

One method frequently used for detection of thrips infestation is branch beating or gently shaking foliage. If thrips are a suspected cause of plant damage, thrips adults and larvae can be monitored by branch beating or gently shaking foliage or flowers onto a light-colored sheet of paper, beating tray, or small cloth. For thrips that feed in buds or unexpanded shoot tips, clip off several plant parts suspected of harbouring thrips, place them in a jar with 70% alcohol (ethanol), and shake vigorously to dislodge the thrips. This method can be effectively used in greenhouse and small farms.

Among other monitoring methods, use of blue and yellow sticky traps has been demonstrated to be helpful for evaluating the degree of thrips infestation in various greenhouse and field crops. Additionally, sticky traps can also provide a way to control pest insects on various crops.

Biological Control

Natural enemies of insect pests play a key role in reducing the levels of pest populations below those causing economic injury. Both natural and applied biological control tactics can be important in successful management of pest populations.

Various biological control agents, including predatory thrips, green lacewings, minute pirate bugs, mites, and certain parasitic wasps help to control plant-feeding thrips. Minute pirate bugs, *Orius* spp. (Hemiptera: Anthocoridae) and entomopathogenic nematodes, *Thripinema* spp. (Tylenchida: Allantonematidae), have been reported to effectively control field populations of the chilli thrips. Adults of *Orius insidiosus* feed on all the life stages of thrips. *Orius insidiosus* also feeds on aphids, mites, moth eggs and pollen, its population does not decline strongly even if thrips populations are drastically reduced. Two phytoseiid mites, *Neoseiulus cucumeris* and *Amblyseius swirskii*, are potential biological control agents of the chilli thrips. *Amblyseius swirskii* can be a promising tool in managing chilli thrips on pepper.

Thrips parasitoids are found in three families (Eulophidae, Trichogrammatidae, Mymaridae) and several genera. Eulophid wasps in the genera *Ceranisus*, *Thripobius*, *Goetheana*, *Entedonastichus* and *Pediobius* are solitary internal parasitoids of thrips larvae. Other natural enemies like lacewings, *Chrysoperla* spp., ladybird beetles predatory thrips, such as *Franklinothrips vespiformis* (vespiform thrips), *Scolothrips sexmaculatus* (sixspotted thrips), *Selenothrips rubrocinctus* (redbanded thrips), *Leptothrips mali* (black hunter thrips), and predatory phytoseiid mites, such as *Amblyseius* spp., *Euseius hibisci* and *Euseius tularensis* also effectively control field population of thrips.

Cultural Control

Cultural controls are prophylactic method to avoid or restrict the pest infestation. Because cultural controls are preventative rather than curative, they need long-term planning. Following are cultural practices for effective management of thrips.

- Avoid planting susceptible alternate hosts plants near the main crop.
- Control of weeds which act as alternate hosts.
- Use thrips resistant cultivars.
- Provide appropriate cultural care to keep plants vigorous and increase their tolerance to thrips damage.

- Installation of blue and yellow sticky traps
- Keep plants well irrigated, and avoid excessive applications of nitrogen fertilizer, which may promote higher populations of thrips.
- Prune and destroy injured and infested terminal plant parts.

Reflective mulching

Mulch or mesh that reflects light interferes with certain flying insect's ability to locate plants. Reflective plastic mulch, or silver colored plastic mulch, significantly reduces arthropod pests such as thrips, spider mites, and whiteflies. Thrips locate suitable host plants part through visual cues in the UV spectrum, materials that reflect UV radiation could obscure host location cues used by thrips. The light reflection repels and confuses these pests, with often controlling pest more effectively than insecticides. In addition to repelling certain flying insects, mulch may improve growth of certain crops by increasing light levels, keeping soil warmer overnight, reducing weed growth, and conserving soil moisture. Organic mulch, such as wood chips, cover crop residues, or straw, can reduce thrips and leaf miner numbers significantly. Silver or gray is the most effective color for synthetic reflective mulch.

Insecticides compatible with thrips IPM

Contact insecticides that do not leave persistent residues can be effective for greenhouse thrips and other species that feed openly on plants. Contact insecticides include azadirachtin, insecticidal soaps, narrow-range oil, neem oil, and few pyrethrins combine with piperonyl butoxide are effective for thrips and safe for natural enemies and pollinators. To be effective, contact sprays must be applied to thoroughly cover buds, shoot tips, and other susceptible plant parts where thrips are present.

Spinosad is more effective against thrips due to its longer persistence and translaminar activity to reach thrips feeding site in protected plant parts. Adding horticultural oil to the spray mix can increase its persistence within plant tissue.

Insecticides to avoid for thrips IPM

Neonicotinoids have low, moderate, or severe adverse impact on natural enemies and pollinators varying with the product, situation, and the species and life stage of invertebrate. Imidacloprid commonly fails to provide satisfactory thrips control, and generally is not recommended for thrips. Neonicotinoid insecticides can translocate to flowers and may harm natural enemies and pollinators that feed on nectar and pollen.

Acephate can be highly toxic to natural enemies and pollinators and can cause spider mites to become abundant and damage plants after its application. Avoid foliar sprays of other organophosphate insecticides (e.g., malathion), carbamates (carbaryl), or pyrethroids (e.g., bifenthrin, cyfluthrin, fluvalinate, and permethrin). These materials are highly toxic to natural enemies and pollinators, can cause spider mite outbreaks, and are not particularly effective against most thrips.

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CONCLUSION

Thrips are hard to control pest and their management is difficult by traditional pesticides. Its successful management is only possible with early detection and immediate implementation of integrated pest management approach. Use of plastic ultraviolet (UV) reflective mulches is the promising cultural control method. Growing vegetables on plastic mulches is a standard cultural practice because these materials provide several benefits, including improved retention of irrigation water and soil moisture, conservation of soil applied fertilizers, modulation of soil temperatures, and weed suppression. Although thrips damage is unsightly, it does not usually warrant the use of insecticides in gardens and landscapes. Thrips can be difficult to control effectively with insecticides, partly because of their mobility, feeding behavior, and protected egg and pupal stages. If insecticides are used, combining their use with appropriate cultural practices and other methods usually improves the pest control.

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Important Diseases and Pests of Mushroom

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Mushroom diseases:

Mushrooms are attacked by a large number of fungi, bacteria, mites, nematodes and viruses. Each mushroom species in a specific environment has different pest/disease complex. Even a little carelessness in the cultivation of mushroom can cause havoc in the mushroom industry. Improper pasteurization of compost and casing becomes a major source of infection of fungi and bacteria. Once the disease has been introduced, it attracts mushroom flies, a common pest among cultivated mushroom species, on the smell of decaying mushroom.

[A] Fungal diseases

(1) Dry Bubble:

Caused by *Verticilium fungicola*, The fungus produces numerous one celled thin walled, oblong to cylindrical, hyaline conidia, 3.5-15.9 x 1.5 - 5u on lateral or terminal, verticillately branched conidiophores (200-800 x 1.5-5.0 u). Conidiophores are relatively slender and tall. Conidia accumulate in clusters surrounded by sticky mucilage. The fungus abounds in soil. Dry bubble, disrupted growth of pin or buttons into ball-like mass, generally the size of grape or longer. Also, there is stem (stipe) "blow-out" where the stem shatters and the cap tilts slightly.

- The pathogen arrives on the cap in splashed water or hands or tools and implements of a picker, dust particles, flies on clothing of workers. This disease causes a crop loss of about 50% upto 70%.

Management: Proper pasteurization of compost as well as casing material and control of insect vectors like-flies, mites, nematodes, etc.

Chemical control: Di-ethane Z-78, Sporgon, Topsin M may be applied in the stage of infection.

(2) Soft Mildew or Cobweb:

Caused by *Dactylium dendroides,* Cobweb appears primarily as small white patches on the casing soil which then spreads to the nearest mushroom by a fine grey white mycelium. A floccose white mycelium covers

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the stipe, pileus and gills, eventually resulting in decomposition of entire fruit body. As the infection develops, mycelium becomes pigmented eventually turning a delicate pink cover.

- Fluffy white cobweb-like growth occurs over the surface of casing soil. Initially white, later it changes to pink colour. Attacked mushroom buttons appear on the surface but are rotten from inside.
- The chief source of infection for this disease is soil humidity, particularly when grown in wet trays.

Management: Good ventilation and prevention of excess humidity in mushroom house to prevent further development of disease.

Chemical control: Best control of disease by applying bavistin + TMTD at 0.9 and 0.6g/m2 followed by TBZ and benlate (0.9g/ m2). Di-ethane Z-78@0.2% and disinfection of mushroom house with formalin solution before starting with new crop.

(3) Green Mould.

This is widespread in soil. Spores are ovoid, rough walled, green and measure 2.8-5x2.8-4. The colony emits coconut odour. This fungus grew slowly at 27°C but faster at 20°C. Caused by *Trichoderma viridae,* the fungus appears in the form of green patches on the trays generally after spawning and casing. The fungi are mostly used as a bio-control against several fungi. The disease occurs in the spawn trays. It also appears after casing; hence it also affects pinhead formation as well as development of enlarged pinheads.

Management: Fungus is favored by improperly pasteurized compost and high humidity in mushroom house, therefore humidity should be maintained. Very good hygiene, Proper pasteurization and conditioning of compost. Using the correct concentration of formalin (maximum 2%).

Chemical control: Weekly sprays of mancozeb (0.2%) or bavistin (0.1%) TBZ (0.2%) or treatment with zineb dust or Calcium hypochlorite (15%) have given effective control of the disease.

[B] Inky Cap:

Common name: Ink weed, wild mushrooms. It is caused by *Coprinus lagopus,* Appearance of long slender stalk with a small slender cap. The slender stalk with thin cap in due course of time dissolves into black inky liquid. Ink caps appear in the compost during spawn run or newly cased beds and outside the manure piles during fermentation. They are slender, bell-shaped mushrooms. Cream coloured at first, blueishblack later and are usually covered with scales. This fungus sometimes grows in clusters in beds and has a long sturdy stem which often reaches deep into the compost layer. Several days after their appearance ink caps decay and form a blackish slimy mass due to autodigestion.

- The disease is favoured by ammonia, which might have been present in compost while peak heating. The black inky liquid confirms the presence of ammonia in the compost.

Management: complete removal of ammonia during compost preparation. If profuse growth occurs, compost from spawned trays should be re-pasteurized. Re-pasteurized compost should be filled in trays, spawned and cased again. Avoid excessive watering. Rogue out young fruit bodies of the weed fungus to avoid its further spread.

[C] Bacterial diseases of Mushroom:

Bacterial Pit or Brown Blotch Caused by *Pseudomonas tolaasii.* Symptoms: The disease produces pale yellow spots on the surface of the pileus which later turn brown. Pits are often found below the surface. In several cases, infected mushrooms are radially streaked.

- The mushrooms are attacked in storage and transit. Bacteria may also be present in soil and water used for mushroom growing. The incidence is highest when mushroom is watered while still very small and humidity is very high and water cannot evaporate quickly. Possibly the Tryoglyphid mites carry the pathogen.

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Management: By control the mites, disease is automatically controlled.

[D] Viral diseases:

Viral diseases have not been reported from India causing infection to mushroom crop. However, the presence of viral particles in mushroom fruit body causing a disease has been reported from other countries. The syndrome includes brown fruiting body, watery stipe and die-back disease etc. The diseased mushroom becomes leathery, shriveled and changes colour to brown in normal dry condition. The transmission of viruses occurs through phorid larvae and tarsonemus mites. The mushroom species including Lacaria lacata have been reported to be the reservoir of mushroom viruses.

Management: Mushroom house should be heat sterilized before starting the crop. Disinfection of mushroom with 4% molybdate solution is also recommended. Phorid should be controlled with systemic insecticide to check further spread of disease.

[E] Nematode diseases:-

There are 3 kinds of nematodes found in the mushroom house. They develop in improperly prepared compost and casing material. The plant parasitic nematode bear stylet which help puncturing the mycelium and sucking its contents. As the nematode feed on the mycelium, it starts disappearing from mushroom trays. Nematodes also feed on the pinhead and caps.

After attack, mushroom becomes brown in colour, watery and stipe becomes stunted. There are several species including-:

1.*Dytelenchus mecelophagus.*

2. Aphalenchoides compositicola, which feed on mushroom.

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Nematodes, apart from feeding on the mushrooms also act as vectors for several viral, bacterial (eg *Pseudomonas tolaasii*) and fungal diseases.

Control:

Keeping in view the nature of the crop, limited availability of safe and potent nematicides, residue problems and other hazards of nematicides it is better to prevent entry of nematodes into the beds rather than controlling them afterwards. So for there is no curative measures which can be adopted during cropping stage. Hence, only control measure to follow is an integrated approach. 40 ml Nemagon in 10 l water for 30 kg wheat straw while or at the time of composting.

Sanitation and hygiene:

Hygiene covers all the measures which are necessary to allow as little chance as possible to the pests and pathogens to survive, develop and spread. Thus hygiene and sanitation go hand in hand at all stages of growing mushrooms. Farm hygiene is the best defense a mushroom grower has against mushroom pests and diseases particularly during the present days, when use of chemicals on food crop is being discouraged.

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Gene Deployment: An alternative approach for disease resistance in crop plant

Article id: 22449

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Plant breeder are generally concerned about durability of resistance gene that they are going to incorporate in crop plant for biotic stress. While, resistance which is controlled by single qualitative major gene (i.e. vertical resistance) is easy to control but the other one controlled by multiple minor gene (i. e. horizontal resistance) is difficult to handle. On account of high degree of resistance due to major genes the pathogen comes under strong selection pressure that becomes a cause of new races or multiplication of less important races due to reduced competition from strong and predominant races. There are number of ways by which one can convert non -durable resistance to durable one with the help of gene deployment and gene pyramiding. Exploitation of quantitative gene and gene deployment can be helpful in achieving durable resistance. There are several approaches for gene deployment in a crop plant to achieve durability of resistance. Prevention of epidemics has been of great concern and the measures to be adopted for this purpose are genetic diversity within and between varieties using vertical resistance and use of horizontal resistance. Therefore, gene deployment in a crop plant can be considered as an alternative approach for disease resistance having durability feature without compromising economic feasibility.

INTRODUCTION

The contribution of crop improvement to feed the ever-growing world population is quite eminent. However, it also generates some undesirable effects like genetic erosion and vulnerability of the improved cultivars to az to be durable, nor how to distinguish durable resistance from non durable resistance, nor even what criteria to use to decide whether a resistance is durable. The exploitation of genes with known durability, the use of quantitative resistance and the use of gene deployment can lead to the better ways of achieving durability of resistance. This study intends to review the various approaches of gene deployment to ensure durability of resistance to diseases.

Because of the wide use of genetically uniform varieties a situation known as the 'boom' and the 'bust' cycle occurs. This concept was first proposed by Priestley and it describes the situation, particularly with regard to cereal varieties. When a new variety with a vertical resistance is developed it soon becomes popular and the area under this cultivar increases. This stage is called as the boom. However, when a new race of the pathogen starts to appear and epidemic occurs, the cultivar loses its popularity and the area under it declines.

Disease resistance: It is the inherent ability of a plant to prevent or restrict the establishment and subsequent activities of a potential pathogen. Resistance is of two types viz., vertical resistance and horizontal resistance. According to Vanderplank vertical resistance is effective only against the initial inoculum reaching a field or a plot. Only horizontal resistance remains in the second cycle onwards with some exceptions.

Durability of resistance: Resistance that remains effective in a cultivar that is widely grown for a long period of time in an environment favorable to the disease is said to be durable resistance. It is exemplified by the "field resistance" of potatoes to the late blight disease.

Major gene resistance against biotrophic pathogens such as mildew and rust is generally highly unstable and non-durable. Polygenic resistance on the whole appears to be durable. In cases, where major genes are

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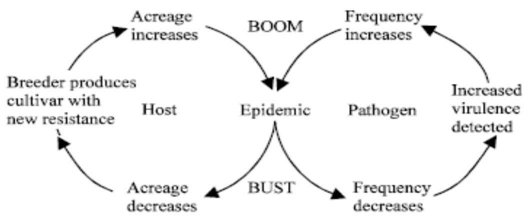
involved it is usually not difficult, but when the resistance is of a quantitative nature various problems may arise in trying to distinguish the more resistant entries from the less resistant ones. Although the pathway to durable resistance is very narrow, there have been some outstanding successes.



Non-durable major genes are used in combination it may be more difficult for the pathogen to build up races with a wider virulence spectrum (complex races). Such genes can be exploited in combination in two ways: 1) Through gene deployment 2) Through multiple gene barriers/gene pyramiding (physical combination in the same genotype)

Aternate approaches of gene deployment: Gene deployment is the guided distribution of genes in space and time. Gene deployment strategies are divided in to two broad categories as 1) spatial (gene deployment at the farm level, at the field level and at the region level) and 2) temporal.

Spatial gene deployment

Gene deployment at the field level: Spatial resistance gene deployment can also be done over a small geographic region such as within a single field. Several authors have explained that if a cultivar consists of individual plants that differ from each other in their resistance, the resultant heterogeneous plant population should reduce the rate of epidemic development and prevent selection of a single compatible phenotype in the pathogen population. Gene deployment at the field level includes variety mixtures, species mixtures, multi lines and multi blends.

Variety mixtures: Variety mixture refers to a homogeneous, spatial mixture of different genotypes of one plant species in a field. Disease resistance in multilines and variety mixtures depends on slowing down the development of the best-adapted race on each component. Mechanisms by which disease reductions are obtained in mixtures include a decrease in susceptible tissue and therefore a decrease in inoculum potential within the mixture, an increase in distance for spores to move from one susceptible plant to another, the physical barrier of resistant plants and possibly cross-protection whereby the defensive mechanisms of one component of the mixture may be activated by an a virulent isolate from another component. Variety mixtures have epidemiological advantage in that the interaction among neighboring plants in terms of spore dispersal leads to a reduction in disease spread relative to that in pure stands moreover cultivation of appropriate mixtures in an environment with a high disease risk provides a degree of high stability, which cannot be obtained from pure stands (buffering effects) another advantage is the use of cultivar mixtures ensures that the farmer does diversity among the cultivars available. However, perhaps the biggest problem with mixtures is finding the correct combination of varieties, the fear as to the development of "super-races" and Therefore, mixtures are widely used in developing countries like Ethiopia where quality is not a priority.

Species mixtures/ mixed cropping: The safest opinion for mixed cropping, which may indeed provide permanent protection for cultivars with durable resistance, is to grow species mixtures in which the important pathogens are incompatible with one or more of the host species used. Of the many examples available, mixtures of barley and oat cultivars are widely used in cereal producing countries. Mixed cropping of cotton species is common in the Malwa plateau of central India. Oat+barley mixtures have been suggested as an agro-technical method for controlling the oat sterile-dwarf virus disease.

Multiline varieties: The term multiline variety was first defined by Jensen as a blend of multiple pure lines, each of which is of a different genotype. Borlaug used an equivalent term 'composite' and proposed as a new approach for resistance to stem rust of wheat (Puccinia graminis tritici). According to Borlaug's definition, these are mixtures of a number of phenotypically similar lines, which are genotypically different for resistance to a disease. These are mixtures of several pure lines of similar height, flowering and maturity dates, seed color and agronomic characteristics, each of which has a different gene for resistance to the given disease. The term multiline in current usage designates a mixture of near-isogenic lines for resistance to a specific race of the pathogen.

By using multilines we can exploit horizontal resistance, which is otherwise difficult to achieve because of the complexities associated with its genetic mechanism, multiline varieties proved to live longer than their corresponding pure stands because of stabilized selection. Another advantageous features of multilines over variety mixtures is that all the component lines are phenotypically similar the only difference being the gene for resistance.

Multiblend varieties/mass reservoirs: Multiblend varieties are generally simple mixtures of existing lines or varieties.

Gene deployment at the farm level (inter field diversification): A very large area of a single variety, or a number of varieties with similar resistance factors, would be vulnerable to any corresponding virulent isolate in the pathogen population. A practical way to protect resistant factors, which the grower can understand and implement, is to diversify by growing a number of varieties, which differ in the form of their resistance to specific diseases. However, a crucial point is that for diversification to be successful, we need more precise information on the differences among cultivars in terms of the genetics and mechanisms of their durability. If the specific resistance genes in each variety selected differ, a pathogen race, which possesses specific virulence genes for one variety, will not spread to the other varieties. Diversification is used primarily in cereal varieties for reduction of mildew and yellow rust.

Gene deployment at the regional level: If the cultivars recommended in different regions of an epidemiological area carry consistently different resistance genes it would certainly reduce the rate at which complex races would develop. The probable success of regional gene deployment to suppress epidemics has good precedent.

Temporal gene deployment: Temporal gene deployment may include 1) sequential release of resistance genes where by each variety is used until populations reach the breakdown population level and is immediately replaced by another variety. The sequential release strategy has been employed for resistance to brown plant hopper (Nilaparvata lugens) at IRRI, 2) Variety rotations from season to season or recycling of resistance genes. Rotation of varieties with different resistances prevents selection of compatible isolates in populations of soil-born pathogens. This approach was used to control stem rust of wheat in Australia between 1938 and 1950.

Multiple gene barriers/ multigenes/ gene pyramids: An alternative to multilines is to pyramid desirable genes to provide a wide array of horizontal resistance. In some areas although a single gene confers resistance to the existing pathogen population, the large-scale use of this gene results in the breakdown of resistance. To delay such breakdown, pyramiding of more than one resistance gene was found to be effective. It is also known as gene stacking. In a way analogous to partial resistance breeding, the combining or pyramiding of resistance genes into individual cultivars has had considerable success in reducing the rate of evolution of pathogens particularly in situations where the pathogen does not reproduce sexually. However, in the future it is possible

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this may also be achieved by combinations of resistance genes that would require combinations of virulence genes that may have detrimental effects on pathogen fitness. When sufficient RFLP markers have become available the application of a multiple gene barrier will become much easier as the tracing of the individual resistance gene becomes much easier.

Achievements of the various approaches of gene deployment: In India wheat multiline varieties were developed that were resistant to Yellow rust and Brown rust. These were: Kalyansona lines KSML3, MLKS11, KML7406/Bithoor and Sonalika lines, MLSKA-9, MLSKA-12.

DNA marker assisted selection was used to pyramid four Bacterial Blight (BB) resistance genes, Xa-4, xa-5, xa-13 and Xa-21 in rice. According to these authors the pyramid rice lines showed a wider spectrum and a higher level of resistance than lines with only a single gene. Moreover, three Bacterial Blight (BB) resistance genes, xa5, xa13 and xa21 were successfully transferred to the New Plant Types (NPT) in rice. so that resistance would be long-lasting.

CONCLISION

Plant breeders are always incorporating resistance genes into their otherwise high yielding but susceptible crop varieties A number of ways have been suggested by different authors to achieve durability of resistance of which gene deployment, the guided distribution of genes in space and time, is one. Although costly, the use of multilines is quite a better approach of gene deployment. Because of their poor uniformity variety mixtures can be used only in countries where quality is less important than yield. The recent approaches of gene deployment like pyramiding of different resistance genes into a common background that are carried out using molecular breeding guided back crossing have global prospects where there is access to carryout molecular analysis.

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Nano-fertilizers and its balanced application for plant Nutrition

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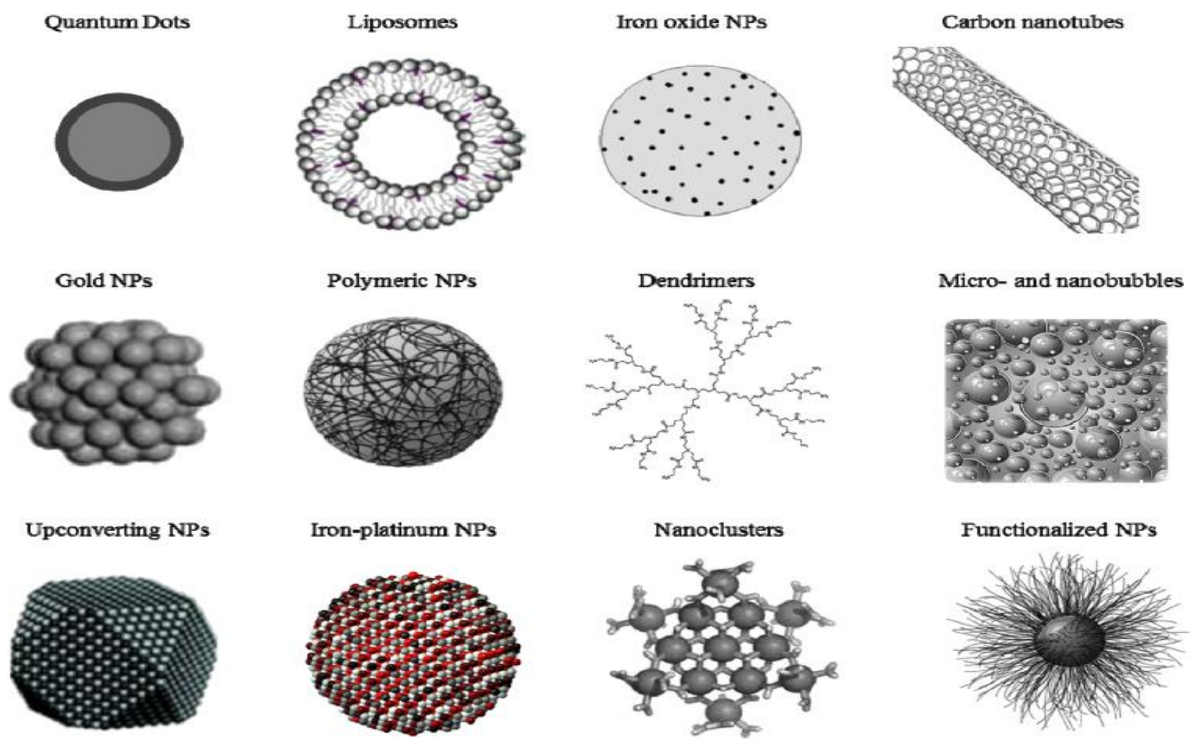
INTRODUCTION

Fertilizers are unavoidable factor in improving soil fruitfulness and efficiency of harvests paying little heed to the idea of trimming succession or ecological conditions. It has been unequivocally exhibited that 33% of yield profitability is managed by manures other than impacting use efficiencies of other agri-inputs. In the previous four decades, supplement use proficiency (NUE) of harvests stayed steady notwithstanding our constant endeavors. The supplements that are left in the dirt may go into the amphibian condition causing eutrophication. In addition to the low nutrient efficiencies, agriculture in developing countries including India is facing a problem of low organic matter, imbalanced fertilization, and low fertilizer response that eventually caused crop yield stagnation (Biswas and Sharma 2008). The fertilizer response ratio in the irrigated areas of the country has decreased drastically. It has been reported that 27 kg NPK ha^{-1} was required to produce one ton of grain in 1970, while the same level of production can be achieved by 109 kg NPK ha^{-1} in 2008. The optimal NPK fertilizer ratio of 4:2:1 is ideal for crop productivity, while the current ratio is being maintained at 6.7:3.1:1 in India due to the excessive use of nitrogenous fertilizers. In order to achieve a target of 300 million tons of food grains and to feed the burgeoning population of 1.4 billion in the year 2025, the country will require 45 Mt of nutrients as against a current consumption level of 23 Mt. The degree of multi-supplement lacks is alarmingly expanding step by step which is intently connected with a yield loss of about 25-30 %. The degree of supplement insufficiencies in the nation is of the request for 90, 80, 50, 41, 49, and 33 % for N, P, K, S, Zn, and B, individually. Subsequently, from all sources, the nation will be required to mastermind the inventory of around 40-45 Mt of supplements by 2025 (Subramanian and Tarafdar 2009).Nano-fertilizers are nutrient carriers of nano-dimensions ranging from 30 to 40 nm (10^{-9} m or one-billionth of a meter) and capable of holding bountiful of nutrient ions due to their high surface area and release it slowly and steadily that commensurate with crop demand.Subramanian et al. (2008) reported that nano-fertilizers and nanocomposites can be used to control the release of nutrients from the fertilizer granules so as to improve the NUE while preventing the nutrient ions from either getting fixed or lost in the environment. Nano-fertilizers have high use efficiency and can be delivered in a timely manner to a rhizospheric target. There are moderate discharge and super sorbent nitrogenous and phosphatic composts. Nanotechnology has given the plausibility of investigating nanoscale or nanostructured materials as manure bearer or controlled-discharge vectors for working of the supposed shrewd composts as new offices to improve the supplement use productivity and diminish the expense of ecological contamination (Chinnamuthu and Boopati, 2009). Al-Kazafy (2014) referenced that potential use and positive effects of nanotechnology are enormous. These effects incorporate expanding rural profitability including nanoporous zeolites for raising productive utilization both of water and manure by controlling their discharging.

Synthesis and Characterization of Nano-fertilizers

Nano-composts are blended by top-down (physical) or base up (synthetic) approaches. Top-down approach is a regularly utilized technique. In top-down approach, the adsorbent or substrate utilized for amalgamation of nano-composts, for example, zeolite or some other bearer is ball processed for a few hours to accomplish nanodimension. Normally, common zeolite estimates a scope of 1,000–3,000 nm, and granulating utilizing high-vitality ball factory decreased the size of the particles. Manikandan and Subramanian (2014) detailed that the ball processing of zeolite at 1, 2, 4, and 6 h had diminished the measurement 1,078, 475, 398, 357, and 203, separately. The size decrease intently corresponded with the expansion in the surface territory of 41, 55, 72, 83, and 110 $m^2 g^{-1}$. Such sensational increment in the surface zone gives broad surface region to supplement adsorption and desorption. In spite of the physical technique for nanoparticle combination is straightforward, the item is heterogeneous and particles frequently get agglomerated.



To counteract agglomeration, balancing out operators, for example, polymers or surfactants are utilized. Incorporated nano-composts are to be described utilizing molecule size analyzer (PSA), zeta analyzer, Fourier change infrared spectroscopy (FTI-IR), Raman spectroscopy, X-beam diffraction (XRD), examining electron magnifying instrument (SEM), vitality dispersive X-beam spectroscopy (EDAX), transmission electron magnifying lens (TEM), and nuclear power magnifying lens (AFM) to affirm the size, shape, charge circulation, practical gatherings, essential arrangement, surfactant connection, and sulfate connection. The synthesized nano-fertilizers have been characterized using the set of equipments listed above. Extensive studies had been undertaken to characterize nitrogenous (Manikandan and Subramanian 2014), phosphatic (Adhikari 2011),

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potassic (Subramanian and SharmilaRahale2012), sulfatic (SelvaPreetha et al. 2014), and zinc (Subramanian and SharmilaRahale 2012) fertilizers.

Effect of optimum application of Nano fertilizer in crop growth

Liu et al. (2005) reported that the kaolinenano-subnanocomposite was prepared by the methods of organic material intercalation under certain temperature and pressure. This compound was utilized as the establishing and covering material of moderate or controlled-discharge manure as a result of its solid adsorption and thickness to macronutrients and natural C. It likewise announced that the expansion of nano-subnano composites benefits the dirt and raises the used effectiveness of manure as a result of its incredible qualities. The physical adsorption and synthetic blend happened between supplement components and nanocomposites because of surface response and little size response of nanocomposites. They shaped the effective multifunctional compost, which uplifted the adsorption of supplement components by plants, brought down the filtering in soil, and the obsession of manure in the dirt. Liu and Zhang (2005) reported that the nano-subnanocomposites significantly affected or controlled the structure and penetrability of the soil, increased the organic mineral granule of thesoil, improved fertilizer storage and water holding capability in the soil, promoted action of microorganisms, regulated the ratio of C/N, enhanced the fertility of the soil, and so on. Improved yields have been guaranteed for manures that are joined into co-chleate nanotubes (moved up lipid bilayer sheets). The arrival of nitrogen by urea hydrolysis has been controlled through the inclusion of urease proteins into nanoporous silica.Eberl (2008) tested the controlled-release fertilizers in greenhouse pot experiments with sorghum–sudangrass using NH_4-saturated zeolite and P-rock with a phosphate application rate of 340 mg kg^{-1} soil and zeolite/P-rock ratios ranging from 0 to 6. Total phosphate uptake and phosphate concentration measured for the grass were related linearly to the zeolite/P-rock ratio, and yields summed over four cuttings were as much as four times larger than control experiments. Sultan et al. (2009) reported that the development of functional nanoscale films and devices has the potential to produce significant gains in the NUE and crop production.

CONCLUSION

Most nutrient sources added to the soil involve a monetary expense and, thus, should be utilized, as far as possible, during the vegetative growth period in order to obtain a quick return. Some residual effect during the following season should be acceptable, but losses should be kept low. The magnitude and duration of the residual effect depends on the nutrient, soil properties and cropping intensity. In agriculture, nanotechnology is least investigated, but the reported literature strongly suggests that nanoscience is expected to play a critical role in developing smart delivery systems. Balanced and adequate supply of plant nutrients through nano fertilizer is important in order to achieve a high degree of nutrient utilization by crops, which also results in lower losses. It has represented the potential to revolutionize in several aspect of food production for instances nanotechnology involved in production various nano-fertilizer. Nano-nutrient system is conducted to deliver nutrients in a regulated pattern in correspondence with the crop requirements and development stages thereby nutrients use efficiency may be developed without side effects. Also reported that nano- scale makes fertilizers nutrients more available to crops for long time than conventional fertilizers form and resulted in raising nutrient use efficiency and reducing environmental contamination with leached minerals. From other view, nanofertilizers may be used to minimize nitrogen loss due to leaching, emissions, and long-term reaction with soil microorganisms. They may permit for selective release related to time or environmental conditions.

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Nanofertilizers allowed minimizing side effects and negative impacts of conventional fertilizers by controlling its release This will enable the plants to produce larger biomass utilizing the available nutrients in the rhizosphere without associated ill-effects in the environment. Regulated and sustained release of nutrients assists in improving the nutrient use efficiencies. Though nutrient release is regulated through physical and chemical processes, the biological significance of nutrient release is yet to be clearly understood. More research is needed to address the smart delivery of nutrients, nutrient interactions at the physiological and molecular levels, antagonistic and synergistic interactions among nutrients, and biosafety of nano-fertilizers besides long-term impact of nano-fertilizers on physical, chemical, and biological properties of soils is yet to be determined.

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Proteomics: Its techniques and application in the field of agriculture

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Introduction the field of proteomics:

Proteomics is the field of molecular biology sciences, which deals with the study of the whole proteome profile of a particular cell. The major role of the proteomics is the study of structure and function of proteins, quantification of proteins and their qualitative analysis of proteins of a particular biological entity. The proteomics is the sub-branch of genomics, which involves the understanding of protein expression under different environmental conditions. Understanding the proteome profile helps in identification of crucial biological regulatory pathways of an organism which further can be subjected to alteration for crop improvement programs.

The broad role of proteomics:

The major role of proteomics is the identification and quantification of the proteome profile of an organism. The protein to protein interaction mechanism is studied to decode the role of an unknown proteins under the interaction proteomics.

Techniques to study proteomics:

The techniques to study proteomics is categorized into two major groups, namely gel-based and gel-free proteomics methods. The brief outline of these techniques is listed in Table-1.

1. **Gel based proteomics methods:**

   In this technique, the particular gel is involved to separate protein molecules. Further, these methods are conjugated with mass spectrometric analysis to quantify the amount of protein retrieved from an organism.

2. **Gel free proteomics methods:**

   These methods are the alternative methods, which often reduces the technical error associated with the gel based proteomics. Gel-free methods use tagging of particular proteins with labels and also uses the spectral counts to quantify the protein profiles.

Application of proteomics in agriculture:

1. Production of new drugs of plant origin to combat lethal disease
2. Production of nutrient-rich food supplements
3. Fortification of valuable crops to combat malnutrition problems
4. Imparting resistance in crop plants against pests and pathogens
5. Synthesis of value-added products of agricultural commodities
6. Identification of toxic components of microbes and their inclusion in pest management strategies
7. Development of toxin-based biopesticides and biofungicides

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Table-1: Techniques in the field of proteomics, its uses and limitations

Gel based methods			
S.no.	**Techniques**	**Uses and Application**	**Limitations**
1	2D-PAGE (Two Dimensional Polyacrylamide Gel Electrophoresis)	Separate proteins biomolecule based on differences in their molecular mass and pH gradients	Prone to manual errors while changing gels and narrow coverage
2	2D-DIGE (Two Dimensional Differential Gel Electrophoresis)	Superior then 2D-PAGE, in term of accuracy and reliability	Narrow coverage of proteome analysis, as tagging is done only for lysine and cysteine amino acids
Gel free label based methods			
S.no.	**Techniques**	**Uses and Application**	**Limitations**
1	Isotope-Coded Affinity Tags (ICAT)	Tagging of proteins with chemical synthesized isotopes labels and detection based on analyzing of MS spectra	The lower proteome coverage due to loss of information in MS spectra analysis
2.	Isotope-Coded Protein Labelling (ICPL)	As like ICAT, with improved adjustments in making isotope labels, labels lysine containing amino acids	The major drawback is labeling after digestion which is prone to manual error, and less mobility while separation by chromatography
3.	Isobaric Tags for Relative and Absolute Quantification (iTRAQ):	Tagging of proteins with chemical synthesized isotopes labels, multiplexing can be done with high acuracy	Needs additionally high throughput data to study exact mass differences
4.	Tandem mass tag	The technique is similar to iTRAQ, except different process of generating chemical tags	Sample preparation is hectic and needs skilled mass spectrometric data analysis experts
5.	Metabolic labelling	Based on incorporation of labeled isotope coded amino acids in biological samples	Less applicability in biological system and not cost effective for routine analysis
6.	Stable Isotopic Labelling of Amino Acids in Cell Culture (SILAC):	In vivo technique, where various combination of labeled amino acids can be incorporated	Laborious, costly and not applicable to all biological samples
Gel free label free methods			
S.no.	**Techniques**	**Uses and Application**	**Limitations**
1.	Spectral intensities measurements	Detection of ions intensity which is proportional to the quantity of peptides	During elusion, the loss of information occurs regarding the presence of low abundant proteins

2.	Spectral counting	Detection of number of MS/MS spectra which is proportional to the quantity of peptides	Loss or negligence of certain specific characteristics of proteins
3.	Global analysis	Based on comparison of fed and sample data, obtained through mass spectrometric analysis	Highly efficient method of protein detection with negligible limitations
4.	Target analysis	As compared to global analysis, only few peptides are taken into study	Negligible limitations

CONCLUSIONS:

There is an immediate need to explore the way to cop up the food demand of overgrowing population of the world. To devolve a unique cultivar with high nutrient content, adjusted to a harsh environment or resistant to pests and disease, one should understand the biological pathways regulating these mechanisms. The role of proteins in cell function is greatest, which is yet to be explored based on the objective of study. Over a while, a huge number of proteomics technologies have been discovered but not a single strategy is exactly efficient to study the whole proteome. In future, there is a huge scope of the unveiling of new technologies and improvement of existing technologies which will further boost the cultivar improvement programs.

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Citrus Thrips, *Scirtothrips dorsalis* Hood and its Management

Article id: 22452

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INTRODUCTION

The Thysanoptera (thrips) exist in a wide array of habitats and many species are serious economic pests of various crops. Several thrips species are important pests of citrus including citrus thrips, *Scirtothrips citri* (Moulton), *S. aurantii* Faure and*Scirtothrips dorsalis* Hood . Feeding injury by these species results in scarring of rind tissue in a fairly uniform ring encircling the stem end of the fruit and subsequent rind blemish injury results in the rejection of fruit for the fresh market. Young twigs, leaves and leaf buds are also fed upon by citrus thrips resulting in non-economic types of injury to the trees.

Pest identification

Adult citrus thrips are small, orange-yellow insects with fringed wings. The nymph is elongated, elliptical, slender and pale-yellow in colour. Males are similar in appearance but somewhat shorter and narrower. Under warm conditions, adult citrus thrips may live as long as 25 to 35 days or longer under cool conditions.

Biology

During its lifetime of about 2-4 weeks, each female citrus thrips lays up to 250 eggs, preferably in the soft tissues of young leaves, fruits or green twigs, and in opening flowers. They may hatch in 6 to 8 days during warm weather. There are two active nymphal stages (first and second instars) requiring 4 to 14 days for development.First and second instar larvae feed actively on tender leaves and fruit. The feeding on young fruit results in cosmetic scarring of the rind. The third and fourth instars are pupation stages and do not feed. A single generation may be completed in a period of 15 days with an average 10 -12 generations per year.

Nature of damage

Nymphs and adults lacerate the leaf tissue and suck the sap from leaves and fruits. Young leaves attacked by thrips may curl and show gray streaks. Ring like appearance on the fruit. Irregular mottled patches on rind feeding punctures young fruit leaving characteristic ring of grey scarring on the rind. Damage young leaves, resulting in leaf distortion.Silvering on leaf surface. Healthy fruit-bearing trees withstand and damage on young trees may become marginally stunted.

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Nymph

Adult

Fruits infested by Thrips

Seasonal Incidence

Thrips are active during February-June with its peak in April-May on *Ambia* season fruits and in July-December with its peak in November-December on *Mrig* season fruits.

Management

- Encourage the activities natural enemies such as Syrphids, Chrysopid and Coccinelids.
- Yellow or Blue sticky trap may be used for monitoring.
- Petroleum spray oils can be used to control thrips and are compatible with IPM programs.
- Foliar application of dimethoate @2ml or acephate 1.25g or phosalone 1.5ml/litre of water at bud burst stage and on berries for effective check the pest.

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Important Pests of tomato and their management

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Serpentine leaf miner, *Liriomyza trifolii* (Burgess); (Diptera: Agromyzidae)

Pale yellowish adult fly punctures the upper surface of the tomato leaf and lays minute orange yellow colour eggs. Newly emerged apodous maggot feeds on the chlorophyll of tomato leaves and do mining in between epidermal layers. Pupation takes place in soil or sometimes in leaf itself. The main symptoms are mining of leaves and drying of leaves at the advance stage of damage.

Management: Avoid excess use of nitrogen; bean as intercrop with tomato reduces damage of leaf miner; soil application of neem cake @ 20 days after planting (DAP); spraying of neem seed powder (NSP) extract or neem soap or pongamia soap; for chemical control, cyantraniliprole 10.26% OD @ 360 ml in 200 lit. water/acre.

Tomato fruit borer, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae)

It is a polyphagous pest and causes severe damage to tomato crop. Female moths lay spherical yellowish eggs singly on the leaves, stem, buds and tender parts of the plant. Greenish larvae initially begin their feeding on the leaves by scrapping green tissue and later infests on the buds, flowers and developing fruits until the crop maturity. The typical symptom shows circular bore holes on tomato fruits plugged by the head of a larva and leaving the rest of the body outside. Larvae feeds on the internal tissues of the fruit and makes the fruit completely hollowed out.

Management: One row of African tall marigold is followed by 14-16 rows of tomato; Collection and destruction of eggs and early stages of larvae; collection and destruction of disease infected and insect damaged parts; hand picking of older larvae on plant parts; light trap @ 1-2/ha; Installation of pheromone traps @ 8-10 traps/ha; Erection of bird perches @ 30-40/ha for encouraging predatory birds; Four -6 sprays of *Helicoverpa armigera* nuclear polyhedrosis virus (Ha NPV) at an interval of 7-8 days, starting from the flowering stage; Release of egg parasitoid, *Trichogramma pretiosum* @ 1, 00, 000 for 4-5 times from flower initiation stage at weekly intervals; Spraying of indoxacarb 14.5% SC @ 160-200 ml in 120-240 lit. water/acre or flubendiamide 20% WG @ 40 g in 150-200 lit. water/acre or chlorantranilioprole 18.5% SC @ 60 ml in 200 lit. water/acre or quinalophos 25% EC @ 400 ml in 200-400 lit. water/acre.

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Whitefly, *Bemisia tabaci* (Hemiptera: Aleyrodidae)

Adults are tiny white scale-like insects. It sucks the sap from the leaves and causes chlorotic and yellowing of leaves. In severe cases, downward curling and drying of leaves occurs and it acts as a vector for tomato leaf curl virus disease. This disease is characterized by severe stunting with downward rolling and crinkling of the leaves. Slight yellow coloration in the newly emerged leaves and older leaves become leathery and brittle. The nodes and internodes are reduced in size and the infected plants look pale and produce more lateral branches giving a bushy appearance. The infected plants remain stunted.

Management:

Using tolerant hybrids/varieties; root dipping in Imidacloprid 17.8 % SL @ 60-70 ml in 200 lit. water/acre just before transplanting and spraying it at 15 days after planting (DAP); uprooting the plants showing leaf curl disease; Spraying of neem seed kernel extract (NSKE) 5%; Spraying of dimethoate 30% EC @ 396 ml in 200-400 lit. water/acre or imidacloprid 17.8 SL @ 60-70 ml in 200 lit. water/acre or thiamethoxam 25 WG @ 80 g in 200 lit. water/acre or spiromesifen 22.9% SC @ 250 ml in 200 lit. water/acre or Cyantraniliprole 10.26% OD @ 360 ml in 200 lit. water/acre.

Spider mites, *Tetranychus urticae* (Koch) (Acarina: Tetranychidae)

Nymphs are yellow in colour and small size adults are reddish. Infested leaves are reddish brown in colour and become bronzy. Silk en webbing of leaves observed on the underside of the leaves in case of severe infestation. Due to this, leaves become wither and dry, in case of severe infestation flower and fruit formation will be affected.

Management:

Spraying of fenazaquin 10% EC @ 500 ml in 200 lit. water/acre or spiromesifen 22.9% SC @ 250 ml in 200 lit. water/acre.

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Nutrient management in organic farming

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INTRODUCTION- Organic production is a holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock and people. The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment. Since, synthetic chemicals are totally ban in organic farming the way of application of nutrient is quite different than the conventional method.

In organic farming, it is important to constantly work to build a healthy soil that is rich in organic matter and has all the nutrients that the plants need. Several methods viz. green manuring, addition of manures and biofertilizers etc can be used to build up soil fertility. These organic sources not only add different nutrients to the soil but also help to prevent weeds and increase soil organic matter to feed soil microorganisms. Soil with high organic matter resists soil erosion, holds water better and thus requires less irrigation. Some natural minerals that are needed by the plants to grow and to improve the soil's consistency can also be added. Soil amendments like lime are added to adjust the soil's pH balance. However soil amendment and water should contain minimum heavy metals. Most of the organic fertilizers used are recycled by-products from other industries that would otherwise go to waste. Farmers also make compost from animal manures and mushroom compost. Before compost can be applied to the fields, it is heated and aged for at least two months, reaching and maintaining an internal temperature of 130°-140°F to kill unwanted bacteria and weed seeds. A number of organic fertilizers / amendments and bacterial and fungal biofertilizers can be used in organic farming depending upon availability and their suitability to crop. Different available organic inputs are described below:

1. Organic manures

Commonly available and applied farm yard manure (FYM) and vermicompost etc. are generally low in nutrient content, so high application rates are needed to meet crop nutrient requirements. However, in many developing countries including India, the availability of organic manures is not sufficient for crop requirements; partly due to its extensive use of cattle dung in energy production. Green manuring with Sesbania, cowpea, green gram etc are quiet effective to improve the organic matter content of soil. However, use of green manuring has declined in last few decades due to intensive cropping and socioeconomic reasons. Considering these constraints International Federation of Organic Agriculture Movement (IFOAM) and Codex Alimentarius have approved the use of some inorganic sources of plant nutrients like rock phosphate, basic slag, rock potash etc. in organic farming systems. These substances can supply essential nutrients and may be from plant, animal, microbial or mineral origin and may undergo physical, enzymatic or microbial processes and their use does not result in unacceptable effects on produce and the environment including soil organisms. Numbers of cow-based and botanical bio-enhancers have been developed in different organic farming systems (Yadav, 2010) which could be used with organic manures to meet the nutrient requirement of crops.

Patel *et al*. (2013) found that foliar spray of *Panchagavya* 3% at 20 and 40 DAS gave significantly higher dry matter accumulation, branches/plant, root nodules/plant, pods/plant, seeds/pod, pod length, 100-seed weight, seed yield and stover yield of cowpea over RDF.

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2. Bacterial and fungal biofertilizers

- ***Rhizobium*** : The effectiveness of symbiotic N_2 fixing bacteria viz. Rhizobia for legume crops eg. *Rhizobium, Bradyrhizobium, Sinorhizobium, Azorhizobium,* and *Mesorhizobium etc* have been well recognized. These bacteria infecting legumes have a global distribution. These rhizobia have a N_2-fixing capability up to 450 kg N ha^{-1} depending on host- plant species and bacterial strains. Carrier based inoculants can be coated on seeds for the introduction of bacterial strains into soil.
- ***Azotobacter:*** N_2 fixing free-living bacteria can fix atmospheric nitrogen in cereal crops without any symbiosis. Such free living bacterias are: *Azotobacter* sp. for different cereal crops; *Acetobacter diazotrophicus* and *Herbaspirillum* spp. for sugarcane, sorghum and maize crop. Beside fixing nitrogen, they also increase germination and vigour in young plants leading to an improved crop stand. They can fix 15-20 $kgha^{-1}$ nitrogen per year. *Azotobacter* sp. also has ability to produce anti fungal compounds against many plant pathogens. *Azotobacter* can biologically control the nematode diseases of plants also.
- ***Azospirillum:*** The genus *Azospirillum* colonizes in a variety of annual and perennial plants. Studies indicate that *Azospirillum* can increase the growth of crops like sunflower, carrot, oak, sugarbeet, tomato, pepper, cotton, wheat and rice. The crop yield can increase from 5-30%. Inoculum of *Azotobacter* and *Azospirillum* can be produced and applied as in peat formulation through seed coating. The peat formulation can also be directly utilized in field applications.
- ***Plant growth promoting rhizobacteria*** : PGPR are thought to improve plant growth by colonizing the root system and pre empting the establishment of suppressing deleterious rhizosphere microorganisms on the roots. Large populations of bacteria established in planting material and roots become a partial sink for nutrients in the rhizosphere thus reducing the amount of C and N available to stimulate spores of fungal pathogens or for subsequent colonization of the root. PGPR belong to several genera viz. *Actinoplanes, Azotobacter, Bacillus, Pseudomonas, Rhizobium, Bradyrhizobium, Streptomyces, Xanthomonas* etc. Bacillus spp. act as biocontrol agent because their endospores are tolerant to heat and desiccation. Seed treatment with *B.subtilis* is reported to increase yield of carrot by 48%, oats by 33% and groundnut upto 37%.
- ***Phosphorus-solubilizing bacteria (PSB):*** Phosphorus is necessary for the nodulation by *Rhizobium* and even to nitrogen fixers, *Azolla* and BGA. The phospho microorganism mainly bacteria and fungi make available insoluble phosphorus to the plants. It can increase crop yield up to 200-500 kg ha^{-1} and thus 30 to 50 kg Super Phosphate can be saved. Most predominant phosphorus-solubilizing bacteria (PSB) belong to the genera *Bacillus* and *Pseudomonas*. At present PSB is most widely used biofertilizer in India. PSB can reduce the P requirement of crop up to 25%.
- ***Mycorrhizal fungi:*** Root-colonizing mycorrhizal fungi increase tolerance of heavy metal contamination and drought. Mycorrhizal fungi improve soil quality also by having a direct influence on soil aggregation and therefore aeration and water dynamics.
- ***Blue green algae (BGA):*** BGA are the pioneer colonizers both in hydrosphere and xerosphere. These organisms have been found to synthesize 0.8 x 10^{11} tonnes of organic matter, constituting about 40 percent of the total organic matter synthesized annually on this planet. BGA constitute the largest, most diverse and widely distributed group of prokaryotic microscopic organisms that perform oxygenic photosynthesis. These are also known as cyanophyceae and cyanobacteria. BGA has been reported to reduce the pH of soil and improve upon exchangeable calcium and water holding capacity. The recommended method of application of the algal inoculum is broadcasting on standing water about 3 to 4 days after transplantation. After the application of algal inoculum the field should be kept water logged for about a week's time. Establishment of the algal

inoculum can be observed within a week of inoculation in the form of floating algal mats, more prominently seen in the afternoon.

- ***Azolla:*** A floating water fern 'Azolla' hosts nitrogen fixing BGA *Anabaena azollae*. Azolla contains 3.4% nitrogen (on dry wt. basis) and add organic matter in soil. This biofertilizer is used for rice cultivation. There are six species of Azolla viz. *A. caroliniana, A. nilotica, A. mexicana, A.filiculoides, A. microphylla* and *A. pinnata*. Azolla plant has a floating, branched stem, deeply bilobed leaves and true roots which penetrate the body of water. It grows well in ditches and stagnant water. Azolla can be easily grown throughout the year in India if water is not a limiting factor and climatic conditions are favourable for its growth. This fern usually forms a green mat over water. Azolla is readily decomposed to NH_4 which is available to the rice plants. Field trial have shown that rice yields increased by 0.5-2 t/ha due to Azolla application. In India and China, about 20 and 18% increase in rice yield, respectively has been reported due to Azolla application.

CONCLUSIONS- Organic farming can be a viable alternative production method for farmers, but there are many challenges. One key to success is being open to alternative organic approaches to solving production problems. Determine the cause of the problem, and assess strategies to avoid or reduce the long term problem rather than a short term fix for it.

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Citrus psylla (*Diaphorina citri* Kuwayama) and its management

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INTRODUCTION

Citrus psylla is one of the major insect pests of citrus cultivars attacking the new flush in *Ambia* and *Mrig* seasons across India. There was a severe 'outbreak' of the pest during the year 1960-62 in central India. Since then it has become endemic causing considerable damage to the crop. Asian citrus psylla, *Diaphorina citri* Kuwayama (ACP) is one of the most serious pests of citrus. Besides causing direct damage, it is an efficient vector of the bacterium, *Liberobacter asiaticum* which causes deadly greening disease. Apart from citrus, psylla also attacks curry leaf plant (Murraya koenigii Unn.), orange jasmine, *M paniculata* (L.) and jackfruit, *Artocarpus heterophyllus* Lamarck. The pest completes 9-10 or even up to 16 overlapping generations in a year.

Damage: Nymphs and adults in flocks of tens and hundreds suck the cell sap from young twigs, leaf and flower buds that results into heavy drop of young flush and fruits and drying of twigs. Nymphs excrete honeydew on which sooty mould grows. Psylla is also known to inject toxin in plant due to which die-back of shoots occurs. More importantly the pest is known to transmit the disease,"huanglongbing (HLB)" *Candidus* Liberibactor asiaticus. Citrus plantations across the citrus growing tracts of the world have been reported to suffer from HLB.

Eggs of citrus psylla

Nymphs of citrus psylla

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Sugary excretion due to psylla infestation

Drying of shoot tip due to psylla infestation

Life cycle:

Ambia and *Mrig* flush seasons are congenial to the pest. Eggs are laid in the folds of half opened leaves or between the flower buds. Development from egg to adult takes 15 days in summer and 45 days in winter completing 9 to 10 overlapping generations in a year. Hibernating adults during cold and hot seasons may live for more than six months.

Seasonal occurrence:

Citrus psylla can occur throughout the year on young growth but numbers of adults are usually lowest on the spring flush (August). It is therefore a good strategy to control citrus psylla on the spring flush because it will take a long time for the population to build up thereafter. Without effective treatments against citrus psylla, adults are most abundant in September and October

Management

- Management of psylla during *Ambia* (March-April) and *Mrig* (June-July) flush is must as the pest causes severe damage.
- Prune the affected and dried shoots and modify the canopy structure which helps in maximum light interception.
- Collateral host like *Curry* leaf *(Murraya koengii* Linn.) plant should not be grown in the vicinity of citrus orchards as it may act as a breeding ground for psylla.
- Spray quinalphos 25 EC @ 1 ml or abamectin 1.8 EC @ 0.42 ml or petroleum spray oil @ 5.9 ml or novaluron 10 EC @ 0.55 ml/l of water at bud burst stage or when infestation is noticed on sprouts in June-July, and February-March. If required, second spray of any of the above insecticides should be given after 15 days.
- Conserve the bio-agents (Coccinellids, Chrysopids, Eulophids) by avoiding application of insecticides from winter to early spring till temperatures raises to 30^0C.

- Among the bio-agents, a chrysopid, *Mallada desjardinsi* and the coccinellid, *Menocheilus sexmaculata* prey upon psylla nymphs and hold promise for biological control of the pest. Two releases of *M. desjardinsi* @ 30 larvae / tree in each flushing season effectively checks citrus psylla. *Tamarixia radiata* Waterston, *Tetrastichus* spp. and *Diaphorencyrtus aligharensis* have been found parasitising the psylla population.
- Parasitism by *T. radiata* on psylla ranged from 15-40% in general and around 80% in certain locations of central India. The parasitoid can be multiplied in captivity on curry leaf plants, *Murraya koenigii* and *Citrus* sp.

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Vegetable grafting

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Need of vegetable grafting:
Generally vegetable grafting is done in cucurbits and solanaceous vegetables. Vegetables grafting has many features in its favor such as better resistant to diseases transmitted from soil, good adaptive capabilities when grown in unfavorable environmental condition, improved product quality, give higher output, earliness.

Objective:

- To develop disease and pest resistance
- To develop tolerance to low and high temperature
- To develop tolerance to salt and flood
- To increase yield of plants.

Basic requirements: The prerequisites are root stock and scion at two true leaves stage, grafting tools (knife, blade, clips, tubes, pins etc), screening house, healing chamber.

Types of vegetable grafting:

1. Approach grafting: Cucurbits and solanaceous vegetables are grafted.
2. Hole insertion method: Popular in cucurbits.
3. Cleft grafting: Suitable for crops with wide hypocotyls, practiced in all vegetable crops.
4. One cotyledon methods.
5. Slant grafting methods: Suitable in most of the vegetables.
6. Tube grafting: Suitable for tomato and brinjal.

CONCLUSION: Grafting technology in vegetable has the potential to promote cultivation of vegetables in nontraditional area and frazil agro-eco system including the area of biotic and abiotic stresses. It will also promote production of quality vegetables and its availability for longer time. Grafting technology besides imparting the resistance, reduce the need of soil disinfectants like methyl bromide and abiotic stress condition without use of chemicals. This technique is highly eco friendly and can be used successfully in sustainable management.

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Role of Glycine-betaine In Abiotic Stress Tolerance In Crop Plants

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INTRODUCTION

The accumulation of low molecular weight water-soluble compounds known as “compatible solutes” or “osmolytes” is the common strategy adopted by many organisms to combat the environmental stresses. The most common compatible solutes are betaines, sugars (mannitol, sorbitol and trehalose), polyols, polyamines and amino acid (proline). Their accumulation is favoured under water-deficit or salt stress as they provide stress tolerance to cell without interfering cellular machinery. The tolerant or sensitive species show differential stress tolerance depending on the levels of accumulation of these compounds during abiotic stresses. Genes participating in the biosynthesis of different kinds of compatible solutes have been identified from varied sources. Genetic engineering with these endogenous or ectopic genes has therefore, been used successfully to synthesize compatible solutes in target organisms and improvement of stress tolerance.

Although compatible solutes fall in different bio-chemical groups, similar roles have been assigned to them in plant protection against stresses. However, a precise role of compatible solutes, including GB, in abiotic stress tolerance is largely unknown and two basic functions attributed to these solutes are osmotic adjustment and cellular compatibility. Osmotic adjustment occurs through concentration dependent effects on osmotic pressure to absorb more water from surroundings. In cellular compatibility mechanism, these compounds replace water in biochemical reactions thereby, maintaining normal metabolism during stress.One major issue with compatible solutes is their lower accumulation in transgenic plants as compared with their natural accumulators. At such low levels, compatible solutes might not contribute significantly to osmotic adjustment. Therefore, these compounds are also suggested to be involved in ROS scavenging, macromolecules (nucleic acids, proteins, lipids) protection, and act as reservoir of carbon and nitrogen source.In addition, new aspects of their functionality, especially GB, are emerging fast. Present review highlights the new emerging roles of GB in protecting plants against environmental stresses.

Glycinebetaine: Roles, Mechanism and Emerging Concepts

Glycinebetaine (GB) accumulates in a variety of organisms under abiotic stresses and has been studied in great details.[1] Plants known to accumulate GB naturally have been reported to grow well under drought and saline environment.[1]Exogenous application of GB improves the growth and survival rate of plants under a variety of stressesand in food born bacteria *Listeria monocytogenes*. GB is synthesized either by oxidation of choline or N-methylation of glycine by three known pathways.[1] In plants, the enzyme choline monooxygenase (CMO) first converts choline into betaine aldehyde and then a NAD+ dependent enzyme, betaine aldehyde dehydrogenase (BADH) produces glycinebetaine. These enzymes are mainly found in chloroplast stroma and their activity is increased in response to salt stress. In *E. coli*, GB is synthesized by choline dehydrogenase enzyme (CDH) along with BADH. Whereas in soil bacterium, *Arthrobacterglobiformis*, choline oxidaseA (codA) converts choline into GB and H_2O_2 in a single step.

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Use of GB biosynthetic genes in transgenic plants

Identification of genes of GB biosynthetic pathways has made it easy to engineer GB biosynthesis into non-accumulators by transgenic approach for improved stress tolerance. This approach has been successfully used in diverse plant species, e.g., Arabidopsis, tobacco, Brassica, Persimmon, tomato, maize, rice, potatoand wheat to improve their abiotic stress tolerance.

Among the different GB biosynthetic genes, choline oxidase (*codA*) from *A. globiformis*has been widely used for GB production in transgenic plants. This gene converts choline into GB in one step. Availability of endogenous choline, therfore, could limit the GB biosynthesis in transgenic plants. However, levels of endogenous choline were not changed significantly in transgenic Arabidopsis and rice plants expressing *codA*gene.Therefore, availability of choline does not affect the GB synthesis in these transgenic plants probably due to synergism in demand and supply of choline metabolism. Therefore, this aspect needs to be further validated to conclude the effect of choline availability on GB levels.

Constitutive accumulation of compatible solutes like ployamines, proline and trehalose resulted in abnormal plant phenotype. Therefore, stress-inducible expression of genes encoding these solutes is often suggested.However, no such abnormality has been observed in transgenic plants accumulating GB constitutively. GB accumulation following the salt stress was higher in lines with constitutive expression, suggesting that constitutive accumulation of GB is beneficial for stress tolerance without any phenotypic abnormality to plants. In some cases, localized accumulation of GB within the cell was found to affect the performance of transgenic plants under stress. GB synthesizing enzymes have been targeted to cytosol, mitochondria and chloroplast.Plantswith chloroplast targeted GB synthesis, even though accumulatedleast amount of GB, showed better seedling growthfollowing chilling treatment. These results suggested that GBaccumulation in chloroplast is a better strategy for engineeringabiotic stress tolerance in plants.

Several alternative modes of GB action (osmoprotection, protection of membrane and quaternary structure of enzymes, ROS detoxification) in abiotic stress tolerance in transgenic plants have also been reported (Table 1).

Table 1: Major roles of GB in transgenic plants under abiotic stresses*

Plant species transformed	Gene	Phenotype	Remark
Arabidopsis thaliana	*codA*	Tolerance to various abioticstresses	Protection against damage of membrane, enzymeactivity, photosynthesis
Oryzasativa	*codA*	Tolerance to salt, cold anddrought stress	Protection against damage of membrane, enzymeactivity, photosynthesis and yield loss; regulation ofROS detoxification and transcriptome changes
Lycopersiconesculentum	*codA*	Cold, salt and oxidative stress tolerance	Protection of photosynthesis and reproductive organs;increased ROS detoxification
Nicotianatabacum	*BetA*	Tolerance to salt and drought	Protection of photosynthesis
	BADH	Tolerance to heat stress	Protection of rubisco activity
Triticumaestivum	*BADH*	Heat and drought	Protection of photosynthesis

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		tolerance	
Zea mays	*BetA*	Cold and drought tolerance	Protection of photosynthesis and membrane integrity
Solanumtuberosum	*codA*	Tolerance to salt, drought and oxidative stress	Protection of photosynthesis and membrane integrity
Gossypiumhirsutum	*BetA*	Drought tolerance	Protection of membrane integrity

*Source of *codA*gene is *Arthrobacterglobiformis,* while *BADH* genes are from spinachand *Artiplex.betA*, *E. coli* gene encoding choline dehydrogenase.

GB, protection of photosynthesis machionary and ROS detoxification during abiotic stress.

GB could be involved in inhibiting ROS accumulation, protection of photosynthetic machinery, activation of some stress related genes and membrane protection. GB has also been implicated in protection of quaternary structure of proteins (thereby maintaining the enzyme activity) from damaging effects of environmental stresses.Many proteins are prone to aggregation under heat and salt stress thereby, losing their native structure and activity.

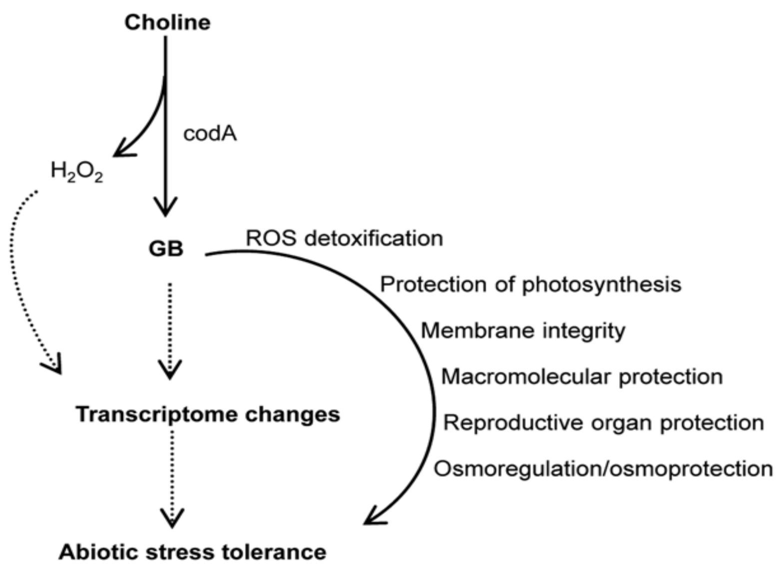
Reactive oxygen species (ROS) are continually produced in chloroplast and mitochondria as byproduct of metabolism. However, their production is enhanced under abiotic stresses which lead to photoinhibition of PSII in chloroplast. GB has been shown to protect the photosynthesis machinery by stabilizing the activity of repair proteins under high concentrations of NaCl.[3] The role of GB in ROS detoxification is also evident by reduced accumulation of ROS in transgenic plants under water-deficit stress as compared with WT plants.[2] Therefore, GB can provide tolerance to abiotic stresses even at low concentration by protecting photosynthesis under abiotic stress.

GB and protection of reproductive organs during abiotic stress.

Plant yield is severelycomprised underabiotic stress due to limited growth of reproductive organs.New evidences indicate toward the protection of reproductiveorgans by GB.Indeed, improved plant growth in terms of biomassand yield was reported in transgenic tomato expressing*codA*gene from *A. Globiformis*.*codA*transgenic Arabidopsis plants produced about 22% more flowers and 28% more seeds than WT plants in unstressed conditions. [4] These effects of GBwere attributed to higher accumulation of GB in reproductive organs. Reproductive organs; flowers, siliques and inflorescenceaccumulated about 5-fold higher GB than leaves in plantsexperessing*codA*gene constitutively. [4] Tomato plants expressing*codA*gene produced 10–30% more fruit than WT plants after chilling stress.[4]All these effects were due to the protectionof reproductive organs from stress by higher localized accumulationof GB.

Tolerance to abiotic stress is coupled with contribution of endogenous genes in transgenic plants.

Recently, genome-wide transcriptome analysis in transgenic rice expressing *codA*gene showed altered expression of several transcripts even under unstressed conditions in relation to wild-type plants. [2] About 50 genes known to be involved in one or other type of stress (both biotic and abiotic) were induced in transgenic plants. Genes involved in variety of cellular processes like transcription, signaling, membrane transport, metabolism and growth were also induced, supporting the idea of complex nature of genetic response to abiotic stress in plants. [2]Upregulation of these genes might be responsible for observed stress tolerance in transgenic rice. However, the activation of these genes exclusively by GB or H_2O_2 alone could not be established, since both are capable of regulating gene expression. Wild-type plants when treated exogenously either with GB or H_2O_2 showed differential expression of some of the stress related genes whose expression levels were also altered in *codA*expressing rice. [2] Furthermore, certain H_2O_2 marker genes like catalase, peroxidise and heat shock factors were induced in transgenic plants in unstressed condition. [2]Therefore, transcriptomic changes, derived in parts by H_2O_2, might also contribute to the stress tolerance in *codA*-expressing transgenic plants along with other direct roles of glycinebetaine (Fig. 1).



CONCLUSION

GB accumulation could contribute to osmoregulation in natural accumulators; however, osmoprotection seems to be responsible for tolerance to abiotic stresses in transgenic plants. Extensive work on GB has suggested its varied roles in plants. New evidences suggest the contribution of differentially expressing endogenous genes in GB mediated stress tolerance in plants. Further work would establish whether the transcriptome changes are direct targets of GB or are product of metabolic adjustment in transgenic plants.

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Citrus mites and its management

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INTRODUCTION

Citrus mites (Acarina: Arachnida) are widely distributed throughout the world and it's one of the important pests of citrus. As many as 54 mite species (Garg, 1978) including 25 phytophagous mite species have been reported on citrus from different parts of India (Dhooria and Mallik, 1999). There are four mite families of relevance to citrus, the Tetranychidae (spider mites) e.g. *Panonychus citri* (Mc-Gregar) and *Eutetranychus orientalis* (Klein.); the Tenuipalpidae e.g. *Brevipalpus phoenicis* (Geijskes) and *B. californicus* (Banks); the Tarsonemidae e.g. *Polyphagotarsonemus latus* (Banks) and the *Eriophyidae* (rust mites and gall mites), e.g. *Phyllocoptruta oleivora* (Ashmead) and *Aceria sheldoni* (Ewig.) (Graham and Graham, 1996). It is a serious pest of citrus in Vidarbha, especially during Ambia (spring) and Hasta (Autumn) seasons (Kalidas and Shivankar, 1994).Citrus mites is more active on new growth of citrus plants, especially in the late spring and early fall. Populations will also be higher at these times of year because in the summer, the higher temperatures and humidity tend to reduce these cool season mite populations.

Species of mites

The phytophagous mites reported so far on citrus from India include, *Panonychus citri* (Me-Gregor) *Schizotetranychus hindustanicus* (Hirst), *Ponychus citri* Channa Basavanna and Lakkundi, *Brevipalpus deleoni* Pritchard and Baker, *B. califormicus* (Banks), *P oleivorus*, *E. orientalis* and *A. sheldoni*. Of these, *E. orientalis* is the only species recorded as a major pest of citrus, though *B. californicus* and *P oleivorus* have also been reported regularly. *Eutetranychus banksi* (Me Gregor), *E. orientalis*, *B. phoenicis* and *P. latus* (Dhooria et al., 1997) from Punjab, *E. sexmaculata* and *T. telarius* from Assam and *Tetranychus fijiensis*, *E. orientalis* from south India have been considered economically important (Ghosh and Singh, 1993).

Biology of pest

The adult females lay 20 to 30 eggs at a rate of 2 or 3 per day placing them on the infested surface commonly along the midribs of the leaves. The egg is about 0.13 mm in diameter bright red and nearly spherical. There is a vertical stalk on the top of the egg with 10 or 12 very fine guy threads radiating from the tip of the stalk to the plant surface. Mite larvae which have 3 pairs of legs hatch from the eggs in 8 to 30 days. They develop through 2 nymphal stages (with 4 pairs of legs), each lasting several days then become adults. In summer, a generation from egg to egg may be as short as 3 weeks, and adults may live 18 days. Development continues all through the year, but at a slower rate in cool conditions. Particularly in hot dry weather accompanied by wind usually causes high mortality of the mites. Prolonged periods of high humidity are also unfavourable to them.

Nature of damage

Citrus mites both nymph and adult suck cell sap from buds, leaves and fruit. Mites generally prefer to feed on young, flushing leaves, but if infestations are severe, they will also feed on older leaves. Mite feeding causes pale stripping on the upper surface of leaves which are not seen on the lower surface. In severe infestation the stripping enlarges to dry necrotic areas. In heavy infestations, leaves and green twigs bronze,

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and trees are less vigorous. But the stripping / silvering of green fruit disappear when the fruit changes colour. Generally leaves drop and die-back of twigs starts. The mites prefer the side of the fruit facing the sun; consequently, fruit damage is greater on the outside of the tree. High numbers can also cause fruit sunburn if hot weather is occurring. Most mite damage occurs from late spring to late summer.

Seasonal occurrence

In areas where mite is endemic infestations are cyclical. The mites survive the winter on foliage. Infestation of the new crop occurs in the spring and depending on situation and general pest control strategies used can reach epidemic proportions during the summer. Monitoring for mites should begin in early April and continue every two to three weeks throughout the season. In general mite populations begin to increase in May and then decline in late August. While mite populations are historically highest from May to July with a second smaller peak in the fall, significant increases in late October and early November have been seen in recent years. Thus monitoring for mites should not be neglected during the fall peak.

Management practices

Cultural

- Water stress frequently provoke mite problem.
- Follow proper irrigation.
- Citrus orchards should be irrigated particularly during the stress in late summer.
- Remove the leaves and fruits infested with mites.
- Grow tolerant rootstock .

Botanical

- Follow the spraying of botanical, Azadirachtin 1% @ 2.0 ml and 5%@ 0.5 ml/lit of water.
- Petroleum oil spray 2% or HMO 2%

Biological

- The predatory mite *Phytoseiulus persimilis* feeds on mite and is available commercially for release.
- The most important natural enemies of citrus mite are a predacious mite *Euseius hibisci* and the predators *Agistemus* sp. and *Ambylesisus hibisci.*
- *Stethorus* predator of mites feeds on both the adults and larvae.

Chemical

- Foliar application of wettable sulphur 80WP @3g or Dicofol (Kelthane®)) 18.5 EC @ 2ml or propargite (Omite®)) 57 EC @ 1ml or Ethion (Fosmite®)) 50 EC @ 1ml/l of water spray immediately after fruit set and during active period of mites checks the pest effectively.
- foliar application of Spiromesifen (Oberon®))240 SC @ 0.3ml or Fenazaquin (Magister®) 10 EC @ 1ml/ l at 15 days interval at berry stage of the fruits during *Ambia* and *Mrig* season reduce mites infestation


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Management options of soil physical constraints for optimum plant growth and sustainable crop yield

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INTRODUCTION

Sustainable agriculture aim at meeting the needs of present generation without affecting natural resources for the future generation but due to use of inorganic synthetic fertilizers, pesticides and agro-chemicalsin non-judicious way/manner resulting to the loss of soil health, unsustainable productivity, yield decline, environmental pollution, decreasing soil organic matter storage, decreasing factor productivity under high intensityagriculture in the post-green revolution era has been animportant concern today. Therefore, sustaining the productivity at higher level is the key issue in Indianagricultural to meet the increasing demands of food and fibre for the growing population. Maintaining soil health/quality is most important concern for sustaining the agricultural productivity at higher level.Soil quality is the capacity of soil to function within natural or managed ecosystem to sustain the biological productivity, to maintain or enhance the water and air quality and support human health and habitation.

Soil quality includes three most important parameters of soil *i.e.* physical, chemical and biological quality, which may be restored its optimum to sustain productivity at higher levels in the long term. If soil physical environment is not maintained at its optimum level, the genetic yield potential of a crop can't be realized even when all the other requirements are fulfilled. Due to mechanization of farm operations, frequent tillage in intensive cropping systems, unscientific and indiscriminate use of agricultural inputs and decline in available soil organic matter etc. are adding new problems to the existing area. Therefore, our sincere efforts must be improve and to maintain the physical environment of the soil at its optimum condition with minimal risks to environment. Soil physical environment can be improved using the fallowing points which are discussed below.

(1) Management Options:

It is estimated that out of the 328 m ha of the total geographical area in India, 173.65 m ha are degraded, producing less than 20% of its potential capacity (GOI, 1990) and out of this 89.52 m ha suffers from one or the other form of physical constraints viz., shallow depth, soil hardening, slow and high permeability, sub-surface compacted layer, surface crusting temporary waterlogging etc. Soil physical environment can be improved by following site specific technologies for optimal use of manures, crop residues, fertilizers, water, tillage practices and following appropriate cropping systems.

(2) Improvement of soil physical environment by use of manures and fertilizers :

Application of organic manures such as FYM, compost, vermicompost and green manure improve the physical properties of soil through improvement of soil organic matter resulting favourable condition for plant growth and development. The increased plant biomass produced by fertilizers results in increased return of organic materials to soil in the form of crop residues. Thus, inorganic fertilizers indirectly influence the soil organic matter content by increasing crop productivity and thereby increasing the amount of organic matter returned to the soil in various crop residues. Increasing soil organic matter content characteristically leads to a

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decrease in bulk density and surface crusting and an increase in water holding capacity, macrospores, infiltration capacity, hydraulic conductivity and soil aggregation. By addition of phosphatic fertilizers to the soil favour the aggregate formation, reduce the bulk density, and increase the water retention capacity of soil. When these characteristics of soil improve, provides favourable condition for the growth and development of crop plant resulting to higher crop yield.

(3) Improving soil physical environment through optimal use of tillage practices:

Tillage practices changes the initial state of soil to a new state, with changes in the physical, chemical and biological environment of soil. These in turn, influence crop growth and yield and thereby, the input use efficiency of crops. Tillage either loosens or compacts the soil and changes its volume and mass relationship. One property of soil that is likely to get changed by tillage is bulk density of soil. A decrease in bulk density increases the total porosity and the proportion of macro pores. The changes in total porosity, pore size distribution and particle-to-particle contact affect all (physical) state variables of soil, which in turn, induce behavioural changes in soil properties and processes, modifying the edaphic environment. Thus, all physical parameters affecting seedling emergence and root growth, *i.e.*soil wetness, aeration, temperature and penetration resistance and affected by the tillage. Loosing of soil by tillage decrease the cohesiveness and particle-to- particle contact and reduce the soil strength in the tilled layer. Tillage increases the proportion of macro-pores in tilled layer which can drain out water more rapidly after heavy rain or irrigation and it able to restore adequate amount of air for proper growth and development of crop plant and beneficial soil micro-organisms. Soil compaction increases the thermal conductivity of soil due to decreased in porosity and increased contact between the particles leading to poor crop plant growth but conservation tillage system, that leaves the crop residues on the soil surface, lowers the soil temperature. Therefore, tillage practices improve the soil environment for the better crop growth resulting higher crop yield.

(4) Improving soil physical environment through mulching practices :

Mulch is any material applied on the soil surface to reduce or check evaporation and improves the moisture content of soiland mulching is the artificial application of mulch, practiced to obtain beneficial changes in soil physical environment. Mulching improves physical conditions, chemical environment and biological activities of soil. Due to the application of mulches results in favourable modification of the soil hydrothermal regime, improvement of soil aggregation, weed control, retardation of erosion and soil loss and improve the physical condition of soil. Application of mulches on the soil surface obstructs the solar radiation reaching to soil surface resulting improve the water content by checking evaporation, runoff and weeds and increase infiltration rate, moderate temperature by decreasing it in summer and by increasing it in winter and improve the soil structure due to decomposition of mulch ultimately results in better crop growth and higher crop yield.

(5) Water condensation at night:

Stone and gravel mulches induce lateral movement of heat and vapour, which could in turn collect water under the stones due to condensation of vapour at night, in amounts sufficient enough to serve as the source of water for some species of desert plant and soil fauna.

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CONCLUSION

In present agriculture scenario, crop yield is declining day by day due to mechanization of farm operations, frequent tillage in intensive cropping systems, unscientific and indiscriminate use of agricultural inputs and decline in available soil organic matter etc. are adding new problems to the existing area.Therefore, our sincere efforts must be improve and to maintain the physical environment of the soil at its optimum condition with minimal risks to environment. Soil physical environment can be improved by following site specific technologies for optimal use of manures, crop residues, fertilizers, water, tillage practices and following appropriate cropping systems resulting better crop growth and higher crop yield.

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PROBIOTICS: Nurture gut micribiome

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INTRODUCTION-

The term Probiotics is derived from Greek words. It is made from two words- *pro* means "for" and *biotic* means "life". Hence Probiotics collectively refers to "for life".*The term Probiotics was coined by Elie Metchnikoff*. The definition of the term Probiotics has evolved over time with increasing interest and progress in the field.Earlier, the term was used to describe substances produce by microorganisms and stimulate the growth of other microorganism. The present definition of Probiotics was given by Food and Agriculture organisation of United Nations World Health Organisations, according to which, *"Probiotics are live microorganism which when administrated in adequate amounts confer health benefit on the host*." (Kechagia and Dimitriosbasoulis, 2013) Development. The Probiotics *Pseudomonas* communities enhance the plant growth and nutrient There are various Probiotics that play important role in plants, animals and humans. The microorganism which are associated with plant play important role in plant growth and assimilation. The presence of microorganisms in the soil improves plant production by causing a significant hype in the production of phytohormones andsiderophores. *Pseudomonas* communities lead to higher accumulation of plant biomass and effective assimilation of nutrients in the plant tissue. Probioticsalso play important role in increasing strawberry yield. Plant Probiotics increases the yield of strawberry in Bangladesh due to their antagonistic properties to phytopathogenic microbes and because of their ability to produce Indole acetic acid (IAA). (Kechagia and Dimitriosbasoulis, 2013)

Chitosan and plant probiotics application enhances growth and yield of strawberry

Strawberry, a new fruit was introduced in Bangladesh. It was liked by both the farmers as well as the consumers. Since, the use of synthetic pesticides was too costly for poor farmers, an alternative production technology need to be implemented to help them cope with the production charges. In this article, the performance of plant probiotic bacteria, chitosan and fungicides was evaluated and compared. Their effect on increasingfruits yield was taken into consideration.[2]

Plant probiotic bacteria

Bph -4 and BTLK6a significantly increase the vegetative growth and fruit yield when used in field as compared to non treated control. When these Probiotic bacteria were further investigated, it was observed that they possessed Indole acetic acid production and antagonistic properties to phytopathogenic microbes i.e. the microbes causing various diseases in plants. With the help of 16s rRNA gene sequencing, the Bph-4 and BPLK6a Probiotic bacteria were identified as*Stenotrophomonas*species and *Ochrobacterium*species respectively. Chitosan particles at 250- 500 ppm and BTLK6a when applied on these tissue cultured plants of strawberry festival, increased the fruit yield by 56% and 43% respectively when compared to non treated control. Two different plant types were tested and it was then observed that the tissue cultured plants responded to the chitosan particles and Probiotics better than the Strawberry runner grown plants for degree of yield increase. Treatment with fungicides did not cause any significant increase in the fruit yield likely due to the absence of targeted disease. Thus from these results it can be inferred that chitosan particles and plant probiotic bacteria could be used as natural bio regulator for better, safe and affordable production of Strawberry fruits in Bangladesh. (Mukta, and Rahman, 2017)

Probiotic Pseudomonas

Microbes associated with plants play an important role in their development and growth. Introducing beneficial microbes in low input agricultural system can increase the production of plants but due to the poor activity and survival rate of probiotics microbes, their use in the real world is not satisfactory. The effect of the higher concentration of Pseudomonas community on the survival of bacteria inoculums and plant growth was tested using BEF i.e. Biodiversity system functioning frameworks. Diversity and strain identity effect on the plant biomass production and nutrient assimilation in vivo with tomato were compared. For this bacterial community inoculants concentration (1, 2, 3, 4 or 8 strains per community) of Pseudomonas species was manipulated. By increasing the richness of bacteria inoculants, the survival and abundance of Pseudomonas communities was enhanced. This further resulted in increased assimilation of nutrients into plant tissue and higher accumulation of plant biomass. Hence, we can infer that effects of diversity was stronger than Pseudomonas strain effect and plant growth promotion mediated by diversity could be associated with elevated production of phytohormones, siderophores and phosphorous solubility in vitro. Therefore, we can conclude that multi strain microbial inoculants can enhancethe growth of plants more reliably and effectively as compared to single strain inoculants.(Jiehu *et al*, 2017)

Probiotic lactobacilli

They have been use for several decades now. Still, we hardly know the molecular mechanisms underlying the probiotic effect. Two strains, *L. rhamnosus* GG and *L. plantarum* WCFS1 have been studied in great detail, and mutants of these strains have greatly aided in our understanding of the interaction with the host. (Koen and Marjolein,2018) ·However, several surprising results were obtained as well, and leave more questions than answers.

Bifidobacteria: Regulators of Intestinal Homeostasis

Bifidobacteria are natural inhabitants of the gastrointestinal tract possessing genetic adaptations that enable colonization of this harsh and complex habitat. Due to their recognized benefits to human health bifidobacteria are used as probiotics; however industrial-scale production of bifidobacteria is a challenge. Bifidobacteria interact with key elements of intestinal functioning and contribute to maintaining homeostasis. Recent scientific progress has demonstrated that bifidobacteria, through strain-dependent interactions with the host may reduce mucosal antigen load, improve the intestinal barrier, and induce regulation of local and systemic immune responses (Thomas *et al*,2017).Continued research on *Bifidobacterium*-host interactions is expected to bring knowledge on the mechanisms involved in these health effects, and to support the identification of even more efficacious strains that will increase the variety of commercially available products.

Propionibacteria - Probiotic Potential

Propionibacteria were first described by the end of the nineteenth century and named some years later by Orla-Jensen (1909) who proposed the genus *Propionibacterium* for referring to bacteria that produce propionic acid as their main fermentation end-product. Based on habitat of origin, they are conventionally divided into

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"classical or dairy" and "cutaneous" microorganisms which mainly inhabit dairy/silage environments and the skin/intestine of human and animals, respectively. Historically, the economic relevance of *Propionibacterium* has been related to the industrial application of classical species as dairy starters for cheeses manufacture and as biological producers of propionic acid. However, propionibacteria also display probiotic potential. Over the last two decades, the ability of these microorganisms to improve the health of humans and animals by being used as dietary microbial adjuncts has been extensively demonstrated. Both *in vitro* and *in vivo* studies revealed that propionibacteria are able to modulate in a favorable way gut physiology, microbiota composition and immunity (Gabriela and Perez). Much of these health benefits could be related to the ability of propionibacteria to remain in high numbers in the gastrointestinal tract by surviving the adverse environmental conditions and adhering to the intestinal mucosa. In addition, other promising properties like the production of nutraceuticals and relevant biomolecules such as vitamins B and K, conjugated linoleic acid (CLA), exopolysaccharides (EPS), trehalose, bifidogenic factors, bacteriocins, etc have been reported. In recent years, the availability of genome sequences of different propionibacteria species have allowed to deep insight into the metabolism and physiology of these microorganisms and became a useful tool for selecting appropriate strains for technological, functional or probiotic applications.

Action of Probiotic Yeasts

Some yeasts such as *Saccharomyces boulardii* 17 and *Saccharomyces cerevisiae* UFMG 905 can be used as probiotics to prevent or treat various infectious and inflammatory diseases. Similar to bacterial probiotics, beneficial effects of these yeasts are the results of simultaneous action of various mechanisms such as modulation of some aspects of local and systemic immune responses, trapping of bacterial toxin or pathogenic bacterial cells on yeast surface, and maintenance of intestinal epithelium integrity (Santos and Robert).Acting together, these mechanisms seem to be responsible for a reduction of inflammatory process, intestinal permeability and bacterial translocation observed during infectious and inflammatory diseases

Application and future aspects of Probiotics

The applicationsof Probiotics are as follows-

- **Promote lactose digestion**

  Probiotics has an effect by 2 levels

  a) Hydrolysis of lactose in the milk products.

  b) The hydrolytic capacity of Probiotics to reduce the actual amount of lactose.
- **Build resistance to enteric pathogens**

  Probiotics modulates the immune system of the body by building resistance to enteric pathogen. They also reduce the duration of any intestinal infections.
- **Decreases blood lipid and aid in heart disease**

  Probiotics helps in decreasing blood cholesterol level by lowering lipids dissolved in blood.
- **Scavenge superoxide radicals**

  Probiotics decreases the level of toxins by scavenging superoxide radicals.
- **Enhance intestinal barrier function**

  Probiotics enhance gut specific IgA responces and increases intestinal permeability.
- **Produce bacteriocins to inhibit pathogens**

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Earlier, Bacteriocins were considered as an important trait in selection of Probiotic strain but now, studies demonstrated that they positively influence health of host.

- **Digest food and compete for nutrients with pathogens**

  Probiotics include food digestion, production of useful products to destroy bad microbes, complement the function of missed digestive enzymes (due to missed or defective genes) and to maintain the digestive system's pH.

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Bioinformatics: Brief outline and its application in agriculture and allied sciences

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INTRODUCTION:

Bioinformatics is the modern field of science that involves the application of information technology and computer application to study and understating of the biological sciences. The term was firstly proposed by PaulienHogeweg and Ben Hesper in the year 1970 to study the informatics processes in the biological systems and pathways. Bioinformatics helps in the understanding of biological phenomenon effectively and provides new biological insights to deal with future challenges related to biological researches. Merging computer sciences with biology enhances the work efficacy and reduces the time span to solve the biological riddles. A number of sophisticated tools and software have been developed to study cellular biological processes. The bioinformatics studies are associated with the acquisition of biological data, analysis and storage of data for further uses, display of the hidden information found in genetic material like DNA, RNA, and proteins.

Scientific fields where bioinformatics tools are used?

The bioinformatics tools have wild utility across different scientific fields. The tools are effectively used in agricultural, animal and humans related scientific fields. These tools are used in the field of ecology, evolution, biochemistry, molecular biology, biophysics, behavioral studies, pathology, pharmacology, cosmetics, and drug development, etc.

The role of biology in the bioinformatics:

The biology parts include the study of genotype to phenotype features of an organism, which includes the whole biological process involved in central dogma concepts. The mechanism of DNA to RNA formation followed by protein expression and the key factors regulating them is studied in this field with the help of tools and software.

The role of information technology in the bioinformatics:

The major role is played by the information technology and computer sciences in the field of bioinformatics. Which includes biological data acquisitions, data analysis, data management, storage and display of data. Further computerized models are made to study data effectively with the help of specialized software.

Major components of bioinformatics field:

1. Information technology
2. Databases of biological information
3. Algorithm to study data
4. Analysis tools and software
5. Computation and storage

Application of bioinformatics in the field of agriculture and allied sciences:

1. To study the resistance mechanism in insects against different pesticides

2. Improvement of nutrition profile of mostly consumable food
3. Synthesis of drought resistant crop varieties by searching forstress tolerant genes
4. Identifying the carbon dioxides neutralizing bacteria to study the climate change processes
5. Genomics assisted breeding of crops for enhanced productivity
6. Genomics assisted breeding of crops for improved traits like tolerant to biotic and abiotic stresses
7. Application in animal husbandry sciences to enhance nutrition value of milk, eggs, meats , and other economically important byproducts
8. Application in waste managementby studying the microbes and their mechanism involved in waste digestion and disintegration
9. Gene therapy to cure the most destructive diseases
10. Understating the mechanism involved in the development of antibiotic resistance

CONCLUSION:

Bioinformatics is the integration of computer science, mathematics models, traditional and molecular biology and information technology which helps in understanding the complex biological processes and pathways. The tools and software of bioinformatics are helpful in every sphere of routine life to enhance the agricultural productivity and improvement of beneficial microbes and animals and better improvement of human life. The availability of genomic sequences of the number of plants and animals will further help in decoding the unexplored biological processes which could be manipulated in a more effective manner. Thus the role of bioinformatics in modern science is unlimited and yet to be explored for a broad level understanding of real-time biological information and data.

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Agricultural adaptation strategies to climate change impacts in india

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INTRODUCTION

Sustainable food production under a changing climate is among the most important international research priorities.(Vermeulen S et el 2014). There is a global consensus among climate and agricultural scientists about the need to quantify the likely impacts of climate change on crop yields due to their significant consequences on both food prices and the global economy. (Ewert F 2015). Globally, an unprecedented increase in greenhouse emissions has led to increased climate change impacts. Agricultural activities have been shown to contribute immensely to climate change as it ranks third after energy consumption and chlorofluorocarbon production in enhancing green house emissions. In fact, emissions from agricultural sources are believed to account for some 15% of today's anthropogenic greenhouse gas emissions. Land use changes, often made for agricultural purposes, contribute another 8% or so to the total (Ozor and Nnaji, 2011).

Agricultural adaptation strategies to climate change impacts

Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. The Intergovernmental Panel on Climaten Change (2007) defines adaptation as adjustments in natural or human systems in response to actual or expected climatic stimuli or effects, which moderates harm or exploits beneficial opportunities. It also refers to actions that people, countries, and societies take to adjust to climate change that has occurred. Adaptation has three possible objectives: to reduce exposure to the risk of damage; to develop the capacity to cope with unavoidable damages; and to take advantage of new opportunities. In this paper, the adaptation used in India was discussed under crop and livestock adaptation strategies.

1. Crop adaptation strategies

1.1 Planting of drought resistant varieties of crops:

Emphasis on more drought resistant crops in drought-prone areas could help in reducing vulnerability to climate change. For example, wheat requires significantly less irrigation water compared to dry season rice. The use of drought- resistant crop varieties have been tried by smallholder farmers as adaptation methods to climate change. in (Ngigi, 2009)

1.2 Crop diversification: Diversification towards high value crops is feasible in the medium to long term. Crop diversity is a high priority adaptation measure in both irrigated and non-irrigated areas. for example, land use is manipulated leading to land use conversion, such as the shift from livestock farming to game farming. (Ziervogel *et al*., 2008).

1.3 Change in cropping pattern and calendar of planting: Climate change adversely affects crop production through long-term alterations in rainfall resulting in changes in cropping pattern and calendar of operations. According to Urama and Ozor (2011).

1.4 Mixed cropping: Mixed cropping involves growing two or more crops in proximity in the same field. The system is commonly practised in Tanzania where cereals (maize, sorghum), legumes (beans) and nuts

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(groundnuts) are grown together. The advantages of mixing crops with varying attributes are in terms of maturity period (e.g. maize and beans), drought tolerance (maize and sorghum), input requirements (cereals and legumes) and end users of the product (e.g. maize as food and sunflower for cash). A research conducted by Mendelsohn *et al.* (2000).

1.5 Improved irrigation efficiency: Success of climate change adaptation depends on availability of fresh water in drought-prone areas. It should be emphasized that most adaptation methods provide benefits even with the lower end of climate change scenarios, such as improved irrigation efficiency. As water becomes a limiting factor, improved irrigation efficiency will become an important adaptation tool, especially in dry season, because irrigation practices the for dry area are water intensive. Climate change is expected to result in decreased fresh water availability (surface and groundwater) and reduced soil moisture during the dry season, while the crop water demand is expected to increase because of increased evapo-transpiration caused by climate change and the continuous introduction of high-yielding varieties and intensive agriculture (Selvaraju *et al*., 2006).

1.6 Adopting soil conservation measures that conserve soil moisture: Soil conservation techniques are increasingly practiced . A study carried out by Lema and Majule (2009)

1.7 Planting of trees (afforestation) and agroforestry: Tree planting is the process of transplanting tree seedlings, generally for forestry, land reclamation, or landscaping purposes. It differs from the transplantation of larger trees in arboriculture, and from the lower cost but slower and less reliable distribution of tree seeds. In silviculture the activity is known as reforestation, or afforestation, depending on whether the area being planted has or has not recently been forested. It involves planting seedlings over an area of land where the forest has been harvested or damaged by fire or disease or insects. Rural farmers in most of the India have been planting trees as a way of adapting to the effect of climate change. Agroforestry is a rational land-use planning system that tries to find some balance in the raising of food crops and forests (Adesina *et al.,* 1999).

2. Livestock adaptation strategies

Livestock producers have traditionally adapted to various environmental and climatic changes by building on their in-depth knowledge of the environment in which they live. The following have been identified by several experts (FAO, 2008; Thornton *et al.,* 2008; Sidahmed, 2008) as ways to increase adaptation in the livestock sector

2.1 Production adjustments: Changes in livestock practices could include: (i) diversification, intensification and/or integration of pasture management, livestock and crop production; (ii) altering the timing of operations; (iii) conservation of nature and ecosystems; (iv) modifying stock routings and distances; (v) introducing mixed livestock farming systems, such as stall-fed systems and pasture grazing. include the use of emergency fodder in times of droughts, multi-species composition of herds to survive climate extremes, and culling of weak livestock for food during periods of drought. During drought periods, pastoralists and agro-pastoralists change from cattle (Bos) to sheep (Capra) and goat (Capra) husbandry as the feed requirements of the later is less than the former (Oba 1997).

2.2 Breeding strategies: Many local breeds are already adapted to harsh living conditions. However, developing countries are usually characterized by a lack of technology in livestock breeding and agricultural programmes that might otherwise help to speed adaptation. Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases (Hoffmann, 2008). Such measures could include: (i) identifying and strengthening local breeds that

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have adapted to local climatic stress and feed sources and (ii) improving local genetics through cross-breeding with heat and disease tolerant breeds. If climate change is faster than natural selection, the risk to the survival and adaptation of the new breed is greater (Hoffmann, 2008)

2.3 Livestock management systems: Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies. These could include (i) provision of shade and water to reduce heat stress from increased temperature. Given current high energy prices, providing natural (low cost) shade instead of high cost air conditioning is more suitable for rural poor producers; (ii) reduction of livestock numbers – a lower number of more productive animals leads to more efficient production and lower GHG emissions from livestock production (Batima, 2006);

2.4 Capacity building for livestock keepers: There is a need to improve the capacity of livestock producers and herders to understand and deal with climate change increasing their awareness of global changes. In addition, training in agro-ecological technologies and practices for the production and conservation of fodder improves the supply of animal feed and reduces malnutrition and mortality in herds.

3. Other adaptation strategies

3.1 Labour migration: Migration is a dominant mode of labour (seasonal migration), providing a critical livelihood source. The role of remittances derived from migration provides a key coping mechanism in drought and non-drought years but is one that can be dramatically affected by periods of climate shock,
when adjustments to basic goods, such as food prices are impacted by food aid and other interventions (Devereux and Maxwell, 2001).

3.2 Income diversification: A survey carried out by Mertz *et al.* (2010) indicated that in Southern Burkina Faso, farmers adapt to the effects of low yield by indulging in the dry season market gardening and non-farm income sources. This is corroborated by additional in-depth studies at local level in northern Burkina Faso, where local people focus on activities that are less dependent on climate. (Nielsen and Reenberg 2010a, 2010b).

Conclusion and Recommendations

India is already under pressure from climate stresses which increase vulnerability to further climate change and reduce adaptive capacity. The adverse effects of climate change have a particularly devastating effect on agriculture, which is the mainstay of most Indian economies. This has affected food production with its resultant effect on widespread poverty. Some Indian communities have developed traditional agricultural adaptation strategies to cope with climate variability and extreme events. Experience with these strategies needs to be shared among communities. Techniques include: diversification of herds and incomes, use of forest products as a buffer against climate induced crop failure, soil fertility improvement techniques, soil moisture and water conservation practices, decentralization of governance of resources and the manipulation of land use leading to land use conversion, to name a few. However, some of these techniques may need to be adjusted to face additional
climate risks associated with climate change.

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Insect vectors of human diseases

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INTRODUCTION

Insect aids in transmitting various dangerous human diseases. Insect-transmitted diseases take a heavy toll of human life. Millions of people suffer and die because of these fatal diseases worldwide. Around 400 million people still live in malariaendemic areasworldwide. It is estimated that at least 100 million cases occur annually resulting in death of one million, Filariasis is another common disease in tropical areas affecting more than 250 million people. The number of deaths due to plague during 1898-1957 has been estimated up to 12,707,475. Similarly,1970-80, sleeping sickness took toll of million lives in West Africa.

COMMON VECTOR INSECTS

Some common insects viz. Mosquitoes, Sandflies, blackflies, housefly, tsetsefly, human flea, human louse etc., transmitpathogens causing various human diseases are described below.

1. MOSQUITOES

The family Culicidae contains about 110 genera and 2400 species. Amongst them, some of the most important genera transmitting diseases are, the Anopheles, Aedes and Culex. Theirdominance isobserved mostly during spring season.Females are biting gnats and play pivotal role in transmitting diseases.

DISEASES

i. 60 species of Anophelescauses malaria by transmitting the pathogen, *Plasmodium vivax*, or *Plasmodium falciparum* (Protozoa: Sporozoa).
ii. *Culex tritaeniorhynchus* causes the diseases, encephalitisby transmitting a virus *Flavivirus* (Togoviridae).
iii. *Aedes aegypti* causes yellow fever in humid tropics by transmitting the pathogen, Yellow fever virus (Togoviridae).
iv. *Culex pipiens quinquefasciatus* causes filariasis of two types: *Bancroftian filariasis* and *Brugian filariasis*, elephantiasisby transmitting the pathogen, the filarian nematodes, *Wucheeria bancofti* and *Brugia malayi.*
v. *Aedes caballus* and *A. circmuluterolus* cause the disease, Rift valley fever virus.

2. SANDFLIES (*Phlebotomus sp.*) (Diptera: Psychodidae)

These are blood sucking type of dipteran fliescommonly called as the ‘owl midges’ or the ‘sandflies’. The females are blood sucking and are nocturnal.

DISEASES

The sandflies *Phlebotomus sp.* And *Lutzomyis sp.* Cause Leishmaniasesby transmitting the pathogen *Leishmania donovani intatum, L. tropica, L. braziliensis, L. mexicana* protozoan.

i. A visceral Leishmaniasis caused by *Leishmania donovani* is also known as Kala azar.
ii. The dermal Leishmaniasis is also known as oriental sore.
iii. Sand flies, *Lutzomyia verrucarum, L. colombians* cause Carrions’s disease.

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iv. The Sandflies *Phlebotomus papatasi* and *P. sergenti* cause the disease, Sandfly fever and papatasi fever.

3. THE BLACKFLIES (*Simulium sp.*) (Diptera:Simulidae)

These flies are also called the “buffalo gnats”.Females are the biting flies.Swarms of blackflies are very troublesome. These are mostly active during morning and evening hours.

DISEASES

The black flies *Simulium damnosum* and *S. neavei* cause Onchocerciasis (River blindness or blinding filarial disease) by transmitting filarial nematode, *Onchocera volvulus.* Upon infection, subcutaneous nodules are formed under the skin, joints, muscles. Gradually, lymph glands swollen leading to elephantiasis. The microfilariae may attack lungs, liver and eyes.

4. THE HOUSEFLIES (*Musca sp.*) (Diptera: Muscidae)

Musca domestica is a very common Indian Housefly. The flies are abundant and very active during summer and rainy seasons. Other species of Musca found Asiatic countries are *M. vicina. M.autumnalis,* and *M. Sorbens.*

DISEASES

The evidence of flies as mechanical vectors of human pathogens is essentially circumstantial. The flies are known to transmit more than 100 species of pathogenic organisms including the causative organisms of amoebic dysentery, typhoid fever, Cholera, shigellosis, salmonellosis, anthrax, yaws trachoma, poliomyelitis, infectious hepatitis and are also responsiblefor carrying and spreading of eggs of helminths like pin worm, whip worm, hook worm and tape worm.

5. TSETSE FLY (*Glossina sp*.) (Muscidae:Diptera)

These occur only in Africa except, *G. gachinoides* forming thee fly belts, which is found in Southern Arabia. Both are the blood sucking flies.

DISEASES

The tsetse fly, *Glossina palpalis* causes Gambian sleeping sickness and *Glossina morsitans* causes Rhodesian sleeping sicknessby transmitting the pathogen, *Trypanosoma brucei-gambiens* and *Trypanosoma rhodesiens* respectively.

Gambian sleeping sickness is very fatal disease and combines with dysentery and pneumonia causing death within two or three years.

6. HUMAN FLEA (*Pulex irritans*) (Siphanoptera: Pulicidae)

They are cosmopolitan in distribution. The orient rat flea, *Xenopsylla cheopsis* (Dolichopsyllidae) is a vector spreading plague from rat to man. The human flea, *Pulex irritans* spreads bubonic plague from man to man.

DISEASES

The fleas *Xenospylla* causes the disease Plauge throughout the world by transmitting the pathogen, *Yersinia pestis.* Bubonic plague is that when inflammation of nymph glands results from the infection and buboes are formed by the second day in femoral, inguino-femoral, axillary, cervical, iliac and pubic regions.

Septicemic plague, when infection course to liver and spleen is prevented and infection massively invades the blood stream, the buboes are inconspicuous.

7. **THE HUMAN LOUSE (*Pediculus humanus*) (Anoplura: Pediculidae)**

It is worldwide in distribution, abundant in over- crowded slum across or prisons, Military barracks etc. The infection is called Pediculosis. Both sexes are blood sucking. They include-

i. *Pediculus humanus capitis*- the head louse living on hairs and skins of the skull
ii. *Pediculus humanus corpis*- the body louse living on garments or body hairs.

iii. *Phithiris pubis,* the crab louse, living on the hairs of pubic region. They cause itching skin and transmission of some disease pathogen.

DISEASES

I. The louse, *Pediculus humanus capitis* causes the disease, Epidemic typhus by transmitting the pathogen, *Rickettsia prowazekii* (Rickettsia).

II. The louse, *Pediculus humanus corpis*causes the diseases, Trench fever by transmitting the pathogen *Rochalimaea quintata* (Rickettsia).

III. The louse, *Phithiris pubis* causes the disease Epidemic Relapsing Fever by transmitting *Borrelia recurrentis* (Spirochete).

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Sweet Sorghum: Special Purpose Smart Biofuel Crop

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Self-sufficiency in energy requirements is critical to the success of any emerging economy. Renewable sources of energy are considered to be one of the major pillars of energy security that reduces dependence on fossil fuels besides negating the negative effects on the environment. Agriculture has always been a source of fuels for energy production such as feed for draught animals and more recently juice for biofuels, e.g., bioethanol (blended with fossil fuels) or biodiesel. Production of fuels, especially bio-ethanol from lignocellulosic biomass, holds remarkable potential to meet the current energy demand as well as to mitigate greenhouse gas emissions for a sustainable clean environment. Sweet sorghum is a widely adapted sugar crop with high potential for bioenergy and ethanol production. Sweet sorghum can yield more ethanol per unit area of land than many other crops especially under minimum input production. Sweet sorghum is well-adapted to marginal growing conditions such as water deficits, water logging, salinity, alkalinity, and other constraints. (Reddy and Sanjana 2003).

Sweet sorghum potential exists for ethanol yield of 6000 L/ha with more than three units of energy attained per unit invested. Sweet sorghum is genetically diverse and variations exits for characteristics such as Brix % (13-24), juice sucrose concentration (7.2-15.5%), total stalk sugar yield (as high as 12 Mg ha/1), fresh stalk yield (24-120 Mg ha/1), biomass yield (36-140 t/ha) and others indicating potential for improvement. Large-scale commercial cultivation of these crops by industries for biofuel production may be economically viable but lack of knowledge and access to seed material besides marketability of the farm produce would potentially deprive the poor dry land farmers from benefitting from the these emerging opportunities. The latter targets to improve sugar and grain productivity of sweet sorghums cultivars for specific semi-arid tropic regions and aware the farmers about cultivation of sweet sorghum as biofuel crop that may leads to sustainable development of farmers communities. It reviews information about uses, current practices and also suggests future prospects of sweet sorghum in India.

INTRODUCTION :

Global population growth continues to rise at an alarming rate in spite of control measures taken by many countries. Predictions are that the population of the world will reach 9.4 billion by 2050 (US Census Bureau, 2006). The demand for food, fuel and energy resources of both developing and developed nations would increase substantially. According to the Food and Agricultural Organization of the United Nations (FAO 2005), fossil fuels are the most important energy source worldwide and also the primary cause for global warming and climate change. In 2008, the volatility of global crude oil prices was unprecedented. On 21 January 2008, the price of crude oil per barrel in the international market was $88.92. Crude oil price rise is now a crude reality. In June 2008, it touched a historic high of $147 per barrel, and hit rock bottom at $33 per barrel in December 2008, owing to global economic recession; subsequently, it increased to $80 in November 2009.

The climate is changing and there is now scientific, social and political recognition that this is very likely a consequence of increasing anthropogenic greenhouse gas (GHG) emissions. Transport now accounts for about 20% of global anthropogenic carbon dioxide emissions and these figures are growing faster than for any other sector. However, access to energy underpins our current way of life and the hopes of people around the world for improved livelihoods. Mobility is a core component of these aspirations. Transport has become the main driver for increasing global primary oil demand, which is predicted to grow by 1.3% per year up to 2030, reaching 116 million barrels per day (up from 84 million barrels per day in 2005).

The continued escalation in crude oil prices will have serious repercussions at the global level, crippling the economies of developing and under developed countries, thus necessitating the monitoring of oil prices on a continuous basis by UN agencies and other world bodies. Many countries, including large economies like USA, China and India are importing huge amounts of petroleum products. Research on renewable sources of energy was initiated in many countries a few decades back especially after the oil shock in 1973. However, success was limited to Brazil, where ethanol distillation from sugarcane has been economically sustainable. Ethanol is blended with petrol for use in flexi-fuel vehicles in Brazil, reducing the dependence on 100% petrol.

This study covers the significance, research status in several areas, potential, food-fuel tradeoff and environmental implications of using sweet sorghum as feedstock for production of ethanol in the context of present food crisis and also global food vs fuel debate. It also briefly addresses the prospects of using sorghum stover/biomass/bagasse for ethanol production through second-generation lignocellulosic technology.

- Now a day's the world's present economy is highly dependent on various fossil energy sources such as oil, coal, gasoline, natural gas, etc. These are being used for the production of fuel, electricity and other goods.
- Due to excessive use of fossil fuels, mainly in urban areas, has resulted in depletion of their resources. The level of greenhouse gasses in the earth's atmosphere has drastically increased.
- In the present demand for renewable, sustainable sources of energy to overcome the burden on world energy crisis, bioethanol have presented exciting options.
- Bio-ethanol is one of the important alternatives being considered due to the easy adaptability of this fuel to existing engines, less greenhouse gas emissions.
- Sweet sorghum is similar to grain sorghum but accumulates sugary juice in its stalk. Traditionally used as livestock fodder, the stalks can now be crushed to extract juice as raw material for ethanol production.
- Because of its short growing period, high biomass and bio-product potential, tolerance to drought, water-logging, salinity and acidity, low water requirement and greater income opportunities, sweet sorghum is the preferred crop for cultivation on dry lands in the semi-arid tropics.
- Sweet sorghum is recognized as an alternate feedstock for bioethanol production by the Government of India (National Biofuel Policy, December 2012).

The sweet sorghum ethanol value chain shows a positive net energy balance of 7.5 and a reduction of greenhouse gas emissions by 86%, compared to fossil fuels.

Why Sweet Sorghum?

Sweet Sorghum is an extraordinarily promising multifunctional crop for several reasons:

- It requires common soil even with high % of sand and it is also adapted to salty areas;
- It requires low water inputs (~200m3/ton), 1/3 of sugarcane requirements, 1/2 of corn;
- It has a shorter growing cycle (4/5 months), 1/3 of that sugar cane;
- A high productivity of several components (grains, sugars, lignocellulose);

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- It can be grown in all continents, in tropical, sub-tropical and temperate regions (covering sugar-cane and most sugar-beet areas);
- Sweet-Sorghum is not a food crop but a multi-functional (energy) crop, thus not a competitor crop for the food market!
- Sweet Sorghum absorbs large amounts of CO2(~50 t CO2/hax cycle);
  ~10 t/ha/y, within the tolerance level (11 t/ha/y);
- Biofertiliser production (compost) from Sweet Sorghum residues can improves the sustainability of cropping;

Comparison with sugarcane:

Sweet sorghum has less water and fertilizer requirements and hence lower cost of cultivation than sugarcane (Table 1). Sweet sorghum can be an additional or an alternative raw material to sugarcane. In most situations, it will be a supplement rather than a substitute for sugarcane.

Table : 1

Crop	Sugarcane	Sweet sorghum
Duration (days)	Seasonal - 360 Pre-seasonal - 420 Adsali - 480	110-150
Fertilizer requirement N: P: K (Kg/ha)	Seasonal - 250:115:115 Preseasonal - 340:170:170 Adsali - 360:170:170	100:50:50
Amount of water required (mm)	Seasonal - 2000-2200 Preseasonal - 2500 Adsali - 3000-3500	400-450
Commercial cane sugar produced (T/ha-season)	9.4	2.4
Cost of cultivation of stalks (Rs./ha - season)	46,355	23,245

❖ High level of competitiveness of Sweet-Sorghum:

- For its high productivity (~100 fresh ton/ ha) sugars and lignocellulosic residues are available at low cost (i.e. sugars ~50 €/ton, residues: ~20€/ton) making possible at viable Co-production of bioethanol and bioelectricity.
- Since the growing cycle of S.S. is ~140 days, in tropical areas, two plantations per year are possible. (10-12m3 ETOH/ha/y) with large increase of the ROI. (but sustainability considerations must be carefully taken in account)
- Optimized S-S. Biorefineries present a high Energy Ratio (outputs/Inputs) ~5-8 is therefore very efficient for atmospheric CO2 absorption and development (in future) of substantial Carbon Credits benefits.

❖ Multiple uses of sweet sorghum crop:

As indicated above, in addition to sweet stalks, average grain yield of 2–2.5 t h^{-1} can be obtained from

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sweet sorghum for use as food or feed. The bagasse (stalks after crushing) remaining afterthe extraction of juice has higher biological value than the bagasse from sugarcane when used as cattle feed, as it is rich in micronutrients and minerals which is also as good as stover in terms of its digestibility. Animal feeding experiments using the sweet sorghum bagasse and stripped leaves-based feed block (BRSLB) by International Livestock Research Institute (ILRI) and ICRISAT showed that no significant differences between BRSLB and commercial sorghum stover-based feed block (CFB) for neutral detergent fiber % (NDF), daily intake (kg d^{-1}) and weight gain per day in animals (Table 3). However for significant differences were observed between BRSLB and CFB for nitrogen content, *in vitro* digestibility and metabolizable energy (ME) contents. As expected, the laboratory quality indices were lowest in the sorghum stover. An important aspect of the present work was to investigate the palatability of feed blocks when sorghum stover was entirely replaced by BRSLB. There was no (statistical) difference in feed intake between the CFB and the BRSLB.

In summary, sweet sorghum is more accessible to poor farmers because of its low cost of cultivation and its ability to grow in areas that receive a minimum of 700 mm annual rainfall. Secondly, sweet sorghum has a high net energy balance, 3.63 compared to grain sorghum (1.50) and corn (1.53) (Wortmann et al. 2008). Even though the ethanol yield per unit weight of feedstock is lower for sweet sorghum compared to sugarcane, the much lower production costs and water requirement for this crop more than compensates for the difference, and hence, it still returns a competitive cost advantage in the production of ethanol in India (Rao et al. 2004). It produces three valuable products: food, fuel and feed, raising smallholder incomes by about 23% in central India (Rajasekhar 2007), while probably reducing net greenhouse gas emissions compared to fossil fuels.

CONCLUSIONS:-

- Sweet-sorghum appears to be a promising viable multi-functional crop for massive production of Bioethanol & Power, worldwide.
- S.S. biorefinieries have the capacity to overcome the major challenging problems existing now in the India:
  - Very high production cost based on the use of expensive food-crops (sugarcane-corn-sugar beets).
  - Low production from cereals, integrated processing not yet adopted.
  - Modest energy Ratio (En. Outputs/ En. Inputs ≤ 2)
- The anticipated production cost of bioethanol from S.S. is ~ 250 €/m3.
  - Its C4 photosynthetic system and rapid dry matter accumulation is an excellent bioenergy crop. Therefore, sorghum is expected to gain importance in the coming years in bioenergy farming. Sweet sorghum can be used as a substitute for sugarcane for syrup making.
  - Sensitivity analysis showed that higher the stripped stalk yield and syrup recovery, lower would be the syrup cost.
  - Comparison of sugarcane with sweet sorghum revealed that sweet sorghum is more economical to grow than sugarcane.

Future Prospectives :-

- Demand for renewable energy sources and biofuel which would minimize pollution are expected to rise rapidly in coming years.

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- It is need to provide consultancy services on commercialization of sweet sorghum for bio-ethanol production.
- Efforts are on for development of sweet sorghums hybrids and varieties with high juice yield with high sugar content.
- Need to aware the farmers about commercial cultivation and valuable uses of sweet sorghum.
- Sweet sorghum will be most important alternative crop for sugarcane in dry land area.
- Sweet sorghum can overcome against the climate change issue and pollution, hence need to increases area under sweet sorghum and establish biorefineries at village level.
- Make a biofule policy for sweet sorghum based bioethanol production.

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System of Millet Intensification (SMI)

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INTRODUCTION

Millets are ancient Super grains which are reservoirs of nutrition for a better health. Millets (sorghum, pearl millet and small millets) are the vital food and fodder crops in semi-arid regions, and are predominantly gaining more prominence in a world that is increasingly becoming populous, malnourished and facing large climatic uncertainties. These crops are adapted to wide range of temperatures, moisture-regimes and input conditions supplying food and feed to millions of dryland farmers, particularly in the developing world. Millets (great millet-Sorghum, pearl millet-Bajara, Finger millet-Ragi, Foxtail millet, Little millet, Proso millet, Barnyard millet and Kodo millet) are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture and are stable yielders (Anon., 2019).

Health Benefits of Millets

Millets were indeed one of the oldest foods known to humans but they were discarded in favor of wheat and rice with urbanization and industrialization. With diabetes, hypertension and cardiovascular disease running rampant, as gifts of newly acquired life-styles, millets have returned as a viable option to live healthy life without consuming loads of anti-diabetic and anti-hypertension medicines that are not only very expansive but also have serious side-effects in the long run.

Indeed millets act as a prebiotic feeding micro-flora in our inner ecosystem. Millet will hydrate our colon to keep us from being constipated. The high levels of tryptophan in millet produce serotonin, which is calming to our moods. Magnesium in millet can help reduce the affects of migraines and heart attacks. Niacin (Vit.B_3) in millet can help lower cholesterol. Millet consumption decreases Triglycerides and C-reactive protein, thereby preventing cardiovascular disease. All millet varieties show high antioxidant activity. Millet is gluten free and non-allergenic.

Above all, Millet's high protein content makes up for energy deficiency in vegetarian diet. Millets are the super foods for the present and future., their short growing season - from planted seeds to mature, ready to harvest plants in as little as 65 days make them commercially sound. The challenge is to food-process millet in to tasty and ready to eat foods like biscuits, noodles and pre baked roties and ofcourse as Ready to eat and Ready to cook novel foods. Indian Institute of Millets Research is working in that diorection to fetch better income to the Millet growers. In order to keep up the momentum and the sustainability of commercialization process, Entrepreneurship development of the stakeholders is necessitated through interventions in food processing and product development and nutritional evaluation.

The stakeholders were trained who includes progressive farmers, rural entrepreneurs, NGOs, SHGs, small and medium scale processors, women group entrepreneurs on topics such as Nutritional importance of sorghum and millets, Post-Harvest Technologies of Sorghum/ Millets, and Branding, Packaging and labelling.

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Similarly, another two projects under NAIP value chain mode were attempted by UAS, Dharwad and Raipur to study on small millets. These project's successful stories may be available as a model for integrated approach for millets promotion across the country. Overall, at least 88% increase in millet acreage over the current levels is expected to be attained by 2050 AD if policy push and demand creation trend is going to be continued (Anon., 2019) .

System of Millet Intensification (SMI)

In order to boost the finger millet cultivation, which is a nutritious and climate resilient local crop, the principle of SRI (System of Rice Intensification) is applied in finger millet cultivation which based on transplanting of older seedling and spaced planting and is popularly named as System of Millet Intensification (SMI) (Anon., 2017).

Journey from SRI to SMI

In 2006, the **NGO PRADAN** began working with farmers in Jharkhand state to extend SRI ideas and methods to their growing of finger millet. The application of SRI practices to this rainfed crop was seen to have effects similar to those observed for irrigated rice.

In Uttarakhand state in the Himalayan foothills, application of SRI ideas and methods to finger millet began in 2007 when the NGO People's Science Institute (PSI) worked with five farmers who transplanted seedlings just 15–20 days old @ 20×20 cm spacing. This raised their yield by 33% compared with the same variety grown with their usual methods.

In the state of Odisha, application of SCI practices to finger millet started in Koraput district in 2010, promoted by the NGO PRAGATI which works with mostly tribal villages. Initial SCI yields of finger millet were 2.1 tonnes/ha compared with farmers' usual yields of 1.0–1.1 tonnes/ha. The highest yield recorded that year was 6 tonnes/ha. On fertile soils, finger millet yields with SMI methods have been found to average 4.5–4.7 tonnes/ha, a four-fold increase over farmers' usual yields (Prabhakar*et al*., 2018).

In Nepal, a recent study by researchers at the Institute of Agriculture and Animal Science in Rampur reported the results of controlled trials that evaluated SMI methods for finger millet relative to standard direct seeded cultivation of this crop and conventional transplanting methods using seedlings 30 days old, rather than 15 days as used in the SMI trials. The gtain yield by SMI was 82% higher than with direct-seeding, and 25% more as compared to transplanting with older seedlings.

Package of Practices for SMI method:

a. Land and Seed selection:

- The low or medium land is used with a critical irrigation can be provided in case of dry spell.
- Seed rate: 300-400 g. for acre of main land in finger millet.
- Seed treatment with jibamrita or bijamrita.

b. Nursery bed raising:

- 40 sq. m. nursery area is necessary for one acre of main land.
- Seeds are shown on raised bed and apply jibamrit to make the root zone more friable.

c. Preparation of main field:

- Well ploughed and friable land is used. At least three plough is required.
- Ridge and furrow method of transplanting is used.

- Spacing for transplanting: 12′′ × 10′′

d. **Transplanting:**
- A 15-25 days old seedling should be uprooted without damaging the roots and used for transplanting.

e. **Weeding cum top dressing (Log rolling):**
- Weeding should be done 10-12 days interval by cycle wheel hoe or hand weeding.
- Total three weeding should be done.

f. **Pest management:**
- Sucking pest, stem borer and some fungal infection may occur. Apply Handidawa/ Garlic-ginger paste/ Nimastra in it is a recommended dose.
- Using locally adapted local varieties is more important to prevent diseases and pests.

Highlights of SMI:

1. SMI plants showed vigorous growth with more number of tillers increasing by as much as 4 to 5 times.
2. Culm branching also showed significant increase, with SMI plants showing 3 to 4 times as much branching as the non SMI control plants.
3. Roots were somewhat longer though not significantly so and much more bushy with many more secondary and tertiary roots in SMI plants compared to control plants. The changed root architecture is similar to what is seen in rice and almost all crops that have been tested under the principles of SRI.
4. The larger, bushy root system is a key factor in ensuring efficient uptake of water and nutrients leading to vigorous plants which show yield increases to varying extents.
5. In SMI plants, vigorous growth extended to the length of the panicles, which showed higher number of fingers in some cases.
6. 1000 gram weight was also higher in the SMI plants, the increase ranging from 22 to 60 %.
7. The maturity period appears to be delayed in plants grown under SMI conditions. This is likely because the large, stronger plants finish their vegetative growth later and seed setting is hence delayed.

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Banana Weevil (*Cosmopolites sordidus* G.) is major Pest of Banana and their Management

Article id: 22466

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INTRODUCTION

Bananas are among the most important food crops in the world. Banana is fourth most important commodity in the world after rice, wheat and corn. It is cultivated over 130 countries in the tropical and subtropical world (Anonymous, 2000). The fruit is preferred for high nutritive value, year round availability and low price (Robinson, 1996). Banana contains large quantities of energy but without any cholesterol. It contains high carbohydrate, low sodium and high potassium (Chandler, 1995). India is the largest producer of banana and plantain in the world. Despite their importance, banana yields are continuously declining due to attack by insect pests. Insects attack the banana rhizome, pseudostem, leaf and fruit. The most serious insect pest on a global basis is the banana weevil. the major insect pests, weevil borers are very important and most destructive because they not only destroy the crop but also affect the yield and quality of the product. Rhizome weevil, Cosmopolites sordidus and pseudostem weevil, Odoiporus longicollis are the two most important weevil borers. In this article an attempt has been made to review the damage, biology and management of these destructive pests of banana.

Banana (Musa spp.) is one of the most important fruits in India for food security and income generation for major smallholders who own less than 10 hectares of land. The weevil (*C. sordidus*) is a devastating pest of banana especially in the warm regions. The larva is the most damaging stage of the weevil and causes tunnelling in the corm. Macropropagation technology is a cost effective method for mass production of banana seedlings from the corm. Heavy attacks by weevils on corms reduce their suitability of selection for propagation, leading to rejection. In this study, selected farms were assessed for certification as sources of healthy banana corms for Macropropagation. In Eastern region, some plantations were heavily infested with weevils leading to a rejection rate of over 20% where the temperatures are warm, (25°C - 30°C) and favour thriving of the weevil. Although weevils are not transmitted from the corm to the suckers generated through macropropagation, the results show that chemical and cultural control measures should be taken to reduce weevil attacks and thereby increase availability of higher quality corms for propagation.

Distribution:

It is one of the most destructive pests of banana. Its native place is South east- Asia (Malaysia) but it is found all the banana growing countries of the world. These are Egypt Israel and Hwawii. In India, it is widely distrubted and has been reported as a major pest from Assam, Kerela, Tamil Nadu, Karnataka and Maharashtra.

Host range:

It is a specific pest of Musa species, Malbhog and Champa are more preferred species by the weevils.

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Nature & extent of damages:

This insect attacks only Musa spp. The damage done by the weevil is through the destruction of corm tissue. Soon after hatching the grubs bore into the stem and feed within. Adults feed during night on pseudo stem and bore into the suckers. The attacked pseudostem gets riddled with holes and the root origins are weaken. Secondarily, the tunnels made by the weevils are occupied by fungi and bacteria and accelerate the process of rotting. It causes break down of plants from the point of infestation in strong blast of winds. If they do not break only few fruits are formed.

Marks of identification:

Eggs are elongated, oval in shape and pure white in colour. Grubs are creamy white, stout, fleshy, highly wr4inkled, leg less with spindle shaped body. Adults are shiny black with fairly long and curved snout and short elytra striated longitudinally.

Life cycle and seasonal history:

Eggs are laid singly in collar of rhizome by biting a small hole in them. Oviposition occurs throughout the year. However, it is heavier during rainy season. Fecundity varies between 10-50 eggs per female. Incubation period is normally about a week but may extent upto weeks depending upon climatic conditions. Grub stage lasts for 2-4 weeks while pupal period is accomplished in 10-12 days. Pupation takes place in the soil. Adult may live for two years and can live even without food for six months.

Management:

- Deep ploughing to expose soil inhabiting pupae of corm weevil.
- Only healthy suckers should be used for planting.
- After cleaning and trimming suckers should be treated with 0.03 % dimethoate solution for 10-12 hours before planting.
- To monitor and manage corm weevil longitudinal splitted pseudo stems of 30 cm long may be placed in the banana orchards @ 20 per 350 plants. The split portion should face the ground. Collect and kill the trapped weevils and renew traps at weekly interval.
- Trap baited with Cosmolure may be used @ 4/ha for monitoring and management of Banana corm weevil. In the beginning, the trap should be placed in a line at 10 m from the border and 20 m apart and then move the traps 20 m along an axis perpendicular to the trap line each month in a manner that the existing traps are within the trapping plots.
- Swabbing of pseudo stem with mehyl-o-dimeton @ 2ml/litre in the holes of weevils during 6th-7the months of planting.
- If damage is noticed again, inject solution of water and methy-o-dimeton made up in the ration of 1.0:3.5 @ 2 ml per plant after 7th month at 2 and 4 feet height from ground. Or
- Soil application of carbofuran 3G @ 20 g per plant at 3rd, 5th and 7th months after plantation is also effective in the management of corm weevil. Or
- Uproot the corm and cut it along with pseudostem into pieces to kill grubs and adults of corm weevil if any infestation of observed.

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CONCLUSION

The study also assessed agronomic and yield parameters, however the study did not follow best banana management practices, for example spacing and fertility management that are reccommended for maximum productivity. In addition infestation with weevils probably implies that the expected productuvity potential was not realised. Nevertheless there were indications of improved / acceptable levels of yield and agronomic performance. Territories occurs in a context of limited access to infrastructure, pesticide alternatives, and markets for both organic and conventional crops. Management of the banana weevil in organic banana is limited to general farm sanitation practices assumed to function as cultural controls, except for occasional use of botanical pesticides by a few farmers.

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Application of Modern Tools in Breeding for Abiotic Stress Tolerance in Wheat

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Abiotic stresses are the most significant causes of yield losses in plants, implicated to reduce yields by as much as 50%. To improve abiotic stress tolerance, particularly drought tolerance of cereals is of extreme importance, as cereals, including wheat is the main constituents of the world food supply. However, many abiotic stresses are complex in nature, controlled by networks of genetic and environmental factors that hamper breeding strategies. For measurement of abiotic stress related traits in wheat several phenomic and genomic tools are available will be discuss in this article.

INTRODUCTION

Wheat (*Triticum aestivum* L.), the world's most important food grain, is the staple food for over 27 percent of global population in more than 40 countries. Wheat is unique in the sense that large number of diverse end-products such as chapati, biscuit, bread, noodles, marconi and other pasta products are made from it. Due to its high economic value and place among food crops, it is popularly known as "King of Cereals". It is being cultivated under varied agro-climatic conditions in India. This golden grain winter cereal is a major contributor (32%) to total food basket of India and thus play an important role in national food security system and economy as well.

During the last decade, we have witnessed globally a decline in annual growth rate in wheat production associated with an unprecedented increase in the price of food grains. It was partially attributed the impact of variety of abiotic stresses including drought and heat due to increasingly variable climate. Five out of 12 wheatmega environments (ME) proposed by Rajaram*et al.,* (1995), ME 4, ME 5, ME 6, ME 9 and ME12 suffer from water deficit and high temperature during crop period. The wheat crop is adapted for cultivation in under cooler climate conditions. Therefore, its cultivation in warmer climates is restricted to cooler months of the year (i.e., winter season).

Major Abiotic Stresses in Wheat:

1. Moisture Stress:

In the past, wheat production was largely constrained due to growing threats of new diseases and pests, but in the present scenario, more important constraints are increasing water stress and heat stress. It is recognized that globally, almost 50% of wheat cultivated in the developing world (50 million ha) is sown under rainfed systems, which receive less than 600mm of rain per annum. This rainfall could be less than 350mm of rain per annum in areas inhabited by the poorest and most disadvantaged farmers of the developing countries.

Traits which are used to measure drought or moisture stress are the following

A. Seedling Emergence, Coleoptile Length, and GA-Sensitive Dwarfness
B. Carbon Isotope Discrimination
C. Water Soluble Carbohydrates
D. Rate of Water Loss and Water Status in Leaves and Uprooted Plants

E. Osmoregulation
F. Root Vigor and Architecture

2. Terminal Heat Stress:

Heat is another stress that restricts wheat production and productivity, both during germination and the grain-filling period. Wheat is cultivated in large areas of the subtropics under continuous heat stress, defined by daily temperature higher than 17.5^0 C in the coolest period of the growing cycle. In India alone, as much as 13.5 million ha of wheat-growing area is very often subjected to heat stress.Rise in temperature at the timeof grain filling is referred to as "terminal heat stress", which is responsible for decline in wheat production in many environments around the world (including 40% of temperate environments), which cover 36 million ha.

3. Salinity Stress:

Crops growing in salt-affected soils may suffer from physiological drought stress, ion toxicity, and mineral deficiency which then lead to reduced growth and productivity.

Modern Tool in Breeding for Abiotic Stress Tolerance

1. Phenomic Tools

Phenomic tools which are available for abiotic stress phenotyping are the following:

A. Infrared Thermal Imaging
B. Magnetic Resonance Imaging
C. Spectral Reflectance Index and Normalized Difference Vegetation Index

2. Genomic Tools

A. Marker Assisted Selection
B. Transgenic Approaches

CONCLUSION

In conclusion, wheat faces many abiotic stresses which causes significant yield reduction. To develop abiotic stress tolerance varieties, phenotyping for the traits related to abiotic stress is very important. So many phenomic tools eg. Infrared thermal imaging, Magnetic resonance imaging and NDVI are available which are used to measure these traits. For the selection of genes(s) related to abiotic stress tolerance, MAS (marker assisted selection) and transgenic approaches are good.

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Cyborg insects: future of the world

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INTRODUCTION:

A cyborg is short for cybernetic organism, being with both organic and biomechatronic body parts. The term was coined in 1960 by Manfred Clynes and Nathan S. Kline. The term cyborg is not the same thing as bionic, biorobot or android; it applies to an organism that has restored function or enhanced abilities due to the integration of some artificial component or technology that relies on some sort of feedback. While cyborgs are commonly thought of as mammals, including humans, they might also conceivably be any kind of organism.

Cyborg Vs Robotics

CYBORG	ROBOT
• Cyborgs are combination of a living organism and a machine • Not necessarily to be a Human; it can be a bird, dog, insect or any other living thing • Part of living things	• Robot is basically a machine that is very advanced • It is often automated • Not alive

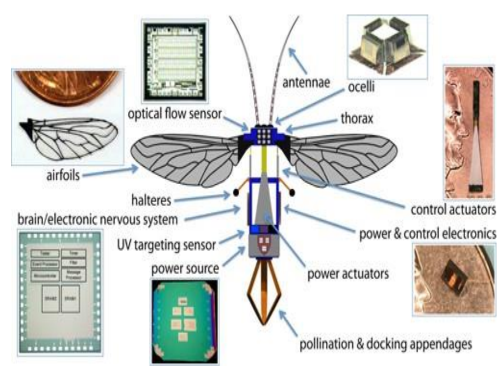
Cybrog insects: Implantation of electrodes into the brain, optic lobes, muscles of insects electrically stimulating the muscles could make the legs extend or retract, lower, lift or fly.

Insects used as Cyborgs:

1)Tobacco horn *worm- Manductasexta*(Bozkurt *et al.*, 2008*)*
2)Flower beetle- *Mecynorrhinapolyphemus*(Doan, 2015*)*
3)American grasshopper- *Schistocerca americana*(*Mehta et al., 2018)*
4)Madagascar Hissing roach (Dutta, 2019)

Reasons to choose insects as Cyborgs

- Flight performance
- Increasingly understood muscular and nervous systems
- Complete metamorphosis
- Locomotion



Brain neural interface (BCI):

BCI is the direct communication pathway between brain and external device. It is designed to restore sensory function, transmit sensory function to brain,

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stimulate the brain through artificially generated electrical signals. It has real time data acquisition and processing.

Principle behind Brain neural interface (BCI)

It consists of a sensor implanted in the brain of insect and a device that analyses brain signals. It consists of signals generated by brain are interpreted and translated to computer commands.

Micro air vehicles:

Micro air vehicles or MAV belongs to class-aircraft which hasmaximum size of about 6 inches. Its speed is about 25 mph or less.MAV areused for missions of surveillance measurements in situations where larger vehicles are not practical. They are small and inexpensive. It includes video cameras, chemical sensors, electronics and communication devices

Sensor implantation:

Electrode stimulators were implanted into the left and right optic lobes, brain, posterior pronotum (counter electrode), right and left basalar flight muscles. Initiation and cessation of flight were accomplished by optic lobe stimulation while muscular stimulation of either right or left basalar flight muscles.

HI MEMS (Hybrid Insect Micro-Electro-Mechanical Systems):

Hybrid Insect Micro-Electro-Mechanical Systems (HI-MEMS) also known as Cybug program. Developed by Defence Advanced Research Projects Agency (DARPA) of cyborg insects controlled by humans. "Early Metamorphosis Insertion Technology" (EMIT)involves inserting structures to the pupae at early stages of metamorphosis such that the body adapts the structures during the development and inserted structures emerge as a part of the body to create insect cyborgs. A reliable bio interface was created by taking the advantage of the rebuilding of the entire tissue system. This hybrid structure enables a platform where CMOS devices and MEMS structures can be used as sensors and actuators not only for insect flight control, but also for biological and environmental sensing. Moreover, this platform can be used to study the probetissue interface in general for MEMS based neuromuscular prosthetic systems.EMIT can benefit from any insect/animal that has metamorphic development (moths, butterflies, beetles, etc.) to create insect cyborgs with different locomotion capabilities. MEMS consist ofControl system and Power system.

Applications of Cyborg insects:

1) Search and rescue:

- Roaches are sent to disaster zones to seek out humans trapped under rubble (Dutta, 2019)
- Used to rescue the lives of disaster victims

2) Military context:

- Explosive detection-Cyborg insects can sniff out bombs
- Eg: Cyborg locusts developed to chemical sensing (Mehta *et al*., 2018)

3) Military context:

- Information gathering-Remote controlled cyborg beetles could be spy on terrorists (Sato and Maharbiz, 2010)

Advantages of Cyborg locusts:

- Cyborg locusts developed to chemical sensing (Mehta *et al*., 2018)
- Sniff out bombs (similar functional group)

Scientific Evidences: Remote control of a cyborg moth using carbon nanotube-enhanced flexible neuroprosthetic probe

Flexible Neuro Prosthetic probe (FNP)

First remote flight control of an insect using microfabricated flexible neuroprosthetic probes (FNPs) that directly interface with the animal's central nervous system. The FNPs have a novel split-ring design that incorporates the anatomical bi-cylinder structure of the nerve cord and allows for an efficient surgical process for implantation. Carbon nanotube (CNT)-Au nanocomposites into the FNPs to enhance the charge injection capability of the probe. The FNPs integrated with a wireless system are able to evoke multi-directional, graded abdominal motions in the moths thus altering their flight path.

Working of FNP:

1. One end of the probe is a ring that clamps around the VNC**2.** Inside the ring there are five electrodes, 3.Stimulation at one side of VNC**, 4.** Moth's abdomen turned left or right based on signal delivered

Advantages:

- Low current required- to control the moth and they were able to pick up nerve signals
- Less weight of FNP
- Low current- less damaging to the moth

CONCLUSION:

Instead of attempting to produce complex robots that mimic the insect form, researchers have hijacked bugs to turn them into robots(Bozkurt *et al*., 2007*)*. These cyborg insects have varied uses, from spying to search-and-rescue missions**.**The future of the world researchers will fully depend on "cyborg insects"

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Bristol Stool: A scale for diagnosis of constipation

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Researchers at the Bristol Royal Infirmary,hospital in Bristol, England developed a visual guide for stools. It is called the Bristol Stool Form Scale, or BSF scale. It helps skittish patients and doctors to distinguish normal stools from abnormal without getting embarrassed over personal details. So, the Bristol Stool scale is originated from Bristol Royal Infirmary hospital, England. It is a self-diagnostic chart designed to help skittish patients discuss this delicate subject with their doctors without getting embarrassed. This is, essentially, what the Brits call getting the "royal treatment.

How to interpretation of Bristol Scale (BSF) scale:

- Types 1, 2 and 3 = hard or impacted stools.
- Type 4 and 5 = normal or optimal.
- Type 6 = loose stool, subnormal, or suboptimal.
- Type 7 = diarrhea.

Type 1: Separate hard lumps, like nuts: This type is a typical for acute dysbacteriosis. These stools lack a normal amorphous quality, because bacteria are missing and there is nothing to retain water. The lumps are hard and abrasive, the typical diameter ranges from 1 to 2 cm (0.4–0.8"), and they're painful to pass, because the lumps are hard and scratchy. There is a high likelihood of anorectal bleeding from mechanical laceration of the anal canal. This type mostly occurs in people attempting fiber-free (low-carb) diets. Flatulence isn't likely occurs because fermentation of fiber isn't taking place.

Type 2: Sausage-like but lumpy

This type representsorganic constipation and a combination of Type 1 stools impacted into a single mass and lumped together by fiber components and some bacteria. The diameter of stool is 3 to 4 cm (1.2–1.6") in this type . This type is the most destructive by far because its size is near or exceeds the maximum opening of the anal canal‘s aperture (3.5 cm). It‘s bound to cause extreme straining during elimination, and most likely to cause anal canal laceration, hemorrhoidal prolapse, or diverticulosis. To attain this form, the stools must be in the colon for at least several weeks instead of the normal 72 hours. Having symptoms like anorectal pain, hemorrhoidal disease, anal fissures, minor flatulence withholding or delaying of defecation, and a history of chronic constipation. A person experiencing these stools is most likely to suffer from irritable bowel syndrome because of continuous pressure of large stools on the intestinal walls. The possibility of obstruction of the small intestine is high, because the large intestine is filled to capacity with stools. Adding supplemental fiber to expel these stools is dangerous, because the expanded fiber has no place to go, and may cause hernia, obstruction, or perforation of the small and large intestine alike.

Type 3: Like a sausage but with cracks in the surface

This form has all of the characteristics of Type 2 stools, but the transit time is faster, between one and two weeks. This is typical for latent constipation. The diameter of stool is 2 to 3.5 cm (0.8–1.4”). Irritable bowel syndrome is likely more and flatulence is minor, because of dysbacteriosis occurs in this type. The fact that it hasn‘t become as enlarged as Type 2 suggests that the defecations are regular. Straining is required. All of the adverse effects typical for Type 2 stools are likely for type 3, especially the rapid deterioration of hemorrhoidal disease.

Type 4: Like a sausage or snake, smooth and soft

This form is normal for someone defecating once daily. The diameter of stool is 1 to 2 cm (0.4–0.8”). The larger diameter suggests a longer transit time or a large amount of dietary fiber in the diet.

Type 5: Soft blobs with clear-cut edges

This type consider as ideal. It is typical for a person who has stools twice or three times daily, after major meals. The diameter of stool is 1 to 1.5 cm (0.4–0.6”).

Type 6: Fluffy pieces with ragged edges, a mushy stool

This form is close to the margins of comfort in several respects. First, it may be difficult to control the urge, especially when you don‘t have immediate access to a bathroom. Second, it is a rather messy affair to manage with toilet paper alone, unless you have access to a flexible shower or bidet. Otherwise, this type also considerborderline normal. These kind of stools may suggest a slightly hyperactive colon (fast motility), excess dietary potassium, or sudden dehydration or spike in blood pressure related to stress (both cause the rapid release of water and potassium from blood plasma into the intestinal cavity). It can also indicate a hypersensitive personality prone to stress, too many spices, drinking water with a high mineral content, or the use of osmotic (mineral salts) laxatives.

Type 7: Watery, no solid pieces

This type is called paradoxical diarrhea. It‘s typical for people (especially young children and infirm or convalescing adults) affected by fecal impaction a condition that follows or accompanies type 1 stools. During paradoxical diarrhea the liquid contents of the small intestine (up to 1.5–2 liters/quarts daily) have no place to go but down, because the large intestine is stuffed with impacted stools throughout its entire length. Some water gets absorbed, the rest accumulates in the rectum. The reason this type of diarrhea is called paradoxical is not because its nature isn‘t known or understood, but because being severely constipated and experiencing diarrhea all at once, is, indeed, a paradoxical situation. Unfortunately, it's all too common.

Classification of constipation with reference of Bristol Scale:

1. Functional constipation: This condition commonly follows a stressful event, surgery, colonoscopy, diarrhea, temporary incapacity, food poisoning, treatment with antibiotics, the side effects of new medication .The circumstances that damage intestinal flora, interfere with intestinal peristalsis, or both. A person becomes irregular, stools correspond to the BSF scale type 1 to 3, and straining is required to move the bowels. The person resorts to fiber or laxatives for help.

2. Latent constipation: If the intestinal flora, stools, and peristalsis aren't properly restored following adverse event(s), functional constipation eventually turns into the latent form (i.e. hidden), because fiber's or the laxative's effects on stools create the impression of normality and regularity. The stools become larger, heavier, and harder, usually the BSF type 3, straining more intense, but for as long as you keep moving your bowels every so often, and without too much pain, there is still an impression of regularity. This is, by far, the most dangerous form of constipation because of what happens next...

3. Organic constipation: As time goes by, large and hard stools between type 2 and 3 keep enlarging internal hemorrhoids and stretching out the colon. This, in turn, reduces the diameter of the anal canal even more, causes near complete anorectal nerve damage, and slows down or cancels out completely the propulsion of stools alongside the colon (motility). At this juncture, the person no longer senses a defecation urge, and becomes dependent on intense straining and/or laxatives to complete a bowel movement. If constipated patientdon't use 'hard' laxatives, they fail to move the bowels even with a good helping of fiber.

SUMMARY:

- Abnormal stools are any stools that require straining and/or you feel pressure from stools passing through the anal canal.
- Abnormal stools may be small or large size-wise, depending on fiber consumption, and frequency of defecation.
- Normal stools can be loose or slightly formed (Such as BSF type 5).
- Normal stools (between BSF type 4 and 6) aren't perfectly round.
- Normal stools for one person may be abnormal for another. The degree of normality is determined by the anatomy of the anal canal.
- Normal stools require zero effort and zero straining for elimination.
- Normal stools pass through the anal canal without any perception of pressure.

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A powerful tool for accelerating plant breeding: Speed breeding

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INTRODUCTION

The food demand of over growing population is increasing in an increasing rate, that creates a challenge for plant breeders to fought with new problems having an ultimate aim to increase the food yield. For most crop plants, the breeding of new, advanced cultivars, takes several years. Following crossing of selected parent lines, 4-6 generations of inbreeding are typically required to develop genetically stable lines for evaluation of agronomic traits and yield. This is particularly time-consuming for field-grown crops that are often limited to only 1-2 generations per year.This slow improvement rate in plants is attributed partly due to the long generation times of crop plants. Long generation time of the crop creates a problem in taking more crops per year.

Speed breeding is a generation advancing method given by Lee T. Hickey from The University of Queensland, Australia; which greatly shortens the generation time and accelerates breeding and research programs. Speed breeding as a flexible protocol, that uses prolonged photoperiods to accelerate the developmental rate of plants, thereby reducing generation time.speed breeding in fully-enclosed controlled-environment growth chambers can accelerate plant development for research purposes, including phenotyping of adult plant traits, mutant studies, and transformation.

METHODS

The use of supplemental lighting in a glasshouse environment allows rapid generation cycling through single seed descent and potential for adaptation to larger-scale crop improvement programs. Cost-saving through LED supplemental lighting is also outlined.Speed breeding can be used to achieve up to 6 generations per year for spring wheat (*Triticum aestivum*), durum wheat (T. durum), barley (*Hordeum vulgare*), chickpea (*Cicer arietinum*), and pea (*Pisum sativum*) and 4 generations for canola (*Brassica napus*), instead of 2-3 under normal glasshouse conditions.To evaluate speed breeding as a method to accelerate applied and basic research on cereal species, standard genotypes of spring bread wheat (*T. aestivum*), durum wheat (T. durum), barley (H. vulgare) and the model grass Brachypodium distachyon were grown in a controlled environment room with extended photoperiod (22 hours light/2 hours dark).A light/dark period was chosen over a continuous photoperiod to support functional expression of circadian clock genes. Growth was compared with that of plants in glasshouses with no supplementary light or heating during the spring and early summer of 2016. Plants grown under speed breeding progressed to anthesis (flowering) in approximately half the time of those from glasshouse conditions. Wheat seed counts per spikedecreased, although not always significantly, in the speed breeding chamber compared to the glasshouse with no supplementary lightand both wheat and barley plants produced a healthy number of spikes per plant, despite the rapid growth. Viability of mature seeds was unaffected by speed breeding with similar seed germination rates observed for all species. Moreover, crosses

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made between wheat cultivars under speed breeding conditions produced viable seed, including crosses between tetraploid and hexaploid wheat.Time to anthesis was significantly reduced for all crop species relative to the 12-hour day-neutral photoperiod conditions, where the average reduction was, depending on genotype, 22 ± 2 days (wheat), 64 ± 8 days (barley), 73 ± 9 days (canola) and 33 ± 2 days (chickpea).

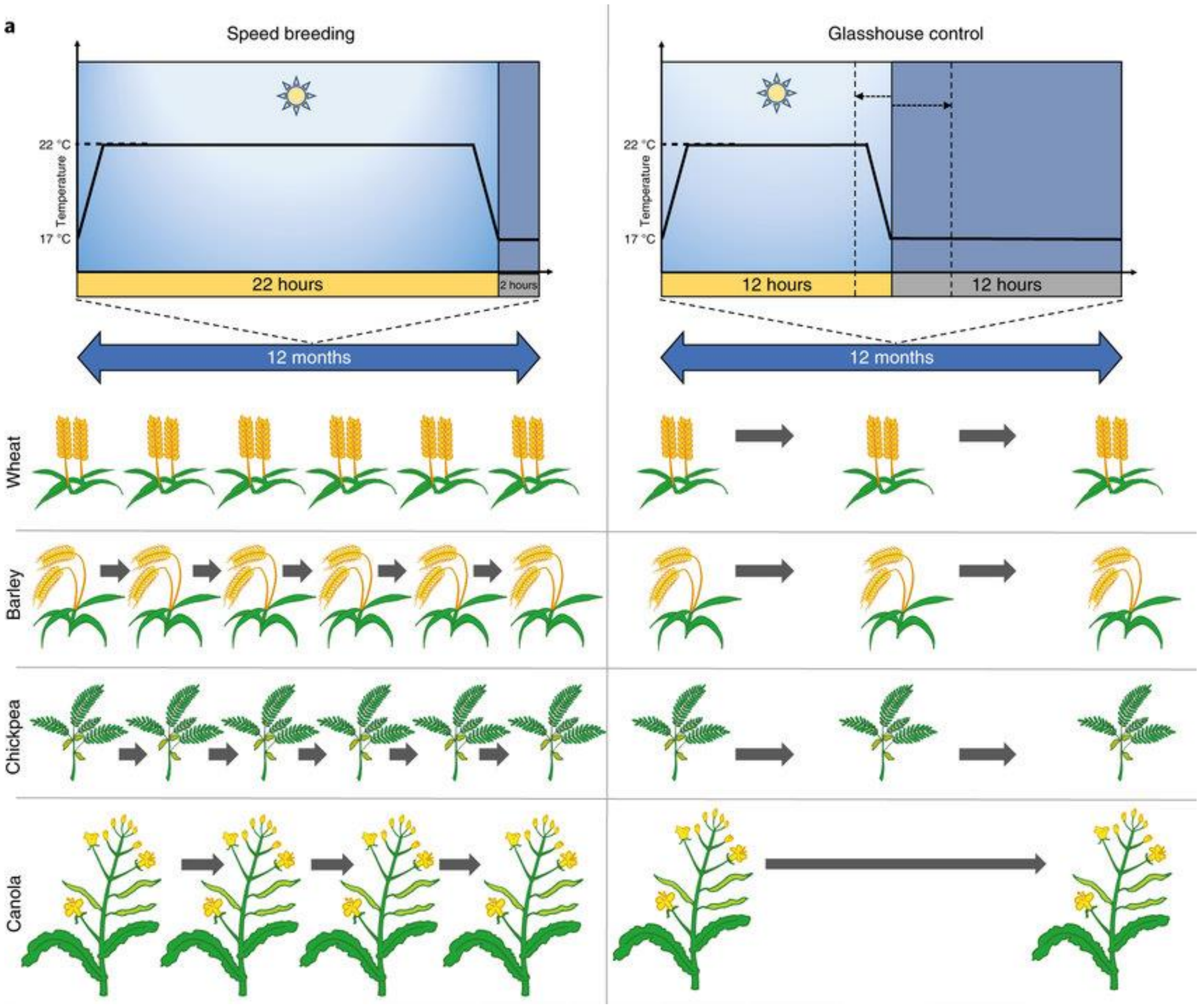

Fig: Compared to a glasshouse with a natural photoperiod, where only 2-3 generations of wheat, barley, chickpea and canola can be achieved per year (right), speed breeding enables 4-6 generations of these crops to be grown in a year (left).

Notably, time to anthesis was more uniform within each species under speed breeding conditionsan important feature, as synchronous flowering across genotypes is desirable for crossing.Additionally, wheat seed was harvested before maturity:14 days post-anthesis in speed breeding conditions and following a 4-day cold treatment seed viability was high indicating generation time can be further reduced by harvesting premature seed without the need for labour intensive embryo rescue. Single seed descent (SSD) is commonly used in breeding programs and research to facilitate development of homozygous lines following a cross as this process only requires one seed per plant to advance each generation.

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CONCLUSION

speed breeding is a recent technique that is popularising among plant breeders by helping easy generation advancement.If a variety takes five years to have in F10 generation in general situation, with the help of this technique we can have it by second year and hence its saves the breeder time. Although no doubt it is a good technique, but the methods are standardised for few crop species, hence more studies are needed to modify this method and have capable to apply on many crops.

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Insect pest management under protected cultivation

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INTRODUCTION

The management and control of insects and mites in a greenhouse can be challenging, even under optimum conditions. Integrated pest management (IPM) is a useful approach for producing greenhouse vegetables. It involves integration of cultural, physical, biological, and chemical methods to maximize productivity in a way that is ecologically sound and safe. The impact of plant pests on the aspiring producer of greenhouse vegetables is direct and significant. The prospective producer must understand that Florida is a paradise for both the crop and the accompanying pests that afflict it. Disease-causing organisms, insects, and nematodes can cause serious problems in greenhouses. Without a real winter period, populations of pests continue to build, and many are sustained throughout the year. With this mild climate comes the adaptability of both temperate and tropical pests to Florida, thus presenting a large number of potential problems for greenhouse crops.

Insect Management

Because of all the problems associated with the use of chemicals in the greenhouse environment, growers need to use exclusion as their first line of defense. Thus, insect management needs to be considered when designing the greenhouse. Insect-proof screening is available for vents and other openings, but because of greater resistance to air flow, the surface area of screened areas must be increased to compensate. For greenhouses that are covered with plastic, the use of ultraviolet-absorbing plastics can reduce insect problems. The UV-free light inside the greenhouse alters insects landing and feeding behavior and can greatly reduce the spread of insect-vectored viruses as well as discourage the establishment of aphids, whiteflies, and thrips. UV-reflective mulches used on the ground around the greenhouse can also help limit the entry of these pests. The protected environment of the greenhouse promotes survival of beneficial insects as well as pests, so biological control is another tactic worth exploring. Much of the research on how best to use natural enemies in greenhouse vegetables production is still in progress, but growers are already experimenting with the use of lady beetles, lacewing larvae, pirate bugs, and predacious mites. This approach can be expensive. Predacious mites are particularly effective for controlling spider mites under greenhouse conditions. Suppliers of natural enemies can recommend the proper species for release.

Nematode Management

In addition to traditional insects and diseases in greenhouses, nematodes can present an additional type of problem. Nematodes are among the pest/disease problems that can be especially troublesome in greenhouse production systems. These relatively microscopic worms feed on or in plant roots, disrupting plant root growth and function. Some redirect significant amounts of plant energy to their own growth and support, reducing quantity and quality of yield and often delaying crop maturity. They reproduce well at 80-90°F and cause significant problems on many of the crops most popular in greenhouse production systems. Nematodes are easily spread in contaminated water, soil or growing media, and plant tissues. They can be especially troublesome in greenhouse systems because, among other things:

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• Nematodes are easily introduced into greenhouse operations, and very difficult to get out of them. Any of several serious vegetable nematodes are commonly found in most native soils. They can get into a greenhouse crop whenever the barrier between the crop and the native soil beneath the house is broken. A single root penetrating through the plastic, concrete, or other flooring material can provide a route of entry. Infested transplants are another especially common means of introducing nematodes into a greenhouse. Any component of the growing
medium that was never sterilized or was exposed to contamination during storage or handling can introduce nematodes. Even the water, if obtained from a shallow or surface source, may carry nematodes into the greenhouse.

Pest Management Considerations:

The planning stage for the production system should include the following considerations:
a) Greenhouse construction design (especially height, heating, insect screens, and ventilation components) and an irrigation system that minimizes leaf wetness and humidity at the plant canopy level.
b) Selection of available pest resistant varieties.
c) Pest-free and healthy transplants that minimize introduction of plant pathogens, nematodes, and insects.
d) Optimum fertilizer programs that result in healthy growth as opposed to maximum growth.
e) Scouting for diseases, nematodes and insects during the growing season.
f) Sanitation practices that minimize microorganism movement from diseased plants to healthy ones, including removal of all plant materials after final harvest.
g) Harvest and shipping practices that maximize product quality. Application of such integrated practices will ensure economically and environmentally acceptable greenhouse vegetable crops.

Using IPM Package on protected Crops in other countries:

Management of vegetables' pests and diseases on protected areas in a country depends on a combination of early detection of pest, an effective method to control nematode such as soil solarization and finding an appropriate fungicide program to control diseases. To adopt the IPM Package, a combined interdisciplinary action must be implemented by a consortium of competent Institutions. The institutions that could be involved include: agricultural research institutions, University, specialists or technicians of vegetables culture and extension services. It is important to emphasize the interdisciplinary character of the work team, due to the method's characteristics.

Early detection of vegetables' pests and diseases on protected areas is essential to preventing infestation in commercial production areas. The Ministry of Agriculture should develop a statewide management plan to detect and combat the pests in commercial vegetables growing districts including IPM control programs. The *Soil Solarization* method to control root knot nematode in general is very simple and not requires extensive technological background and a great amount of knowledge to be transfer to the farmers.The necessary technical equipment consists only in plastic sheets 0,06-0,08mm, that are produced by specialized private companies of different Mediterranean Countries and that are easy find in several agricultural shops. Steps for IPM Package implementation:

- Making a Consortium with Agricultural Research Institutes and universities.
- The Consortium will carried on the following activities:
- Identification of potential area of IPM implementation

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- Monitoring of key pests
- Controlling the root knot nematode(RKN) through *Soil Solarization* method
- Controlling the key diseases through Integrated fungicidal control programs
- IPM Package designing, based in the previous steps

General Strategies for Insect and Mite Management

Cultural Controls are Essential Pests are generally brought into the greenhouse on new plant material. Others may enter the greenhouse in the summer when the ventilators are open. Many are able to survive short periods of time between harvest or plant removal and production of the next crop. Cultural controls are the primary defense against insect infestations. The following cultural practices will help to prevent pest infestations:

- Inspect new plants thoroughly to prevent the accidental introduction of pests into the greenhouse.
- Keep doors, screens and ventilators in good repair.
- Use clean or sterile soils or ground media. Clean or sterilize tools, flats and other equipment.
- Maintain a clean, closely mowed area around the greenhouse to reduce invasion by pests that develop in weeds outdoors.
- Eliminate pools of standing water on floors. Algal and moss growth in these areas can be sources of fungus gnat and shore fly problems.
- Dispose of trash, boards and old plant debris in the area.
- Remove all plants and any plant debris, clean the greenhouse thoroughly after each production cycle.
- If possible, allow the greenhouse to freeze in winter to eliminate tender insects like whiteflies.
- Avoid overwatering and promote good ventilation to minimize wet areas conducive to fly breeding.
- Avoid wearing yellow clothing which is attractive to many insect pests.
- Maintain a weed free greenhouse at all times.
- Eliminate infestations by discarding or removing heavily infested plants.

Biological Control Agents

Natural enemies are commercially available for control of some greenhouse pests. For a listing of sources, see ENT53, Vendors of Beneficial Organisms in North America. Levels of pest control obtained with beneficial organisms will vary greatly depending on a number of factors, including: species of pest involved species of natural enemy used timing of release of natural enemy relative to pest buildup and crop development numbers of beneficials released greenhouse temperature and range of fluctuation time of year condition of the beneficials at release pesticide usage before and after release of beneficials. Biological control generally requires more time than pesticides to bring a pest population under control. Natural enemies require time to disperse from release sites and to search for prey or hosts. Appropriate natural enemies should be released as soon as the pest is detected in the greenhouse. Natural enemies do not provide sufficiently rapid control of pests that are already causing serious losses, and they will not generally eradicate an infestation. In some instances, using an insecticidal soap or other nonresidual insecticide is recommended to reduce the infestation before releasing the natural enemies. Knowledge of pest biology and monitoring of pest populations are critical to determining when to make releases. Greenhouse managers should avoid unnecessary insecticide/miticide applications before and after release of natural enemies. If insecticide/miticide treatments are required, limit treatments to pest “hot spots” to avoid treating the entire greenhouse. Use a selective, short residual pesticide if possible. For example, *Bacillius thuringiensis* (Bt) products can be used to control caterpillars without harm to natural enemies in the greenhouse.

Pesticide Management

Greenhouse operators need to maximize the effectiveness of insecticides and miticides. To provide adequate control, a pesticide must be applied at the proper rate, when the pest is present. Coverage and sufficient pressure are needed to penetrate dense foliage and reach the target pest. This is especially important for sucking insects that infest the lower surface of leaves. Older, lower leaves can be removed to open the canopy of some crops to increase spray coverage. Insecticide or miticide applications must sometimes be repeated frequently to maintain a pest at acceptable levels. Timing of pesticide applications is important. Some pests are vulnerable to pesticides only at certain stages in their life cycle. For whitefly management, begin control measures early. If control action is delayed until an abundance of adult whiteflies can be seen, then numerous eggs and immature stages, which are more difficult to control, are usually present. With a limited number of pesticides available for greenhouse use, it is always a concern that pests may develop resistance to pesticides. Managers should rotate among different\ pesticides for successive applications when controlling specific pests. Rotations must include pesticides belonging to different chemical classes that use different modes of action to control the pests. This will prevent, or at least delay, the development of resistance to a particular pesticide. To aid pesticide applications, plants that are frequently infested by the same pest and can be legally sprayed with the same material should be grouped together. This will reduce the potential for misapplications to unlabelled crops. Additionally, moving infested material through the greenhouse can spread an infestation to other areas.

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Genetic Regulations of Floral Organ Development in Plants

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INTRODUCTION:

Floral development involves a transition in the shoot apical meristem (SAM) to form flowers. Specifically, endogenous and environmental signals convert the vegetative SAM into an inflorescence meristem (IM), which then laterally initiates floral meristems (FMs) like sepal, petal, carpel and stamen. Due to the Auxin hormone stimulation, the vegetative parts are transformed to the reproductive parts. At a certain stage of the plant development, the epical meristem switches program from a leaf producing tissue to the flower producing tissue (Butuo*et al*., 2019).

Different parts of a complete flower:

Flowers function as reproductive structures for many plants, and each part of a complete flower helps the flower serve that ultimate purpose (Anon., 2015).

- **Sepals**, which are the leaf-like, usually green structures at the flower base. They function to protect the flower as it's forming.
- **Petals** are the colorful parts of the flower that function to attract pollinators. Different petal colors can attract different types of animals and insects to act as pollinators.
- **Stamens** are male reproductive parts of a flower. Each stamen looks like a long tube with a ball on the end. The tube is called the filament, and the ball on top is called the anther. The anther produces pollen grains, which contain the flower's sperm. When pollinators come into contact with the anther, they may carry pollen grains away to fertilize a flower.
- **Pistils** are the female reproductive parts of the flower. A pistil is often bottle-shaped, and it has three main parts: the stigma, style and ovary. The sticky surface on top of the pistil is called the stigma. When a pollinator rubs a flower the right way, pollen will stick to the stigma.
- The **style** is the slender stalk that connects stigma to the ovary. The pollen grains deposited on the stigma form pollen tube and burrow through the style to reach the ovary.
- The **ovary** is a hollow cavity that contains immature seeds called ovules.

Architecture of gene regulatory networks controlling flower development:

The transition from vegetative to reproductive growth in plants is controlled by the sequential and coordinated activity of transcription factors (TFs) that integrate environmental signals, such as photoperiod, temperature and nutrient status, and endogenous cues such as plant age. Over the past three decades, key TFs controlling floral transition and flower formation have been identified in *Arabidopsis thaliana*.

a. ABC Model of Floral organ Development:

The ABC model of flower development explains about the genetic behind the formation of different whorls in a flower. This model was first formulated by George Houghn and Chris Somerville in 1988, with the

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experimental material of *Arabidopsis thaliana*.In 1991, E S. Coen.and E. M. Meyerowitz proposed the ABC Model to explain how floral whorls develop in *Arabidopsis thaliana* and *Antirrhinum majus*.

Genes controlling ABC Model:

- According to ABC model, three genes namely; gene A, gene B and gene C controlling the floral development in higher plants.
- Gene A and gene C are equally dominant in nature.
- If gene A is mutated, then gene C will become more active and if gene C is mutated then gene A will become more active.
- Gene B always express in association with gene A and gene C.

Organization of genes for ABC model of floral organ development:

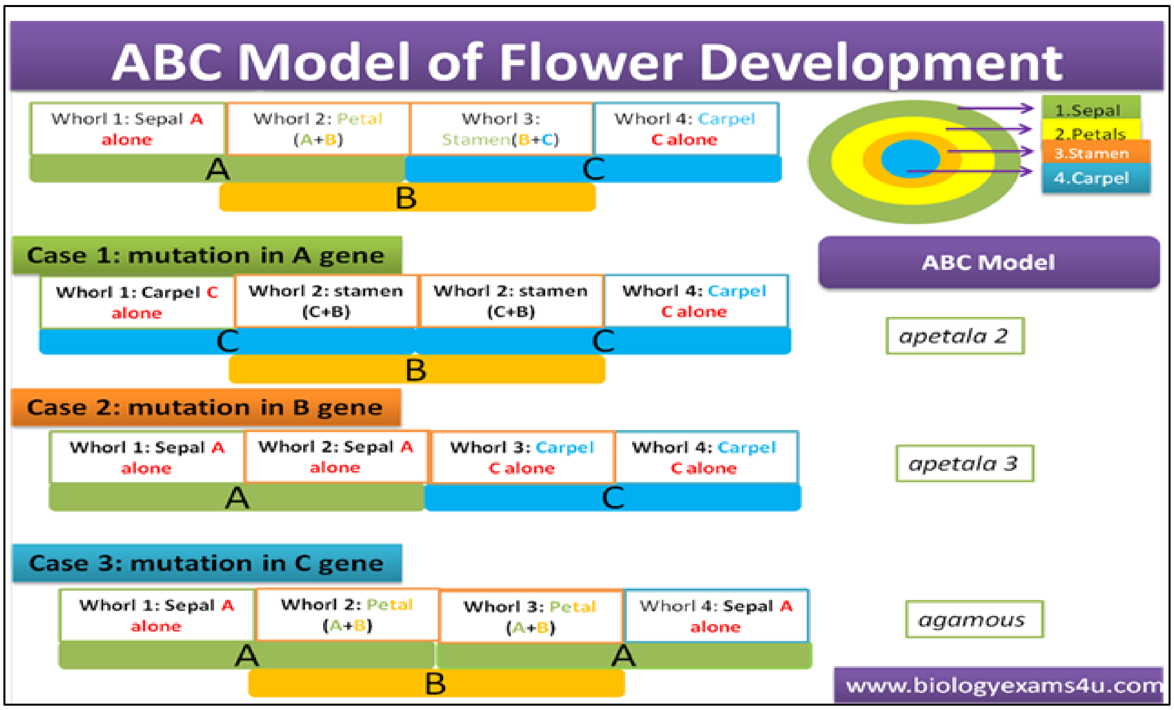

Fig.The ABC model of floral organ development in *Arabidopsis thaliana.*

This indicates that:

- Gene A alone develops the sepal.
- Gene A with gene B will develop petal.
- Gene B with gene C will develop stamen.
- Gene C alone develops carpels.

b. ABCDE Model of Floral organ Development:

The ABCDE model for flower development proposes that floral organ identity is defined by five classes of homeotic genes, named A, B, C, D and E (Rijpkema, *et al*., 2010). According to the floral quartet models of

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floral organ specification, the A- and E-class protein complex develop sepals as the ground-state floral organs in the first floral whorl, the A-, B- and E-class protein complex specify petals in the second whorl, the B-, C- and E-class protein complex specify stamens in the third whorl, and the C- and E-class protein complex specify carpels in the fourth whorl. Cloning of ABCDE homeotic genes in Arabidopsis showed that they encode MADS-box transcription factors except for the class A gene, *APETALA2* (*AP2*). In Arabidopsis, the class A MADS-box gene is AP1, the class B genes are *AP3* and *PISTILLATA* (*PI*), the class C gene is *AGAMOUS* (AG), and the class D genes are *SEEDSTICK* (*STK*), *SHATTERPROOF1* (*SHP1*) and *SHP2*. The D-class proteins interact in larger complex with the E-class proteins to specify ovule identity. In the Arabidopsis genome, four class E genes have been found, *SEPALLATA1* (*SEP1*), *SEP2*, *SEP3* and *SEP4*, which show partially redundant functions in identity determination of sepals, petals, stamens and carpels.

MAD-Box gene:

The MADS box is a conserved sequence motif found in genes which comprise the MADS-box gene family (Koji, 2013). The MADS box encodes the DNA-binding MADS domain and the length of the MADS-box are in the range of 168 to 180 base pairs.

Origin of MAD-box genes:

- MCM1 from the budding yeast, *Saccharomyces cerevisiae*.
- AGAMOUS from the thale cress *Arabidopsis thaliana*.
- DEFICIENS from the snapdragon *Antirrhinum majus*.
- SRF (serum response factor) from the human *Homo sapiens*.

In plants, MADS-box genes are involved in controlling all major aspects of development, including male & female gametophyte development, embryo and seed development, as well as root, flower and fruit development, floral organ identity and flowering time determination.

Organization of genes for ABCDE model of floral organ development:

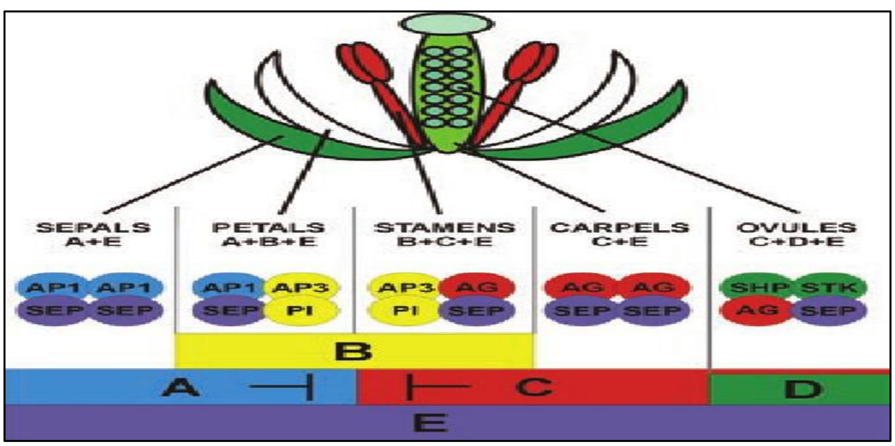

Fig. ABCDE model of floral organ development (Theissen and Saedler, 2001).

This indicates that;

- Class A genes (e.g-APETALA1) controls sepal development and together with class B genes (e.g-PISTILATA and APETALA3) regulates the formation of petals.
- Class B genes, together with class C genes (e.g-AGAMOUS), mediates stamen development.

- Class C genes determines the formation of Carpel/pistil.
- The class D genes (e.g-SEEDSTICK and SHATTERPROOF) specify the identity of the ovule.
- Class E genes (e.g-SEPALLATA), expressed in the entire floral meristem.

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Entomophagy- An Inclusive Solution for Global Food Security

Article id: 22473

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INTRODUCTION

Recent report indicates that the global population will increase to 9 billion people by 2050 which indirectly implies that there will be a great demand for quality and nutritious food. This projected population will require double the rate of food grainproduction when compared with the current level of output. Intensifying the existing production level with the available resources will lead to greater pressure on the environment along with the global environmental crises like climatic change, global warming, deforestation of forest cover for industrial development etc. Many alternatives were proposed to increase the global food availability through a sustainable way, among that entomophagy got more attention. Entomophagy is not a novel idea or term, consumption of insect was being followed since historic period, because ofthe influence of western food habits, traditional food habits were replaced lot. It was recorded that more than 2000 species of insects were found to be edible and interestingly nearly 2 billion people around the globe consumingthe insect as food because of its high nutrient values, easy availability, cost-effective and so on.

Why entomophagy is a reliable source for food security?

Insects are available in the biosphere long before the human arrival and they are found to be abundant in natural ecosystems. Nowadays, food insecurity is a major issue in many developing countries like South Asia and Sub-Saharan Africa. World Food Programme (WFP, 2015) revealed that about 805 million people are living without adequate food to maintain a healthy and active lifestyle. Insects are the cheap source of quality food because of their essential nutrients and the same time, feed conversion ratio is very high compared to the normal livestock proteins.

Some of the popular edible insects: Recent estimation showed that 2111 insect species were considered to be a potent edible source of proteins. Some of the popular edible insects are as follows:

- *Bombyx mori*- Silkworm
- *Musca domestica* - Common housefly
- *Hermetia illucens*- Black soldier fly
- *Tenebrio molitor*- Mealworm
- *Zophobas atratus* - Giant mealworm
- *Alphitobius diaperinus*- Lesser mealworm
- *Galleria mellonella*- Greater wax moth
- *Achroia grisella*- Lesser wax moth
- *Cheta domesticus*- House cricket
- *Gryllodes sigillatus*- Banded cricket
- *Locusta migratoria migratorioides*- African migratory locust
- *Schistocera americana*- American grasshopper

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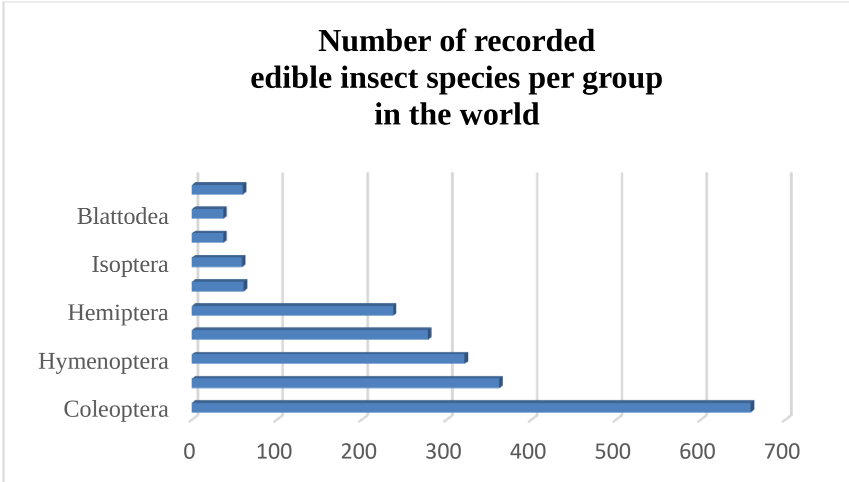

Source: Yde Jongema (2017)

Benefits of entomophagy

There are many benefits from entomophagy in different aspects of life

- Being a cold-blooded organism, insects are having a high feed conversion efficiency compared to other livestock animals (How much feed is required to produce 1 kg increase in weight). Approximately insect can convert 2 kg of feed into 1 kg of insect mass, whereas cattle require 8kg of feed to produce 1 kg of body mass.
- Greenhouse gas emission from the commercial insect production will be less when compared to the normal livestock productions. For example, pigs release 10-100 times more greenhouse gas per kg of weight than mealworms.
- Less space will be required for commercial insect rearing. In case of water utilization, insect need a very little amount of water than the conventional livestock production. Available data says 8% of global available water is used for livestock productions. So, insect rearing is having a positive impact on environment.
- Depending on insect'smetamorphic stage, habitat and diet, their nutritional content also differs. However, insects are a potent source of high-quality protein and nutrients comparable with meat and fish.
- Insect diet may give enough nourishment for ill-fed kids in the poor economy classes because they contain a high amount of fatty acids along with some major micronutrients. Still now, there is no evidence of transmitting zoonotic disease in edible insects.
- Insect rearing for commercial purpose mayintroduce the new sector of a field in the developing, transitional and developed countries which may increase country's economic value.
- Commercial insect farming provides employment directly and indirectly to many youths and women community in the developing nations.

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Constrainsin accepting insect as food

Major constraint is the western attitude towards the food selection by the consumers. Although insects contain high nutrients, negative attitude towards the entomophagy is still a challenging fact. Many consider insect as disgusting and nuisance pest which is attributed due to neophobia, a fear of trying new things. Another constraint to the latent consumer is some insect having harmful toxins and associated microbes which may cause an allergic reaction and other health ailments.

How to overcome these constraints?

Neophobia about entomophagy is just a temporary barrier, it can be easily lifted by certain techniques like value addition in insect products, introduction of new dishes by using raw insects and so on. Presently, lobster is one of the famous foods in the world which faced the enough barriers in the early 17th and 18th centuries, perhaps it was used to feed servants and prisoners for punishments. Research regarding the harmful effects of edible insects are still nutshell, different aspects of research as well as public awareness about the entomophagy has to be conductedon the different community level. Parents should teach their children about the entomophagyat the earliest stage, so they can adapt to the food habits.The survey suggested that many people are not showing interest to eat the insect as whole buton the other hand they are preferring the other forms of insect food like insect flour, insect fortified rice flour and other such insect's admixtured products.

CONCLUSION

Many of them around the world having the perception that insect consumption will be applicable only for people who are suffering in hunger. But, thestatistical data indicating that Global edible insect market will reach USD 1,181.6million by 2023 (Meticulous Market Research) and Asia Pacific region will occupy a major share in global edible insects market.So, the insects could be the alternative diet for its better tastes, high nutrient content, anti-inflammatory properties. Although it is having all benefits, still entomophagy have not replaced the traditional animal food worldwide. Entomophagycan be considered to be perfect choice of food for the increasing global food demand in near future.

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Effects of various abiotic stresses on growth and physiology of maize and important sources conferring resistance against them

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Maize (*Zea mays* L.) popularly called as the queen of cereals is an important cereal crop in the world after wheat and rice. Grown in more than 166 countries it contributes to food security in most of the developing countries and has varied uses including corn oil production, baby corn, sweet corn, corn starch industry, forage corn etc. With high yield potential maize can be grown under diverse agroecological conditions all over the world including countries as USA, Brazil, China, India etc. In India maize is grown under varied environmental conditions ranging from semiarid to temperate environment and in various seasons. Although it is predominantly a kharif crop with 85 % of the area under cultivation in the season but can be grown in both *kharif* and *rabi* season covering an area of 7.2 mha during *kharif* and 1.45 mha during *rabi* season with a productivity of 2187 kg/ha and 4125 kg/ha, respectively. Although the area under irrigated maize have increased from 11% (1950-51) to 25.3% (2011-12) but majority of area under maize cultivation is still unirrigated. Maize productivity in India at 2.5 MT/ha is almost half that of world productivity (5.5MT/ha). There are a number of reasons for poorer productivity of maize in India including lower area under cultivation of single cross maize hybrid (30% area), small and fragmented land holdings with limited availability of resources, lack of production and distribution of good quality seeds but the most predominant reason is cultivation of kharif maize mainly under rain fed conditions and other associated abiotic factors which makes the plant more susceptible to disease and pest attack.A number of abiotic stresses as drought stress, water logging stress, high temperature stress, chilling stress, salt and nutrients stress affects maize production in India withdrought and water logging being the most important (Joshi *et. al*., 2005).

Drought stress

Water is required in an optimum amount for maize production and any deficiency or excess of water creates a stressful conditions and hampers the normal growth and development of crop. Maize is particularly very susceptible to water deficiency. Water requirement of maize during early growth stages is low, reaches its highest during reproductive phase and thereafter it declines as the crop reaches maturity. Soft dough formation and grain filling is most sensitive to water deficiency while pre tasseling and physiological maturity are relatively insensitive. Deficiency of water beyond the critical limit causes dehydration of cell protoplast leading to increase in ion concentration causing membrane fusion, degradation of protein and negative impact on plant metabolism. Reduction in plant height and leaf area, accelerated senescence of leaf, greater anthesissilking interval, reduced photosynthesis, reduced translocation of assimilates to growing organs, ear abortion, lower production of biomass and remobilisation of stem reserves are some of the consequences of extreme water deficiency.

Drought tolerance in maize is associated with a number of morphological adaptations as pubescent leaves, waxiness, deeper root system and accumulation of certain osmolytes as proline and glycine betaine in plant tissues. Glycine betaine is a quaternary ammonium derivative of glycine accumulated in chroloplast and plastids ensuring protection of cell membrane. Two genes involved in glycine betaiebiosynthesis namely, betA (choline dehydrogenase) and CMO (Choline monooxygenase), can be modulated to achieve enhanced yield and tolerance to draught. Abscisic acid also plays an important role in conferring adaptive responses to draught stress. The level of ABA is regulated by de novo biosynthesis and catabolism. CYP707A gene is responsible for ABA catabolism and regulates the endogenous level of ABA. Specific inhibitors of CYP707A genes can be developed to increase tolerance of maize for draught stress (Saito*et al.,* 2004). Genome wide association studies have shown that a transposable element i.e, MITE (Miniature inverted-repeat transposable element) inserted into the promoter region on ZmNAC111 gene of maize is responsible for variation in maize draught tolerance. Enhanced expression of ZmNAC111 in transgenic maize causes upregulation of draught responsive genes, increases water use efficiency and leads to increased draught tolerance at seedling stage (Mao et al., 2015). A negative cytokinin signalling gene ARR is also responsible for water deficiency tolerance. Tolerance to draught is also conferred by upregulation of a number of other genes as AB13, HVA22 etc. Differential regulation of other genes as AP2, C2C2, C3H, C2H2, WRKY and HAP 2 genes is also involved in producing draught tolerant maize lines.

Water logging stress

Other deleterious stress in maize is the water logging stress. Poor drainage and high water stress is the main reason for flooding. A substantial amount of area planted under maize is exposed to flooding conditions causing considerable loss of production annually. Flooding leads to lower oxygen diffusion rate. The continuing respiration by soil microorganism and other soil fauna and flora causes further soil oxygen depletion leading to hypoxia in the initial stages followed anoxia i.e., complete absence of oxygen in case flooding conditions persists for longer duration of time. The hypoxic and anoxic conditions prevents the oxidative phosphorylation due to reduced oxygen availability. Reduced production of ATP leads to membrane damage and acidosis of the cytoplasm. At high moisture content in the root zone toxic levels of Mn^{2+}, Fe^{2+} and S^{2-} builds up and enhances root damage. Leakage of protons from vacuoles to cytoplasm occurs leading to acidification of cytoplasm and cell death. Cellular damage is also mediated by toxic accumulation of reactive oxygen species in response to water logging stress. Restricted root development associated with lodging, decreased root volume causing less water and mineral nutrient transport to sink are some of the negative effects of high soil moisture on maize.

Water logging resistance in maize is characterized by development of brace roots. ZmRHCP1 gene in maize is associated with the production of RING-HC protein and is expressed ubiquitously in different organs as root, stem, leaf, seedling etc. ZmRHCP1 gene also functions in brace root initiation and therefore is associated with abiotic stress resistance in maize. Development of aerenchyma cell by cell collapse (lysigeny) is another mechanism which imparts water logging resistance to maize genotypes. Production of aerenchyma in root cortex is a result of ethylene mediated programmed cell death (PCD). Respiratory burst oxidase homolog (RBOH) gene plays an important role in generation of reactive oxygen species. Aerenchyma formation in cortical cell of maize is assoiciated with upregulation of RBOH and downregulation of metallothionein (MT) gene (ROS scavenging gene) leading to higher accumulation of ROS in root cortex and hence inducing PCD for aerenchyma production. Cell death in cortex is preceded by degradation of cell wall mediated by increased level of cellulase enzymes under water logging. Water logging is also associated with increased soil acidity hence toxicities of certain mineral nutrients as Fe^{2+}, Al^{3+} occurs. Resistance to toxic level of aluminium can be achieved by expansion in multidrug and toxic compound extrusion 1 (MATE1) gene copy number which is associated with higher expression of MATE1 gene and superior Al^{3+}tolerance. Wild species have always been a good source for introducing high level of biotic and abiotic stress tolerance (Harlan, 1976). The distant relative of maize “teosinte” can play an important role in imparting flood tolerance to cultivated maize genotypes.

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Teosintes growing in regions of high rainfall as Mexico, Guatemala, Hondrus and Nicaragua may act as a superior genetic resource for development of flood tolerant maize. *Z. luxurians*and *Z. mays* ssp. Huehuetenangensis are associated with adventitious root formation at soil surface during flooding (Mano *et al*., 2005a). Maize develops lysigenousaerenchyma only when exposed to flood conditions however, a plant which possessaerenchyma channels when not flooded, may be able to adapt more rapidly to flooding conditions when they occur. This character may be transferred from *Z. luxurians* which is reported to form well developed aerenchyma in adult plants (Ray *et al*., 1999). Tolerance to reducing soil conditions is also an important feature which can be transferred to cultivated maize from teosinte and imparts flood tolerance. *Z. nicaraguensis* exhibited an extremely high adaptability to flooding under reducing soil conditions.

Salinity stress

Salt affected soils are soils with excess of soluble salt or exchangeable sodium in the root zone. Less rainfall, high evapotranspiration along with poor water and soil management practices have led to increase in salt affected areas and is a serious threat to crop production. High amount of soluble salts in the soil leads to increased osmotic pressure, sodium and chloride ion toxicity and nutrient imbalance due to obstruction in nutrient uptake and transport. Damaged biological membranes and subcellular organelles may be the result of high amount of sodium in plants. Maize is moderately sensitive to salt stress and this sensitivity is mainly associated with higher accumulation of sodium in the leaves (Fortmeier and Schubert, 1995). Higher sodium content in maize interferes with potassium uptake causing stomatal undulations, water loss and necrosis. The uptake of ions as calcium, nitrogen, phosphorous, magnesium, iron, manganese, copper and zinc is markedly reduced (Hasegawa *et al*., 2000).Increased level of reactive oxygen species leads to oxidative damage to maize crop. Salt stress in maize have a number of negative consequences including poor germination, yellowing of leaves, rottening of leaves , leaf tip burning and plant mortality. High amount of soil salinity during germination leads to delayed germination accompanied with reduced rate and increased dispersion of germination events (Ashraf and Foolad, 2005). Maize carbon fixation is one of the most sensitive mechanism in maize under salinity stress conditions and reduction in carbon fixation ability is associated to reducedstomatal conductance, decreased activity of carbon fixation enzymes, reduction in levels of photosynthetic pigments and destruction of photosynthetic apparatus (Kaya *et al.,* 2010). Reduced photosynthesis is mainly due to imbalance between reactive oxygen species production and antioxidant defense and reduced activity of ribulose-1,5- bisphosphate carboxylase (Rubisco), phosphoenolpyruvate carboxylase (PEPCase) and NADP- malic enzyme (NADP-ME). Salt stress during reproductive stage leads to an appreciable loss in grain weight, grain number which ultimately results in lower grain yield. Also sink limitation and reduced acid invertase activity in maize grain is the main reason of poor kernel setting in salt affected soils.
Salt stress resistance in maize can be induced by a number of resistance mechanism including

1. **Osmoprotection and osmoregulation**: Osmoregulation is achieved by increasing the amount of organic and inorganic solutes in order to decrease the water potential without reducing the water content. Compounds as soluble sugars, sugar alcohols, glycine, proline, organic acid, trehalose and glycine betaine are among the major osmolytes conferring tolerance to salinity stress in maize. Reduced arginine, lysine, glutamic acid and serine was also linked to salt tolerance.
2. **Ion homeostasis**: Excessive sodium accumulation in maize leads to decreased potassium concentration and disturbs the stomatal regulation. Thus protection of cytosol and lowering of osmotic potential is brought about by either sodium exclusion from the cell or throughcompartmentation of sodium into vacuoles with

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the help of tonoplast hydrogen/sodium antiporters. Transportation of sodium to developing shoot is prevented either by shifting sodium ion to vacuoles in the root cells or by its absorption by xylem parenchyma. A maize transgenic expressing rice sodium/hydrogen antiporter gene (OsNHX1) was found to be tolerant towards salinity stress. Salt stress tolerance in maize was thus associated with the ability of the cell to divert excessive sodium to vacuoles and not to low concentration of sodium in the shoots.

3. **Apoplastic acidification**: Salt stress in maize is associated with increased plasma membrane H+ pumping by ATPase. This increased pumping is achieved by activation of the cell wall loosening enzymes i.e, expansins which leads to acidification of the cell apoplast and hence salt stress tolerance. Acidification of the apoplast is associated only with increased salt stress tolerance and may not necessarily lead to better growth.
4. **Antioxidant defense system**: Growing of maize under salt stress conditions leads to overgeneration of reactive oxygen species which damages proteins, lipids, carbohydrates and deoxyribonucleic acid. Therefore the detoxification of the cell can be achieved by antioxidant defense mechanisms (Zhu, 2001). Greater polyphenol accumulation was associated with better leaf growth and membrane stability index. Higher catalase, glutathione reductase, glutathione-S-transferase, superoxide dismutase, ascorbate peroxidase and guaiacolperoxidaesactivities were associated with high salt tolerance in maize genotypes. Ascorbate peroxidase, catalase and guaiacol peroxidase along with superoxide dismutase have highest hydrogen peroxide scavenging activity hence providing better adaptability against salt stress.
5. **Hormonal regulations**: Plant growth and development depends on the synthesis of various types of hormones. Salinity stress tolerance in maize is often found to be associated with increased abscisic acid levels at the expense of indole acetic acid. This modification causes stomatal closure and thus minimizes water loss.
6. **Molecular mechanisms**: Accumulation or inhibition of certain proteins and upregulation and downregulation of several genes confers salt stress resistance. Upregulation of Zmodc and Zmspds2A leading to polyamine and spermidine synthesis and ZmExpB2, ZmExpB6, ZmExpB8 causing stable expression of beta expansin can help plant acquire stress tolerance. Development of transgenic maize with different salinity stress tolerance genes can also be helpful to retain optimum production under stress conditions.

Table: Transgenic maize for salt tolerance

Gene	Source	Gene product	Cellular role	Referance
A tNHX1	*Arabidopsis thaliana*	Vacuolar sodium/proton antiporter	Sodium vacuolar sequestration	Yin et al. (2004)
OsNHX1	Rice	Vacuolar sodium/proton antiporter	Sodium vacuolar sequestration	Chen et al. (2007)
GutD	*E. coli*	Glucitol-6-phosphate dehydrogenase	Synthesis and accumulation of sorbitol	Liu et al. (1999)
BADH	*Suaeda liaotungensis Kitag*	Betaine aldehyde dehydrogenase	Synthesis and accumulation of glycine betain	Wu et al. (2008)

BADH	*Atriplex hortensis*	Betaine aldehyde dehydrogenase	Synthesis and accumulation of glycine betain	He et al. (1999)
AtNHX1	*Arabidopsis*	Vacuolar sodium/proton antiporter	Sodium vacuolar sequestration	Li et al. (2010)
Bt	*Bacillus thuringiensis*	Expression of low-molecularweight proteins	Synthesis of stressresponsive proteins	Beltagi (2008)

Thus the major obstacle in ensuring national and global food security is the presence of abiotic stress. It imposes osmotic stress and ion toxicity to plants and have an antagonistic effect on stand establishment, plant growth and development. A drastic reduction in maize yield occurs and is attributed to disturbed activities of cytosolic enzymes causing nutritional disorders and oxidative damage. Both conventional breeding and genetic engineering have been used to develop resistant plants and by far conventional breeding have been the most successful in this regard. However, future lies in the exploitation oftransformation technology as RNAi, transposon insertional knockouts and knowledge of signalling pathways leading to stress tolerance and is expected to generate resistant maize genotypes and hence stabilize the crop yield.

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TINY BUGS: FARMER'S HERO

Article id: 22475

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INTRODUCTION

The agricultural economy of India is vulnerable to the threat posed from the introduction of exotic pests/diseases. Recently, an infestation of yet another invasive species, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae), commonly known as the rugose spiraling whitefly (RSW), was observed on coconut palm (*Cocos nucifera* L) in Pollachi, Tamil Nadu, India. Still now there are no management studies for this new invasive pest.

Invasive pests

There is more to sustainable agriculture than just farmer awareness and an emphasis on biological crop pest management. It involves coming to terms with the biocontrol and making it part of broad crop production and management strategy. One of the most commonly heard platitudes about the sustainable agriculture in India is that it is characterized by a severe pest outbreak. And this in turn is presented as the chief problem of the sustainable agriculture and the main cause of the high rates of crop pest incidence and the persistently low income for farmers who are forced to remain in chemical-based pest control methods. This approach is summarized neatly in the official website of the Tamil Nadu Agricultural University of the Government of Tamil Nadu: "In rapidly growing economies like India with a vast and ever-increasing population, the problem is two-fold. On one hand, there is a severe paucity of highly-effective, quality biocontrol agents, while on the other, larger sections of the farming community possess little or no insect pest biocontrol skills.

Biological control

This makes "pest biocontrol" the policy of choice for dealing with problems of inadequate biocontrol strategies and low crop productivity. The matter is given greater urgency by the fact that the potential advantages of the "climate change" provided by the pest outbreak that will result is larger pest incidence.Due to climate change, the incidence of invasive alien pests in India is not surprising. Recently, a coconut insect pest (Rugose spiralling whitefly) is spotted in India. Scientists from Tamil Nadu Agricultural University suspect that it could have migrated from Central America into India.

Rugose spiralling whitefly

Rugose spiralling whitefly is an exotic pest, which attacks a wide range of host plants including Palms, woody ornamentals and fruit crop (Sundaraj and selvaraj,2017).It was first identified Tamil Nadu infecting coconut crops during 2016. Once entered into the host plants, this pest cause severe tissue damage and tissue collapse. Due to this, the coconut production in southern states of India is severely affected (Shanas *et al.,* 2016).

Following the requests from farmers, myself and colleagues visited the alien whitefly affected coconut orchard in late 2016. To our surprise, we incidentally identified tiny bugs, which are feeding the earlier growth stage of whitefly pest. Later, we collected the bugs and researched in our laboratory. We then identified those

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tiny bugs as *Chrysoperla zastrowi sillemi*, a predator commonly called as "green lacewing fly". It is an entomophagous.

Green lacewing fly Vs Rugose spiralling whitefly

This insect having four life stages namely egg, grub, pupa & adult and its completing their life cycle within 30-40 days (Selvaraj *et al.,* 2016). Among the life stages grub stage only the active stage which is searching food (insects) for its own growth. We are artificially provided whitefly's earlier stages as food for the tiny bugs under laboratory condition. The grub period was 10-12 days. Based on the growth we can differentiate their sizes small (First instar), Medium (Second instar) and Large (Third instar) comparing to other sizes larger size grub feeding more number of whiteflies. The predator was successfully completing the life and also producing their progeny. We came to know that one tiny predator can eat 400-500 whiteflies throughout their life stages with this back ground we made an attempt to mass multiply this insect for controlling the dominance of new invasive.

CONCLUSION

Successfully, we are mass culturing this tiny predator and providing to the coconut growing farmers of Tamil Nadu. Now the population of new exotic whitefly was reduced by Our hero (Green lacewing fly). Finally the tiny bug made a smile on the farmer's face.

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Linkage Disequilibrium (LD) Mapping: An Alternative to QTL Mapping

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INTRODUCTION:

- Linkage disequilibrium mapping is used as an alternative to QTL mapping because in case of QTL mapping we have to develop first a sufficient mapping population than used for the study. But, Linkage disequilibrium mapping don't need any preliminary mapping population, it directly used the natural population (Gupta *et al*., 2005).
- DNA based molecular markers have been extensively used in the variety of studies in plant and animal system. The molecular markers mainly used for genome wide molecular mapping and linkage analysis of simple and complex traits.
- So for this, we have to first develop a mapping population than used in the study. That creates a limitation in the use of molecular markers because in many cases development of mapping population is not easy. The crops like perennial fruit crop, forest trees, crossing is very difficult so sufficient mapping population can't developed.
- Keeping these limitations in view, alternative approaches have been developed and linkage disequilibrium mapping is one of such which don't need any mapping population and it utilizes the natural population.
- This LD mapping approach has the potential to identify and map QTLs but also to identify causal polymorphism within a gene that is responsible for the difference in two alternative phenotypes.

What is Linkage Equilibrium?

- If the haplotype frequencies observed in the population is similar to multiplied allelic frequencies, then the two alleles are said to be linkage equilibrium.
- In other words, when linkage disequilibrium value is zero then it is said to be linkage equilibrium.
- Linkage equilibrium can be thought of as the two locus version of the Hardy-Weinberg ratio, but it is a haplotype not genotype.

What is Linkage Diseqilibrium (LD)?

- The linkage disequilibrium (LD) signifies that a specific allele at a locus occurs with a specific allele at the second locus more often than the expected on the basis of random assortment of the two loci.In simple words, LD is the non-random association between alleles of the two or more loci (Flint-Garcia *et al*., 2003).
- These two loci may be two gene/QTLs or two markers or may be one gene and one marker.
- LD is also called gametic phase disequilibrium (GPD) or gametic linkage disequilibrium (GLD). It is ideally applied to random mating populations that exhibit Hardy-Weinberg equilibrium.

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How linkage and linkage disequilibrium differs?

- The tendency of two or more genes or loci being inherited together is known as linkage. They have a tendency to pass to the same gametes during segregation, and don't show independent segregation.
- But, LD is the occurrence of non-random associations between alleles of the two or more loci in a population irrespective of their physical location in the genome.

How LD Mapping related to Association Mapping?

- Linkage disequilibrium mapping and Association mapping have been mostly used interchangeably in the literature. But some basic difference is there.Association mapping considers high association of a molecular marker with a trait.Whereas, Linkage disequilibrium refers to non-random association between two markers or two gene or one QTLs and one marker (Karim *et al*., 2008).
- Therefore, association mapping is one of the applications of linkage disequilibrium.
- Statistically, association is covariance of a marker polymorphism and a trait of interest, whereas linkage disequilibrium refers to covariance of polymorphisms represented by two molecular markers/genes.

Test of linkage equilibrium and LD:

Consider two loci and each having two alleles. Suppose, locus 'A' has alleles 'A' and 'a', and locus 'B' has alleles 'B' and 'b' with their allelic frequencies 0.7 (A), 0.3 (a), 0.4 (B) and 0.6 (b) respectively. The allelic frequency of When independent segregation takes place between the two loci than the following four haplotype combinations found with their respective frequencies (Singh and Singh, 2015).

Alleles	A (0.7)	a (0.3)	Total
B (0.4)	AB (0.28)	aB (0.12)	0.4
b (0.6)	Ab (0.42)	ab (0.18)	0.6
Total	0.7	0.3	

Independent segregation of genes A and B

Here, $pAB.pab = pAb.paB$

$(0.28 \times 0.18) = (0.12 \times 0.42)$

$0.0504 = 0.0504$

D = ($pAB.pab$) - ($pAb.paB$) = 0.0504 - 0.0504 = 0

Where, D = Linkage disequilibrium coefficient

The difference between the products of two diagonal haplotypes is zero; it means the linkage disequilibrium coefficient is zero. So the two loci are in linkage equilibrium condition. If 'D' value except zero, any other numerical value than we can say that the population is at linkage disequilibrium condition.

Applications of LD:

- Marker-trait association followed by marker assisted selection.
- Population genetics and evolutionary studies.
- Demographic history study.

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- Haplotype block identification and SNP tagging.

Advantages of LD:

Advantage of linkage disequilibrium mapping over conventional linkage mapping population:

- Much higher resolution mapping can be constructing.
- Much larger and more representative gene pool can be utilized.
- Greater number of allelic diversity can be analyzed.
- No need of bi-parental mapping population.
- Ultimately searching time is less.
- It has ability of mapping many traits in one set of genotypes.
- It has potentiality not only to identify and map QTLs but also to identify the causal polymorphism within a gene.

Software packages for LD study:

There are several software packages are available for association based linkage disequilibrium study, out of them some are free and some are chargeable. Some of them are as follows: TASSEL, STRUCTURE, SAS, EMMA, PLINK, JMP, GGT, MIDAS, SVS7, Genstat, FaST-LMM etc.

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Trees for agroforestry systems in north east INDIA

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INTRODUCTION:

The ICRAFdefine Agroforestry as 'a land use systems and technology where woody perennial plants (tree, shrubs, herbs etc.) are deliberately introduced in the same land management practices, along with the agricultural crops and/or livestock, in a spatial temporal sequence.' The different agroforestry systems include: Agri-silviculture, Silvipastoral, Agrisilvipastoral, Horti-silviculture, Agri-horticulture, Agrihortisilviculture, Aquasilviculture/ Aquaforestry, Agrisilviaquaculture and Multipurpose forest tree production (other specialized agroforestry systems. Depending on the systems followed, numerous tree species are adopted to be planted in integration with agricultural crops and/or livestock.

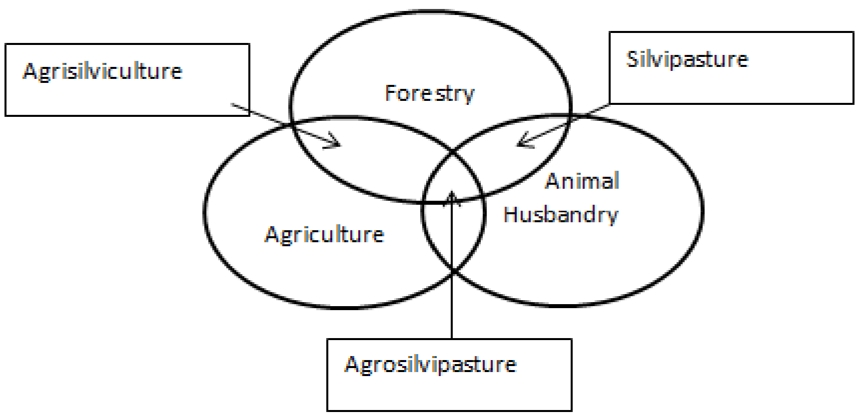

Fig: Interrelationship of different components in agroforestry (Source: Gill and Roy, 2012)

Objectives

The objectives of agroforestry system are:

- To utilize the available farm resource properly
- To maximize per unit production of food, fodder, fuel
- To optimizing-biological and physiological resources
- To maintain the ecological balance
- To check soil erosion, conserve soil moisture andincrease the soil fertility

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Table: Some of the Tree Species for Agroforestry Systems of North East Region

Tree Species	Photo	Remarks
Areca nut (*Areca catechu)*		It can be inter-crop with betel vine, pineapple, pineapple and betel vine, black pepper and/or pineapple and black pepper
Alnus nepalensis		with large cardamom, maize, pineapple and vegetables.
Schimawallichii		with large cardamom, ginger/turmeric, pineapple.
Anacardium occidentale		with vegetables, ginger/turmeric. The shell have been traditionally used for snake bites and other folk remedies
Cocos nucifera		with betel vine, black pepper and / or vegetables. Leaves are used for thatch and weaving.
Livistona jenkinsiana		Leaves are used as thatching material and the fruits are edible.

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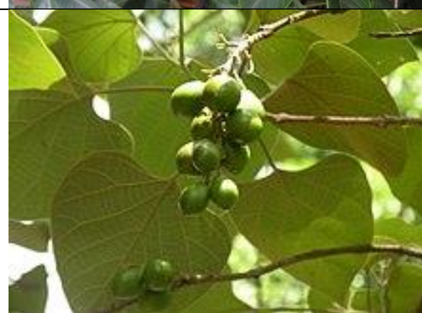
Moringa olifera		Suitable for boundary plantation. Tender pods are cooked as vegetables, leaves has medicinal values and regarded as most nutritious tree on earth.
Hevea brassilinsis		Commercial species yielding rubber, can be inter crop with elephant foot yam, ginger/turmeric, maize, vegetables, etc.
Gmelina arborea		In some parts of NE leaves are used as vegetables, timber for furniture. Can be planted in borders of a field/farm.
Artocarpus heterophyllus		Fruits used as desert, unripe fruits as vegetable, leaves as fodder, timber is valuable for furniture and construction, fuel wood.
Parkiati moriana		Nitrogen fixing trees, pods are edible. Suitable for boundary plantation and home gardens.

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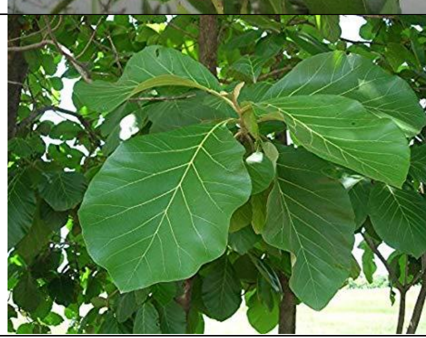
Phyllanthus emblica		Medicinal tree used for various formulations, wood is used as timber.
Dillenia indica		Minor fruits crops of the region, rich source of vitamin C. Suitable for home garden and boundary plantation.
Syzygium cumini		Fruits used as desert, for making of beverages, jellies. Highly used as boundary plantation.
Elaeocarpus floribundus		Edible fruits, timber are used for domestic purpose, source of fuel wood.
Tectona grandis		Excellent timber species of India. Suitable for boundary plantation.

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Annona squamosal		Bark produces tannins, seeds has insecticidal properties, edible fruits.
Averrhoa carambola		is a rich source of antioxidant, potassium and vitamin C, low in sugar sodium and acid. It is a potent source of both primary and secondary polyphenolic.
Artrocarpus fraxinolius		with ginger/ turmeric. Suitable for boundary plantation.
Prunus domestica		Fruits are used in making of RTS, wine. It can be inter crop with mustard, ginger/turmeric, maize, vegetables.

CONCLUSION:

Agroforestry is a composite, diversified and sustainable production system. It provides unique opportunity for integration of different components of the farming systems. This helps to optimize the ecosystem functioning and better management of land, water and biological resources. North East Hill region trees are deliberately grown with various crop and livestock under traditional production systems.Selection of tree species according to the system followed is the most important criteria in any agroforestry system. Hence one's must take into the following account for tree species to be chosen for agroforestry:

a) They should be amenable to early wide spacement.

b) They should tolerate relatively high incidence of pruning, i.e., their photosynthetic efficiency should not decrease with heavy pruning.

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c) They should be light branching in their habit.
d) They should be tolerant to side shades.
e) Their phenology, particularly with reference to leaf flushing and leaf fall, should be advantageous to the growth of the annual crop in conjunction with which they are being raised.
f) The rate of litter fall and litter decomposition should have positive effects on the soil.
g) Their root systems and root growth characteristics should ideally result exploration of soil layers that are different to those being tapped by agricultural crops.
h) Nitrogen fixing tree species.

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Women and forestry in parts of developing world

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INTRODUCTION

In developing countries, men and women play different roles in forestry and agroforestry systems. For a range of interrelated cultural, social, economic and institutional reasons such as in their access to and control over forest resources, and in the economic opportunities available to them, women are frequently disadvantaged as compared with men. For example, minor forest product economy though it has been dominated by women has never been the focus of government policy. On the other hand, cash crops which mostly benefit men tend to be highly considered in social forestry. Many women have highly specialized knowledge of trees and forests in terms of biological diversity, sustainable management and use for various purposes, and conservation practices. Women are aware of the food and medicinal values of forest products, which are particularly important during a crisis.

Women role in developing world

In the developing world women often assume the role of "caretaker" for their families as well as for the other people and things around them. In some parts of the world, women rely on forest-related resources for the well-being of all who fall under their care. This effort typically involves the gathering of forest products for such purposes as fuel, fencing, food for the family, and fodder for the livestock (IUCN). Some examples of the specific relationship between women and forests are highlighted below.

1. In Zimbabwe: “Over half of the 800,000 farm families living in communal areas are headed by women. In these areas, women’s groups manage forest resources and development projects through woodlot ownership, tree planting, nursery development, and woodlot management” (IUCN, No date).
2. In Uttar Pradesh, India: “A study showed that women obtained 33-45% of their income from forests and common land, compared with only 13% in the case of men” (IUCN, No date).

Even given this reality though, women are often ignored when it comes to developing policies for forest management. In East Kalimantan, Indonesia, “women’s concern to supply their families with sufficient rice for subsistence was a major factor in family decisions about how much forest to clear each year. Yet the idea that women’s views and activities might be of relevance was alien…to the foresters” (FAO/Colfer).

The gender politics of forestry

Generally speaking, forestry is not an anthropocentric field – it is about trees. Yet, the experiences of women in relation to forestry have been markedly different from those of their male counterparts, making gender issues pertinent to forestry. In comparison to men, women have often been slighted in terms of the types of jobs they are hired for and their access to and/or influence on forest policy decisions. While there is hard evidence to back these claims, women face an uphill battle in raising their concerns because, as a general rule, “forestry is not [and has not been] particularly responsive to social equity issues, including those pertaining to gender” (FAO/Williams).

Some of the issues women are confronted with relating directly to the manner in which forestry is defined. While forestry can be defined beyond the limits of timber extraction, it is often equated with logging, which has historically been considered "men's work" (IUFRO; FAO/Williams).

Women knowledge of forest

Women's knowledge of forests is often found to be qualitatively different from that of men. Fortmann (1986) argues that their extensive contact with the forest may give local women amore detailed understanding of forest resources than local men or forestersfrom other localities. This is partly because women relate to the forest in a number of contexts. They are more likely to make daily trips into forest areas in different seasons for food, fodder, and fuel. Cruz Garcia (2006) in his study from the Western Ghats in India found that women hold significant amounts of knowledge about wild plant foods and that spending time with their mothers during collection and processing of wild foods is the primary means by which children learn about such foods. Local women can differentiate among species that provide a long-lasting, low heat, a quick high heat, or those which smoke and so on. Where wood is the main energy source for cooking, knowing such characteristics is important for planning.

Women and forest in india

The relationship between women and forests varies considerably depending on whether one is: (a) tribal women in forest-dwelling communities, (b) hill women in various parts of the country, (c) peasant women (land-owning and agricultural labourers) in the plains, or (d) the urban poor.

Women play a dominant role in food production in some farming systems, such as the tribal system of shifting cultivation. In the states of Maharashtra, Madhya Pradesh, Bihar, Orissa, Andhra Pradesh and the North-Eastern Hill states of India, home for most of the Indian tribes, the subsistence economy is entirely dependent on the forest. Shifting cultivation, described as a female farming system by Ester Boserup (1970), persists in these areas. Hundreds of hectares are still under this system of farming in the hilly parts of North Eastern states of India.

Women everywhere and in India derive a large number of products from the forest. Trees are used not only for fuel, food, and fodder; the forest habitat provides innumerable other useful products. Forest-dwelling communities derive the maximum number of products and this dependency decreases as one moves to other habitats, urban women being the least dependent due to lack of access to a forest.

Women use flowers, fruits, roots, tubers, honey, oil, seeds, leafy wild vegetables, mushrooms, and some edible insects. Most forest foods are high in calories, proteins, and vitamins. For most communities, they are contributing to a balanced diet.

Women also use a large number of plants and herbs for medicinal purposes. Where health facilities are few and far between, tried and tested remedies from the forest are the basic ingredients of health care. For example, the tendu tree *(Diospyrosmelanoxylon)* has an astringent bark used to treat diarrhea and dyspepsia.

CONCLUSION

Rural women have valuable knowledge about forest resources and can play a key role in improving forest management. Women participation in the forestry sector must be recognized. Policies and programmes that empower women in the forest sector are an essential prerequisite for building economies based on social justice and environmental conservation. Forestry policy-makers should concentrate on: ensuring that women's

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work in forestry (both paid and unpaid) is captured in national statistics, and increasing the availability and use of sex-disaggregated data for the forest sector; improving women's safe access to fuelwood, supporting the use of healthier, more energy-efficient technologies and equipment, designing forestry and agroforestry programmes that recognize women as users of forests (along with men) and acknowledge women's valuable knowledge, experience, and specific needs; enhancing the understanding of gender roles along forestry value chains, supporting value chain activities performed by women, and working with existing processing and marketing groups in which women participate; aiming to achieve gender balance in forestry associations and forest user groups, and enabling women to participate fully in decision-making within these associations/groups, through formal education, training, and support for income generation; systematically integrating gender into policy frameworks through gender-specific needs assessments, gender audits, gender-sensitive data collection systems and budget allocations, and support to women's active participation in policy processes.

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Farmer Producer Organization (FPO): the need of the hour

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INTRODUCTION

Agriculture plays a pivotal role in developing economies.About 54.6% of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17.4% to the country's Gross Value Added for the year 2016-17 (at current prices).The small and marginal holdings taken together (0.00-2.00 ha) constituted 86.21% in 2015-16 against 84.97% in 2010-11 while their share in the operated area stood 47.34% in the current census as against 44.31% in 2010-11. The small farmers with weak bargaining powers suffer from greater dependency in the cultivation and monopolistic exploitation under formal contracts (Bachke, 2009). To minimize the gap between the farmers and consumers, Government of India aimed at new institutional options which can provide the farmers, a level playing field to compete in the modern agro-food networks. With the recommendations of Y K Alagh Committee in 2001, amendments were brought to the Companies Act, 1956 which paved the way for the concept of 'Producer Companies' (PC). PC can increase the skills, revenue and bargaining power of the smallholder farmers in the production and marketing of the produce. They disseminate technical knowledge to its beneficiaries, improve their production efficiency, reduce the transaction costs, market the final produce and are even successful in capacity building thereby, fabricating the social capital.In the era of globalization and climate change, producer organizations are regarded as the only institutional option to safeguard the best interest of the farmers and facilitate them to reach a higher level of profits through novel agro-food networks (Trebbin and Hassler, 2012). SFAC is the nodal agency coordinate the between the states and single window for the technical advice and investment needs. Producer Organization Development Fund (PODF) has been created by NABARD to specially promote the FPOs (Farmer Producer organizations) which lies outside the ambit of SFAC. As a major reform, GOI has announced cent percent tax holiday for all the FPOs below 100 crores up to five years. Producer organizations can evolve as a major step toward doubling the farmers' income.

MEANING OF FPO

It is one type of Producer Organization(PO)where the members are farmers. Small farmers' Agribusiness Consortium (SFAC) is providing support for promotion of FPOs. PO is a generic name for an organisation of producers of any produce. eg., agricultural, non-farm products, artisan products, etc. FPO is a legal entity formed by group of farmers or primary producers, viz: agriculture farmers, milk producers, fisherman, small Tea growers, weavers, craftsman etc. A FPO can be a producer company, a cooperative society or any other legal form which provides for sharing of profits /benefits among the members.

NEED FOR FPO

The main objective of FPO is to ensure better income for the producers through an organisation of their own. Small producers do not have the volume individually (both inputs and produce) to get the benefit of economies of scale. Besides, in agricultural marketing, there is a long chain of intermediaries who very often work non-

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transparently leading to the situation where the producer receives only a small part of the value that the ultimate consumer pays. Through aggregation, the primary producers can avail the benefit of economies of scale. They will also have better bargaining power vis-à-vis the bulk buyers of produce and bulk suppliers of inputs.

Table1: Key differences between cooperative and Producer Company

Parameters	Cooperative	Producer company
Registration	Cooperative Societies Act.	Indian Companies Act
Objectives	Single object	Multi-object
Area of Operation	Restricted, discretionary	Entire Union of India
Membership	Individuals and cooperatives	Any individual, group, association, producer of the goods or services
Share	Non-tradable	Non-tradable But transferable limited to members on par value
Profit sharing	Limited dividends on shares	Commensurate with volume of business
Voting rights	One member, one vote, but Government and Registrar of Cooperatives hold veto power	One member, one vote. Members not having transactions with the company cannot vote
Government control	Highly patronized to the extent of interference	Minimal, limited to statutory requirements
Extent of Autonomy	Limited in “real world scenario	Fully autonomous, self-ruled within the provisions of Act
Reserves	Created if there are profits	Mandatory to create every year
Borrowing power	Restricted	More freedom and alternatives
Relationship with other corporate/ business houses/NGOs	Transaction based	Producers and corporate entity can together float a producer company

(Source: www.sfacindia.in)

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STEPS IN ESTABLISHING FPO

The steps involved for establishing FPOs as per the policy and process guidelines for Farmer Producer Organizations issued by Department of Agriculture and Cooperation in 2013 are as follows:

a. Cluster Identification– Cluster areas are to be selected by the Resource Institutions (RIs) in consultation with the respective State Government departments. However, it should be ensured that a cluster of 8,000-10,000 farmers should be formulated, within one or two blocks, identifying 80 to 120 contiguous villages of a particular district.

b. Diagnostic Study– A Diagnostic Study is to be conducted by the RI in the selected cluster area. The Diagnostic Study is conducted to assess the preliminary situation of the farmers and level of agriculture in the area. The study will also help in identifying the potential interventions required and understand the specific project implementation context.

c. Feasibility Analysis– Feasibility Analysis for the formation of FPCs should be carried out by RIs and then appraised by hired external experts in various technical areas. A normal feasibility study should cover aspects such as financial, technical, legal, political, socio-cultural, environmental, economic and resource feasibility. The Feasibility Analysis will establish a case for promotion of FPCs in the prevailing specific regional environmental context of the FPOs.

d. Baseline Assessment– Baseline Assessment, to be carried out by RI, will help in generating data related to the current prevailing situation of farming and small, marginal and tenant farmers. Baseline assessment will cover a variety of factors to identify the potential interventions, to plan development and business plans and to establish the base figures based on future outcome indicators that can be measured to understand the change contribution. The assessment shall be conducted using stratified random sampling through structured household-level interviews and open-ended focus group discussions with a variety of stakeholders.

e. Business Planning– Business Planning will be carried out by RIs with the help of selected farmers' representatives. Business planning is a process through which the strategic and operational orientation of an emerging FPO is shaped. While baseline assessment figures will be important inputs to understand the level from which products and services for farmers' members should be developed, more important will be the collective visualization of the future of the FPO. Using a variety of tools and systematic collective reflections, a business plan with proper projections on various aspects needs to be developed. The key is to develop business plans in detail with at least 10 percent of FPO farmer members to provide clear vision.

f. Mobilization of Farmers– Once a strong case has been established by spearhead team (SHT) with the help of a selected group of farmers through the business planning process, it is time to mobilize farmers into Farmers Interest Groups (FIGs) and eventually as farmer-members of FPOs. Mobilization of farmers should be done with a variety of communication aids like – pamphlets, documentary movies, posters, regular village-level meetings, proper vision development of promoter farmer-members. Promoter farmer-members are those who are eager to form a FPO on voluntary basis, having understood the importance and potential benefits of forming FPOs, obtained through training programmes and exposure provided by SHT of RIs.

g. Organizing and Formalizing– FIGs in an aggregated cluster together form FPOs. Typically, around 50-70 FIGs can come together to form a FPO. FPOs can be registered under the Producer Company provision under the Companies Act. However, it must be clarified that the purpose of mobilizing farmers is not merely to achieve the target of registering a formal entity. The final form which the FPO assumes (i.e. cooperative, producer company, multi- state cooperative etc.) must be a decision taken by FIG members at an appropriate time. It is important to stress that the process must not be hurried in any manner and there is no "right time" by which

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the FPO must be registered. Any period between 18 months to 24 months may be necessary for the FIGs to settle down and understand the implications of aggregation. Only then should the FPO registration be attempted.

h. Resource Mobilization– Before initiating the operations of an FPO all required resources should be mobilized by the RI with the help of FPO representatives and board of directors. Financial, human (staff), technical and physical resources should be developed during this particular step. Based on the business plan the RI should liaise with various financing agencies and mobilize resources for hiring/purchasing and developing various resources.

i. Management Systems Development– RIs should facilitate the development of management systems in the FPO. Guidelines for management systems should be able to address all requirements related to financial services, input and output management services. Systems related to management of finance, human resources, stock and inventory, procurement and quality management, marketing, internal audit, internal conflict resolution and other important functional areas should be developed. Standard operating procedures for the same should be established.

j. Business Operations– Business operations is the commencement of procurement, production, processing, marketing and financial service activities of a FPO. RIs should carefully train both the governing and operational structures of the FPO in order to ensure smooth functioning of business operations. The entire value-chain related to various agriculture and allied products and commodities needs to be managed.

k. Assessment & Audit– RIs should facilitate constant assessment of performance of various stakeholders like farmer members, governing board of directors and service providers. They should also help FPOs to reflect using Institutional Maturity Index to understand areas of improvement. Internal process and accounting audits will help maintain both transparency and accountability.

TYPICAL SERVICES OF FPO

An indicative list of services includes:

i. Financial Services: The FPO will provide loans for crops, purchase of tractors, pump sets, construction of wells, laying of pipelines.

ii. Input Supply Services: The FPO will provide low cost and quality inputs to member farmers. It will supply fertilizers, pesticides, seeds, sprayers, pumpsets, accessories, pipelines.

iii.Procurement and Packaging Services: The FPO will procure agriculture produce from its member farmers; will do the storage, value addition and packaging.

iv.Marketing Services: The FPO will do the direct marketing after procurement of agricultural produce. This will enable members to save in terms of time, transaction costs, weighment losses, distress sales, price fluctuations, transportation, quality maintenance etc.

v.Insurance Services: The FPO will provide various insurance like crop insurance, electric motors insurance and life insurance.

vi.Technical Services: FPO will promote best practices of farming, maintain marketing information system, diversifying and raising levels of knowledge and skills in agricultural production and post-harvest processing that adds value to products.

vii.Networking Services: Making channels of information (e.g. about product specifications, market prices) and other business services accessible to rural producers; facilitating linkages with financial institutions, building linkages of producers, processors, traders and consumers, facilitating linkages with government programmes.

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DIFFERENT INSTITUTIONS INVOLVED IN PROMOTION OF FPOs

The Government of India according to year 2018 reported that NABARD has recognized relatively higher number of promoting institutions i.e.,818 while SFAC has recognized 127 promotinginstitutions accounting for 86.5 % and 13.43 % of the total, respectively. Highest number of promoting institutions havefound in Karnataka (85) constituting about 8.9 % ofthe total promoting agencies functioning in the country. Karnataka also has the highest number of FPOs registered in the state. Other states which have high number promoting institutions are Uttar Pradesh, Kerala, Rajasthan with 8.7, 7.72 and 6.56 % of the total promoting institutions respectively. Andaman &Nicobar and Nagaland showed poor performance in the establishment of promoting institutions with one institution each. NABARD has recognized highest number of promoting institutions in the state of Karnataka (78) and is followed by Uttar Pradesh (77), Kerala (73), Rajasthan (57), Andhra Pradesh (57), Bihar (52) etc. Similarly, SFAC has recognized highest number of promoting institutions in the state of Madhya Pradesh (21) and is followed by Assam (12), Uttar Pradesh (6) etc.

SFAC reported that the state wise progress of farmers mobilization under FPO promotion (as on 31.03.2019) was found out that Madhya Pradesh ranks highest in farmers mobilization upto149000 farmers followed by Karnataka state (127500 farmers). The state lowest in farmers mobilization was Goa with 1810 farmers and Mizoram with 2700 farmers.It was also revealed that till March 2019,highest number of registered FPOs was Madhya Pradesh with 143 numbers followed by Karnataka state with 125 registered FPOs. The lowest states with only 1 registered FPO were Mizoram, Jammu (Division) and Srinagar (Division).

CHALLENGES FACED BY FPO:

Agriculture experts are of the view that there are many challenges in setting up FPOs. Such FPOs require an ecosystem of support to prosper. Today hundreds of such FPOs have already been set up but very few are making profits.Managing Director of MAHA FPC, YogeshThoratopined that merely establishing the FPOs will not work, as it requires a good ecosystem to operate. These organizations face challenges such as funding, capacity building and value chain investments. Domestic policies and laws also needed to be addressed for growing the FPOs, he said. Thorat pointed out that the success of FPO will also depend on other players such as Banks, Retailers and Corporate sector. The value chain required for the development of FPOs cannot be done by one player. Agriculture Consultant, JagadeeshSunkad said that there are thousands of FPOs in the country but only a few are successful and are making money. In an FPO, business competence will develop when you have corporate skills and leadership. But most of the FPOs depend on Government programs and have no business acumen (The Hindu, 2019).

CONCLUSION:

As majority of the marginal and small farmers are facing a great suppression by the middle men/ commission agents for remunerative price and profitable income, FPO could be an ultimate solution to the problem. More and more contribution from the promoting institutions is of utmost need for education, business planning and market linkage with various national and international companies.A support from the policy makers in running the FPO will be a great boon to the farming community. The farmers must encourage their children to involve more in agriculture to induce a loving spirit and passion for agriculture.

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Molecular approaches to disease resistance in *Fragaria* spp.

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INTRODUCTION

Resistance to economically important diseases is one of the most desired traits to have in plant crops. The *Fragaria* genus including 21 wild and cultivated species (*Fragaria* x *ananassa*), contains genetic sources of diseases resistance that are quite rich but not fullyexploited in breeding for resistance. Usefulness of different molecular techniques and high throughput technologies for the dissection of genetic resistance mechanisms and the explanation of plant diversity in relation to pathogens at the DNA level are described in this paper. The descriptions are based on the results of different studies on genome of *Fragaria* that were carried out in many research institutions in the world. The proposed model of comprehensive exploration of the strawberry genome, summarized with generating resistance markers and identification of genes involved with induction or regulation of plant response to pathogen attack, appear to be very useful in breeding strawberry for resistance. The genus *Fragaria* L., a member of the family Rosaceae and sub-family Potentilloideae includes 21 species distinguished by their ploidy level (Staudt 1989). The species are distributed almost everywhere, from the arctic to the tropics. The diploid group is represented by *F. vesca*, *F. daltoniana, F. viridis* and *F. iinumae*, the tetraploids and hexaploids by *F. orientalis* and *F. moschata,* respectively, whereas *F. virginiana* and *F. chiloensis* dispose an octoploid chromosome set (Staudt 1989; Folta and Davis 2006).

Cultivated strawberry (*Fragaria* x *ananassa* Duch., 8n), an accidental hybrid of two native species *F. chiloensis* and *F. virginiana* (Darrow 1966) is one of the most important small fruit crops. Due to an attractive taste and relatively high content of bioactive compounds valuable for human health, strawberries are a part of the diet of millions of people (Maas *et al*. 1991, 1996; Tulipani *et al*. 2008). The annual world production of these fruits has increased in the last decade, from 3 to over 4 million tons. More than 70 countries are noted as significant strawberry producers (FAOStat 2009).

The inheritance of resistance

When considering the suitability of the resistance sources for breeding, four aspects have to be analyzed: the degree, the durability, the specificity and the inheritance of the resistance trait. Most commonly, plants with monogenically inherited resistance have been introduced to breeding programs. This type of resistance in plants is based on the activity of single R gene(s) that provide total protection against the pathogen, including hyper-sensitive reaction with cell death around the site of plant-pathogen interactions

Two monogenically inherited resistances of *Fragaria* plants have been fully characterized. They are resistance to red stele root rot (red core) caused by soil-borne fungus, *Phytophthora fragariae,* and resistance to anthracnose caused by *Colletotrichum acutatum*. Mendelian segregation of resistance to red core in appropriate F_1 populations, and the analysis of phenotypic interactions between numerous strawberry cultivars and pathogen races from different geographical regions confirmed the existence of race specificity typical for monogenic resistance (van de Weg 1989a). The mechanism of resistance to red stele root rot is based on a gene-for-gene concept (Flor 1956), with five virulence and five resistance factors (van de Weg 1989a). The establishment of the GFG model has canceled out the previous theory of polygenic inheritance (Scott *et al*.

1984) and explained the phenomenon of the incomplete resistance. It was also a major step in the explanation of the genetics of strawberry resistance to *P. fragariae*, and identification of two highly effective and race specific R genes: *Rpf1* and *Rpf2* (van de Weg 1997a, b). A key point for the elucidation of mechanism(s) of strawberry resistance to anthracnose was the distinction of two pathogenicity groups of *C. acutatum* (Denoyes-Rothan and Baundry 1995). Plants infected with *C. acutatum* isolates belonging to group 2 pathogenicity showed a high level of resistance controlled by a single dominant *Rca2* gene (Lerceteau-Kohler *et al*. 2002), at the same time, a polygenically inheritanced resistance was observed in plants infected with the isolates from group 1 pathogenicity. Strawberry resistance to black leaf spot also has a monogenic character. Black leaf spot is a disease caused by the fungus *Alternaria alternata*. The single locus of this trait was identified in a study on numerous strawberry cultivars and genetic mutants obtained in Japan (Takahashi *et al*. 1991; 1997).

Natural sources of strawberry resistance to diseases

Phenotypic variability of *Fragaria* plants in regard to strawberry diseases has been broadly investigated. Among wild species, resistance sources to *Verticillium* wilt, black root rot, powdery mildew and crown rot were found in *F. vesca* (Harland and King 1957; Gooding *et al.* 1981; Hancock and Luby 1993), immunity to powdery mildew in *F. moschata* (Maas 1998), while some clones of diversified *F. chiloensis* carry resistance to red stele, leaf spot and powdery mildew (Hancock *et al*. 1989). Potential resources of resistance in native octoploid species also include viral tolerance (Darrow 1966).

Many cultivated *F*. x *ananassa* varieties were also characterized as the phenotypes resistant or tolerant to respective strawberry diseases in field conditions (Maas and Smith 1978; Melville *et al*. 1980; Hancock *et al*. 1990; Rothan *et al*. 2004), grey mould (Barritt 1980; Popova *et al.* 1985), *Verticillium* wilt (Zebrowska *et al*. 2006) and bacterial angular leaf spot (Lewers *et al*. 2003) for which *C. acutatum* (group 1 pathogenicity), *Phytophthora cactorum*, *Botrytis cinerea*, *Verticillium dahliae*, and respectively, *Xanthomonas fragariae* are indicated as causative agents of the diseases. In all these cases, the study on identification of genome regions containing sets of genes that control resistance and called quantitative trait loci (QTL), have been undertaken. No genetic and molecular dissections of host-pathogen interactions and inheritance character have been performed for other diseases that affect plants belonging to the *Fragaria* genus.

Strawberry markers linked to disease resistance

The term “molecular markers” is applied to a large number of different molecular techniques that detect plant variability at the DNA level. Properly prepared DNA markers tightly linked to the resistance genes can assist plant breeders to improve their breeding outcomes. This means improvement, from assessing genetic diversity of the germplasm used in breeding programs to marker assisted selection of progeny (MAS) (Charcosset and Moreau 2004). Particularly, markers of monogenic traits are readily available, easy to map on plant chromosomes and relatively easy to apply to breeding. The availability of polygenic trait markers is more limited and still controversial, due to the number of genes involved in the plant defense process and because of their quantitative character. Assuming that polygenic traits are controlled by a number of QTL that are inherited in a Mendelian fashion (Hospital and Charcosset 1997), the principles of MAS should be the same as for the R genes. However, due to the minor effects of QTL on the trait of interest, their map positions are less precise than for R genes. Therefore, well-chosen markers spanning the intervals defining map positions are recommended (Gimelfarb and Lande 1995).

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Recombinant technology has been explored for improvement of disease resistance characteristics in strawberry since the 1990s. Transgenic strawberries transformed via *Agrobacterium tumefaciens* with a thaumatin II gene (Schestibratov and Dolgov 2005) and a pectate lyase gene (Jimenez-Bermundez *et al.* 2002) enhanced their resistance to grey mould. Resistance against the fungal pathogen *Sphaerotheca humuli* was enhanced in transgenic strawberry expressing a rice chitinase gene (Asao *et al*. 1997). Chalavi and co-workers (2003) observed enhanced strawberry resistance to *Verticillium* wilt after plant transformation with chitinase gene isolated from *Lycopersicon chilense*. Schart (2004) produced genetically modified strawberry which is less susceptible to grey mould, using cisgenic strategy that is based on plant modification with its own *F*. x *ananassa* genes.

New strategies in *Fragaria* genotyping

In the last decade several new strategies, such as circumstantial study on candidate gene and QTL-based pedigree genotyping approach, bin mapping, and the use of genomics technology to sequence genome and screen expressed sequence tags (ESTs) through RNA assays, have been developed to increase the efficiency of plant variability detection.

First of all, the new technologies allowed for significant saturation of strawberry maps being a compendium of knowledge about plant diversity. The pioneering linked map based on random RAPD markers was constructed for *F. vesca* (Davis *et al* 1995). Using over two hundred progenies from cross 'Capitola' x CF1116 and over seven hundred AFLP, SSR and SCAR markers for anthracnose resistance, the French team constructed the linkage map for *F*. x *ananassa* (Lerceteau-Köhler *et al*. 2002; 2003; Denoyes-Rothan *et al*. 2004). The new generation of strawberry maps are enhanced by additional microsatellite, gene-specific intron polymorphism, cleaved-amplified polymorphic sequence (CAPS) markers (Cipriani *et al*. 2006; Sargent *et al*. 2006, 2007).

CONCLUSION

Strawberry is susceptible to many diseases, with high costs in terms of yield losses and pesticide treatments. New EU regulations are headed towards the use of resistant plant material and sustainable crop management practices. Meanwhile, strawberry cultivars fully resistant to any disease have not been bred so far, nor have wild *Fragaria* species been extensively characterized as a source of resistance (Schwab *et al*. 2009). In this situation, the deep molecular-based characterization and wide exploitation of gene pools, and their introgression and pyramiding in new genotypes, can be a key strategy for generating strawberry with durable resistance, desirable for new horticulture.

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Biofertilizers and their role in soil fertility

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Biofertilizers are the product containing living cells of different type of micro-organisms which have ability to mobilize nutritionally important element from non-usable form to usable form through biological process. It refers to living micro organisms which augment the plant nutrient supply.Biofertilizers or microbial inoculants are biologically active products containing active strains of specific bacteria, algae, fungi alone or in combination which may help in increasing crop productivity by the following ways:

- Helping the biological nitrogen fixation
- Solubilisation of insoluble fertilizer materials
- Stimulating plant growth
- Decomposition of plant residues

Uses of biofertilizers:

1. To fix atmospheric nitrogen and thus to supplement organic and inorganic fertilizer.
2. To solubilise plant nutrients like phosphorus and sulphur.
3. To stimulate plant growth through synthesis of growth promoting substance.
4. Help in uptake of available nutrient through VAM.

How biofertilizers work?

- ✓ Biofertilizers fix atmospheric nitrogen in the soil and root nodules of legume crops and make it available to the plant.
- ✓ They solubilise the insoluble forms of phosphates like tricalcium, iron and aluminium phosphates into available forms.
- ✓ They scavenge phosphate from soil layers.
- ✓ They produce hormones and anti metabolites which promote root growth.
- ✓ They decompose organic matter and help in mineralization in soil.
- ✓ When applied to seed or soil, biofertilizers increase the availability of nutrients and improve the yield by 10 to 25% without adversely affecting the soil and environment.

Types of biofertilizers:

1. N-supplying: These are of 4 types.
   a. Symbiotic nitrogen fixer- *Rhizobium* spp.
   b. Associative nitrogen fixer- *Azospirillum* spp.
   c. Non-symbiotic nitrogen fixer (free living) -*Azotobacter* spp.
   d. Biofertilizers for rice crop- Azolla, Blue green Algae, *Azospirillum*spp.
2. P-supplying:These are of 2 types.
   a. P solubilizer- Bacteria- *Bacillus polymyxa, Pseudomonas stratiata.*
      Fungi- *Aspergillus awamori, Penicillum digitatum.*
   b. P absorber- Vesicular Arbuscular Mycorrhiza (VAM)

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3. K-solubilizing microorganism: *Bacillus* spp., *Arthobacter* spp., *Aspergillus* spp.
4. Organic matter decomposer: These are of 2 types.
   a. Cellulotytic microbes- *Trichoderma*spp*.*, *Cellulomonas*spp*.*, *Clostridium* spp.
   b. Lignolytic microbes- *Clavaria, Humicola, Cephalosporium*
5. S-supplying: These are of 2 types.
   a. Heterotrophic- *Pseudomonas*spp*.*, *Aspergillus* spp.
   b. Autotrophic- *Thiobacillus* spp.

Biofertilizers application methods: There are three ways of using these biofertilizers.

1. Seed treatment: It is a most common method adopted for all types of inoculants. The seed treatment is effective and economic.Seed treatment with *Rhizobium, Azotobacter, Azospirillum*along withPSM. It can be done with any of two or more bacteria. It has no side effect. The important things to be noted is that the seeds must be coated first with *Rhizobium* or *Azotobacter* or *Azospirillum* when each seeds get a layer of above bacteria then the PSM. inoculants has to be treated on outer layer of the seeds.This method will provide maximum number of population of each bacterium required for better results.
2. Root dipping: This method is needed for the application of *Azospirillum* with the paddy/vegetable plants. The required quantity of *Azospirillum* has to be mixed with 5-10 litre of water at one corner of the field and all the plants have to keep for minimum ½ an hour before sowing.
3. Soil application: PSM has to be used as a soil application. Use 2 kg of PSMper acre. Mix PSMwith 400 to 600 kg of Cowdung along with ½ bag of rock phosphate if available. The mixture of P.S.M., Cowdung and rock phosphate have to be kept under any tree shade or celling for overnight and maintain 50% moisture. Use the mixture as a soil application in rows or during leveling of soil.

Precautions for biofertilizers application:

- Store biofertilizer packets in cool and dry place away from direct sunlight and heat, not below 0°C and over 35°C.
- Do not mix with chemicals.
- Use right combination of biofertilizers.
- *Rhizobium* is crop specific, so use in specified crop.
- Do not keep used solution overnight.
- Use the packet before expiry, only on the specified crop, by the recommended method.

Advantages of biofertilizers:

1. Increases the crop yield by 20-30%.
2. Reduce the chemical nitrogen and phosphorus requirement by 25%.
3. Stimulates the plant growth by producing growth promoting substances.
4. Activates the soil biologically as microbes secrete the organic acids which increase the aggregation of soil particles.
5. Restores natural soil fertility by mobilizing the nutrients in the soil.
6. Provides protection against drought and some soil borne diseases.
7. It is cost effective, pollution free and based on renewable energy sources.
8. It supplements the fertilizers.
9. Since they are biodegradable, so they are eco-friendly and do not deteriorate the environment.

10. By increasing the aggregation of soil particles, it reduces the chemical runoff from the field.
11. It is required in small quantity, thus pose no problem in packing, storing and handling.
12. It has no harmful effect on soil fertility, also improves the soil health by decreasing the bulk density of the soil.
13. It shows beneficial residual effect on soil fertility.
14. It secretes growth promoting substances (IAA/ GA) and vitamins (vit. B).

Constraints in usage of biofertilizers:

1. Farmers' acceptance has been far from satisfaction.
2. It is difficult to demonstrate the increase in yield due to biofertilizers.
3. Strains fail to establish if the soil moisture in the surface in the surface zone.
4. Fungicide treatment is a problem in crops like groundnut.
5. Availability of quality of inoculants is another problem.
6. Seed inoculation is no more suitable when seeds are sown on dry soil.
7. When seeds are coated with toxic chemicals and pesticides.
8. Seeds have fragile seed coat.
9. When seed coat is toxic to rhizobia.
10. Problem like transport form the manufacturing centre.

Guidelines on Buying and Storage of Biofertilizers:

1. Biofertilizer package should be ensured before buying. It should be crop specific.
2. The biofertilizer should be fresh, thus, check the expiration date.
3. Package should be kept in cool place until ready to use. Storage in refrigerator is good.
4. It is best to inoculate seeds prior to planting. Bacteria die quickly on drying seeds.
5. Chemicals on seeds and applied to the soil (e.g. insecticides, fungicides) may be toxic to the bacteria.
6. Store the inoculated seeds in a cool protected place until planting. Keep them out of direct sunlight and protect them from excessive drying.
7. Remaining inoculants may be kept safely in the package provided; it is closed tightly to prevent excessive drying or stored in a refrigerator at $4^{o}C$ or lower that will remain effective for several months.

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An Introduction to Watershed Management

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INTRODUCTION:

Watershed is any surface from which rain water is collected and drained through a common point. It is similar to drainage area and catchment area. Watershed management is a integrated technologies within the mutual boundaries of drainage area for optimum development of land, water and plant resources to meet the basic needs of people and animal in a sustainable way. It involves conservation, development and management of water. The basic approaches in watershed management is integrated effort on land development for effective soil and water conservation with a view to 'in situ' utilization of rain water for crop production and animal husbandry.

Objectives of watershed management:

- To protect, conserve and improve the land resources.
- To protect and enhance water resources
- To utilize the natural local resources for improving agriculture and allied industries/occupations.
- To restore ecological balance.

Benefits of watershed management:

- Watershed management helps the farmers through improving soil health, better drainage and more efficient use of rainwater and storing of excess rain water.
- The society benefits from floods to downstream farmland and human habitation, reduce saltation of expensive irrigation projects and protection to natural resources.
- The watershed for agriculture purpose may be several fields of farmers that contribute runoff water to flow at lower point.

Watershed development methods:

- Basic land treatment to conserve soil moisture, control land erosion and harvest runoff.
- Application of crop and animal management practices.
- Alternate land use such as agroforestry, social and silvi-pastoral system.

The government of India launched watershed management programme in seventh five years plan to develop dryland areas on the basis of watershed for soil and water conservation watershed are demarcated in to sub watershed and micro watersheds. The department of Agricultural provide funds for this programme.
The features of this watershed management programme are:-

1) Soil and water conservation measures.
2) Scientific dry farming.
3) Forestry and development of pastures.
4) Animal husbandry and development of dairy.

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Adaptation and mitigation strategies for climate change in Indian agriculture

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INTRODUCTION

Climate change is real and happening as evidence over the past few decades have established the significant changes occurring in climate due to enhanced anthropogenic activity. It is considered as the biggest environmental threat in human history in twenty first century. By definition "A change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings or to persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC, 2007). This definition differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change is defined as: *"a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."* The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Effects of climate change

The changes in climate parameters are being felt globally in the form of changes in temperature and rainfall pattern. The global atmospheric concentration of carbon dioxide, a greenhouse gas (GHG) largely responsible for global warming, has increased from a pre-industrial value of about 280 ppm to 406 ppm in 2018. Similarly, the global atmospheric concentration of methane and nitrous oxides, other important GHGs, has also increased considerably resulting in the warming of the climate system by 0.74°C between 1906 and 2005 (IPCC, 2007). The IPCC (2007) projected that temperature increase by the end of this century is expected to be in the range 1.8 to 4.0°C. For the Indian region (South Asia), the IPCC projected 0.5 to 1.2°C rise in temperature by 2020, 0.88 to 3.16°C by 2050 and 1.56 to 5.44°C by 2080, depending on the future development scenario (IPCC, 2007). Overall, the temperature rise is likely to be much higher during the winter (Rabi) rather than in the rainy season (Kharif).

Global climatic changes can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. An increase in atmospheric carbon dioxide level will have a fertilization effect on crops with C_3 photosynthetic pathway and thus will promote their growth and productivity. The increase in temperature, depending upon the current ambient temperature, can reduce crop duration, increase crop respiration rates, alter photosynthates partitioning to economic products, affect the survival and distribution of pest populations, hasten nutrient mineralization in soils, decrease fertilizer-use efficiencies, and increase evapotranspiration rate. Indirectly, there may be considerable effects on land use due to snow melt, availability of irrigation water, frequency and intensity of inter- and intra-seasonal droughts and floods, soil organic matter

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transformations, soil erosion, changes in pest profiles, decline in arable areas due to submergence of coastal lands, and availability of energy. In general, climate change may affect the agricultural production system by intensifying abiotic and biotic stresses which influences germination, growth, reproduction, pollination, fertilization and maturity processes of crops besides crop durations and incidence of diseases and pests, enhanced photosynthesis and water use efficiency, limiting water availability for irrigation, and enhancing frequency of extreme weather events (Sikka *et al*., 2016). The Government of India through the Indian Council of Agricultural Research (ICAR) initiated a National Network Project on Climate Change (2004-13) to assess the impact of medium term (2010-2039) changing climate on Indian agriculture especially crops. The study indicated average reduction in productivity by 4-6% in rice, 6% in wheat, 18% in maize, 2.5% in sorghum, 2% in mustard and 2.5% in potato besides significant regional variability (Naresh Kumar *et al*., 2012).

Adaptation strategies

Adaptation technologies are primarily developed through research programs of public and/ or private sectors, and often targets on development of tolerant crop varieties, strengthen real-time forecast system, and efficient management of resources to effectively deal with of climate-related risks.

Rain water harvesting: Rain water is the important source of water for agriculture as rain fed agriculture accounts more than 60% of Indian agriculture. In the present scenario of climate change the number of intermittent dry spell and intense rainy days has increased considerably without much change in rainfall quantity. Thus, due attention has to be paid for in-situ and ex-situ conservation of rain water to address the rainfall variability. Summer ploughing is one of the important in-situ conservation practices and water harvesting structure is one of the important ex-situ conservation practices. Farm pond is one of the low cost water harvesting structures in up and medium lands in farmer's field itself for collection and storage of rain water during the peak period of runoff and judicious utilization of stored water during the dry spell. Lining the farm pond with 8 cm thick plaster of 6:1soil: cement mixture or bentonite clay can increase the period of storage which can take care of the kharif crop during the intermittent dry spell and also can increase the possibility of growing short duration high value crops in rice fallows.

Adjusting cropping season: Adjustment of planting dates to minimize the effect of temperature increase induced spikelet sterility can be used to reduce yield instability, by avoiding having the flowering period to coincide with the hottest period. Adaptation measures to reduce the negative effects of increased climatic variability as normally experienced in arid and semi-arid tropics may include changing of the cropping calendar to take advantage of the wet period and to avoid extreme weather events (e.g., typhoons and storms) during the growing season. Farmers will have to adapt to changing hydrological regimes by changing crops.

Crop diversification: It is one of the best adaptation strategies to climatic vulnerability. In the process of diversification either the variety or if needed the crop is substituted with high value remunerative crops to fit to the present situation. Rice being the dominant crop and staple food of the nation, development of rice varieties that have not only high-yielding potential, but also a good degree of tolerance to high temperature, salinity, drought and flood, would be very helpful under the environment of global warming. Wherever it is thought that rice crop is not profitable any alternative low water requiring remunerative crops like maize, groundnut, green gram, black gram, red gram, vegetables etc can be fitted into the system.

Efficient water use: Climate change is going to require a re-examination of current approaches in water management. There is an urgent need to switch over from the surface flooding method of irrigation to other

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controlled surface methods like furrow, boarder strip and check basin and whosoever practicing controlled surface methods to pressurized irrigation like sprinkler and drip method to increase the water use efficiency and addressing the climate change related issues. In recent years, there has been a shift from TPR to other alternative method of rice establishment like DSR, SRI and Aerobic rice in several countries of Southeast Asia. These alternative methods of rice cultivation are considered as the water saving methods which save water to the tune of 25-50 % as it eliminates rising of seedlings in a nursery, puddling, transplanting under puddled soil and maintaining 4-5 inches of water at the base of the transplanted seedlings. The yield levels are comparable with the transplanted rice or even surpasses in many cases.

Efficient energy use: The functionality of environmentally friendly agricultural management practices is highly dependent on suitable mechanization technologies. Agricultural mechanization removes the drudgery associated with agricultural labour, overcomes time and labour bottlenecks to perform tasks within optimum time windows and can influence the environmental footprint of agriculture leading to sustainable outcomes. On the other hand, inappropriate mechanization can place pressure on fragile natural resources by increasing soil erosion and compaction, promoting overuse of chemical inputs and encouraging farmers to open lands that currently serve as valuable forest and rangelands.

Sustainable land use: Degradation of soil fertility due to many drivers is a serious constraint for sustainable agriculture. Top soil erosion is the most detrimental form of soil degradation and likely to be aggravated by long term removal of crop residues and the increased number of intense rainy days during the wet season. Conservation tillage, integrated nutrient management, cover crop, crop rotation and rotational grazing are the important practices in farm soils whereas agro forestry or tree plantations are the important measures to increase carbon stock in soil through the process of carbon sequestration.

Better Weather Forecasting and Crop Insurance Schemes: Weather forecasting and early warning systems will be very useful in minimizing risks of climatic adversaries. Information and communication technologies (ICT) could greatly help the researchers and administrators in developing contingency plans. Effective crop insurance schemes should be evolved to help the farmers in reducing the risk of crop failure due to these events. Both formal and informal, as well as private and public, insurance programs need to be put in place to help reduce income losses as a result of climate-related impacts. However, information is needed to frame out policies that encourage effective insurance opportunities. The recently launched Pradhan Mantri Fasal Bima Yojana (PMFBY) is a new initiative in crop insurance sector which addresses all loaned and non loaned farmers and also the tenant farmers who are having written agreement of tenancy with the owner.

Mitigation strategies

Agriculture is both a source and sink for greenhouse gases (GHG). Mitigation measures aim at reducing the net emission of greenhouse gases into the atmosphere. Some of the mitigation measures are as follows:

Tillage/residue management: Soil disturbance stimulate soil carbon losses through enhanced decomposition and erosion while reduced or no tillage agriculture often results in soil carbon gain (West and Post, 2002) and usually lower N_2O emissions. Advances in weed control methods and farm machinery now allow many crops to be grown with minimal tillage (reduced tillage) or without tillage (no-till). These practices are now increasingly adopted throughout the world. In addition, recycling crop residues tends to improve soil carbon, while burning of residues promotes emissions of aerosols and GHGs. Residue retention on soil surface reduces erosion from falling rain drops and maintains the soil temperature.

Crop management: Improved agronomic practices that increase yields and produce higher carbon residue could augment soil carbon storage. Important agronomic practices include improved crop varieties, extended crop rotations especially with perennial crops that allocate more carbon below ground, avoiding fallows (West and Post, 2002; Lal, 2003, 2004), balanced nutrition, reduced reliance on fertilizers and catch/cover/intercrops to enhance soil cover.

Nutrient management: Nitrogen applied through fertilizers, manures and other N sources is not always used efficiently by crops as it is easily leached through water and various gaseous losses. Improving N use efficiency can reduce N_2O emissions and indirectly reduce GHG emissions from N fertilizer manufacture (Scanhlesinger, 1999). Integrated Nutrient Management (INM) and Site-Specific Nutrient Management (SSNM) have the potential to mitigate effects of climate change. For example, adoption of INM and SSNM practices under flooded rice significantly improves the yield, net CO_2 assimilation, and nitrogen use efficiency while decreases GHG emission over traditional practices. Similarly, split application of nitrogen fertilizers, simultaneous application of urease inhibitor, hydroquinone (HQ), and a nitrification inhibitor, dicyandiamide (DCD) with urea is an effective technology to reduce N_2O and CH_4 emission from rice field.

Water management: Expanding area under irrigated agriculture or adoption of more efficient water management practices can enhance carbon storage in soils through enhanced yields and residue returns (Lal, 2004). For example, intermittent flooding in rice could reduce global warming potential by 25-30% over continuous flooding (Pathak, 2015). Similarly, adoption of the micro irrigation technology will not only result in saving of water but also saving of energy and reducing carbon emission. Resource conserving technologies (RCTs) like zero or minimum tillage (with or without crop residues), bed planting of crops and direct-seeded rice have a substantial scope in improving irrigation efficiency and saving energy for groundwater withdrawal.

Agro-forestry: Agro forestry is a combination of crops and perennial trees used as a sustainable land management practice. Agro-forestry systems buffer farmers against climate variability and reduce atmospheric loads of greenhouse gases. Agro-forestry can both sequester carbon and produce a range of economic, environmental, and socio-economic benefits. However, the amount of carbon sequestered and other tangible benefits largely depend on the type of agro-forestry systems besides environmental and socio-economic factors that determines its composition.

Land cover and land use Change: Lands differ in their ability to grow plants and resilient capacity to weathering forces. Usually, a climax ecotype for a land use is thermodynamically the most efficient system that often leads to lowest GHG emission and maximum carbon sequestration. Any deviation from climax vegetation causes imbalances and accelerates entropy. Thus, reverting a crop land to another land cover, typically one similar to the native climax vegetation is one of the most effective methods of reducing emissions. However, such land cover changes often increase carbon storage, but comes at the expense of lost agricultural land. It is usually an option only on surplus agricultural land or on croplands of marginal productivity (Smith *et al*., 2007).

SRI: System intensification of rice is another approach which can reduce 30-60% methane emission with judicious utilization of water. Although aerobic rice may reduce CH_4 emissions from rice fields, it may results into increased N_2O emissions. The N_2O is having 310 times global warming potential than CO_2. The trick is to find a way to maximize the benefit of positive aspects and minimize the environmentally negative effects. N_2O emissions can be mitigated using an appropriate combination of irrigation timing and N application.

Mid-season drainage: In common practice, water is drained out of the field during vegetative period. Shifting drainage time from vegetative period to reproductive period can reduce methane production and emission. Shorten drainage day also help reduce nitrous oxide emission. The effect of midseason drainage are in controlling nitrogen absorption, keeping oxidative soil condition, increasing productivity and quality of rice and decreasing methane emissions.

Fertilizer management: The four management factor that help to reduce N_2O emissions from applied N fertilizers are commonly known as 4Rs as application of nitrogen at right quantity from right source at right time and right placement. Fertilizers need to be applied in convergence with crop demand and soil supplying capacity. Soil test based applications need to be encouraged.

Short duration varieties: Generally, methane emissions are proportional to the number of days the crop is flooded. By switching from long duration varieties to short duration varieties of rice cultivars, the number of flooded days will decrease. Normally, the paddy soil should be dry for a month before harvesting, which equals one fourth of the growing season of the short duration varieties.

Carbon Sequestration: Cultivated lands have the potential to contribute significantly to climate change mitigation by improved cropping practices and greater number of trees on farms. The global estimated potential of all GHG sequestration in agriculture ranges from 1500 to 4300 ml CO_2 e/yr. with about 70% from developing countries, 90% of this lies in soil carbon restoration and avoided net soil carbon emission.

CONCLUSION

Climate is changing and changing at a rapid pace than anticipated before. Impact of climate change on agriculture and allied sectors will be one of the major factors influencing future food security in coming times. Adaptive responses are mainly related to technological interventions, management practices, sound governmental policy and political will to overcome the ill effects of climate change. The success of agronomic management interventions implemented under NICRA across vulnerable districts in India has demonstrated the ability of different low cost interventions at enhancing resilience to climate change for sustainable agriculture. Development of submergence tolerance, heat and drought tolerant and pest resistant varieties of major crops, identification of production systems which are most resistant to climate change rather than trying to manage a particular climate regime, including development of new agronomic practices and water management system, rain water harvesting, soil conservation measures and suitable cropping patterns for maximum in-situ retention of rain water; developing decision support system, combining databases (crop, soil and climate) and modern information tools (simulation models, remotely sensed information, geographic information system) to establish drought/ flood alerts, monitor the vegetation conditions, develop crop yield forecasts, identify best agronomic practices and to define land use suitability classes are some of the measures to be taken up to minimize the ill effects of climate change.

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Insect Herbicide

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The leaf-cutting ant, e.g. *Atta sexdens* from South America shows a creative way to establish and preserve their "fungus gardens" as a food source. The process by which harvest ants were able to preserve grain collected in storerooms without sprouting for prolonged periods was unexplained earlier. Researchers have isolated and identified β-indolylacetic acid (IAA) and phenylacetic acid (PAA) from the metathoracic glands of Myrmicine ants along with a miracle compound Myrmicacin.

Fig. 1. Myrmicinae ant producing Myrmicacin

Identification and structural analysis of Myrmicacin:

- Thin-layer chromatography of metathoracic gland secretion followed by vitriol (conc. sulfuric acid) treatment disclosed an earlier unidentified substance between the PAA- and IAA-spots named Myrmicacin.
- It used to show positive test for all the basic carboxylic acid reactions, indicated a carboxylic acid.
- Mass spectrometry confirms the molecular weight of the silylated Myrmicacin and molecular formula to be 332.229271 and $C_{10}H_{20}O_3$, respectively.
- The methyl ester with diazomethane was prepared for structural analysis using a combination of mass spectrometry and gas chromatography. It has been found that the fragment mass (m/z = 103) is a key fragment indicating a β-hydroxy ester. There remained a C-7 fragment after the subtraction of this primary fragment, which was easily detected in the silylated carboxylic acid mass spectrum. As a result of the mass spectral analysis, D-β-hydroxydecanoic acid (1) has been found to be myrmicacin and β-hydroxyoctanoic acid (2) and β-hydroxyhexanoic acid have also been repoted in further analysis of the secretion. Myrmicacin (1) was found to be the levorotatory D-acid with a specific rotation of $[\alpha]_D^{20} = -3^o$ (in chloroform, $CHCl_3$).

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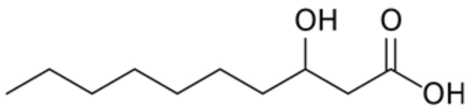
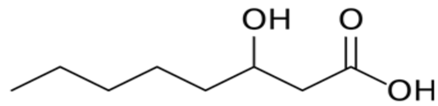


(1)



(2)

Table.1. Concentrations of the acids in the metathoracic glands of the leaf-cutting ants (*A. sexdens*)

Acids	Conc. (µg/gland)
Phenylacetic acid (PAA)	1.3 - 3.0
Indolylacetic acid (IAA)	0.01 - 0.1
D-β-Hydroxydecanoic acid (Myrmicacin)	2.0 - 3.5
β-Hydroxyoctanoic acid	0.5 - 5.0
β-Hydroxyhexanoic acid	<0.1

Myrmicacin as a herbicide:

Together with the IAA and PAA bioregulators, the presence of hydroxyl acids indicated that they too could be growth regulators. Since the seed-storing ant *Messor* does not have the IAA growth regulator but produces Myrmicacin, the germination-inhibiting effect could be anticipated from the hydroxy acids. In support of this, the fungicide tests showed that Myrmicacin has an efficacy of 25% & 90% for growth inhibition of *Altenaria tennis* and *Botryris cinerea* at a concentration of 0.015% & 0.03%, respectively. During an experiment, Myrmicacin was added to plum puree. It was observed that the puree was not attacked by fungi or fruit flies for several weeks, while in the same time the control puree without Myrmicacin was completely overgrown with microorganisms. Therefore a conclusion can be made that the harvest ants are able to prevent the sprouting of the gathered grass seeds and the leaf-cutting ants prevent the spores from sprouting by using Myrmicacin as an herbicide. Additional experiments show that PAA inhibits the growth of bacteria in the garden, and IAA supports mycelia growth. Thus, only the symbiotic fungus will survive at the new nest as the queen ants carry them as post nuptial flight mycelia. All the other spore-intruding fungi remain undeveloped.

Ant–plant mutualism:

Myrmelachista schumanni, also known as the lemon ant, is an ant species famous for the construction of Devil's garden. Worker ants were found to inject formic acid to leaves, and the plants began to die within few hours. The only insect known to use formic acid as an herbicide is lemon ant. They destroy all the plants in an area except the myrmecophytes, or ant-plants in which they live, using their own herbicide.

CONCLUSION:

Chemicals like Myrmicacin & related compounds and formic acid produced from specific ant species are known to have herbicidal as well as selective fungicidal activity, can be proved effective as natural growth regulators.

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Mulching- An Important Tool for Mitigating Climate Change

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INTRODUCTION

For decades, farmers have been trying to use various natural mulch materials such as dry leaves, paddy straw, paddy husk, sawdust, dry grasses etc. for moisture conservation (reducing water evaporation loss) checking weed growth and moderation of soil temperature. When compared to other mulches, plastic mulch is completely impermeable to water, prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. Mulching in general creates a kind of micro climate for the plant, which is best suited for best performance by regulating soil water, soil temperature, humidity, carbon dioxide enrichment and increased microbial activity in the soil. Thus mulching is the process of covering the soil around the plant root area with a view to insulate the plant and its root from the effects of extreme temperature fluctuation. In other words, mulching is the process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production.

Why to use mulch?

Mulch can be any material which cover and protects the soil. Plants in the forests get natural mulch with the help of fallen leaves, fruits, branches, flowers etc. There are many problems if the land is left bare. Soil can be washed away by the rain, it may get dry in the hot sun and wind can blow the soil off. By all these causes' beneficial microorganisms in the soil can be endangered. Altogether leads to the soil loss and decreased fertility. The added advantages of mulching are mentioned below:

- Conserves soil moisture
- Moderates soil temperature by insulating the soil surface
- Control weed growth under mulch film
- Reduces soil erosion caused by water
- Prevents leaching of fertilizers
- Improves quality of produce, reduces fruit rot by eliminating direct contact between fruit and soil
- Enhance early maturity
- Improves seed germination and productivity
- Mulches can also provide a barrier to soil pathogens
- Synthetic mulches play a major role in soil solarisation process

Types of mulch

There are two categories of mulches namely: Organic and Inorganic mulches.

The organic materials such as crop residues & by products, grasses, straws, animal manure and by products of timber industry like saw dust when uses for mulching are known as organic mulches. Organic mulches create no post utilization disposal problem but their availability is an issue.

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The inorganic materials such as plastic films when used for mulching are known as inorganic mulches. While natural mulches may not be easily available at all times and places. Plastic mulches can be made available in different colours and thickness to obtain the desired results.

Types of plastic mulch

1. **Black mulches:** The black plastic film does not allow sunlight to pass through the soil. Thus, photosynthesis does not take place in absence of sunlight below the black film. Hence, it arrests weed growth completely. It may increase the soil temperature.
2. **Clear or transparent mulches:** The clear or transparent film will allow sunlight to pass through and weeds will grow. However, by using herbicide coating on the inner side of film weed growth can be checked. The transparent film is quite successful as soil solarization film for disinfecting the soil in order to reduce soil borne diseases. This application is quite successful in nursery raising by solarising the beds before sowing seeds for nursery raising, which gives good seed germination and disease free nursery. The transparent film is effective in hilly areas for raising soil temperature in cold climatic conditions during winter.
3. **Two sided colour mulches:** Wavelength selective or photo-selective films (also called two sided coloured) are designed to absorb specific wavelengths of the sun's radiation, which changes the spectrum of the sunlight passing through the film or being reflected back into the plant canopy. These light changes can have a marked effect on plant growth and development. Wavelength selective mulches re-emit less heat, thus maintaining lower leaf temperatures altering red-far-red light balance leading to phytochrome mediated changes in the plant morphology and reflect more ultraviolet rays which repel s insects and pests such as aphids, thrips and whiteflies which transmit virus. The white/black. Silver/black, aluminium/black mulches generally maintain cooler root zone temperatures.

Selection of plastic mulch

The selection of mulches depends upon the ecological situations and primary and secondary aspects of mulching.

Conditions	Plastic mulch material
For rainy season	Perforated mulch
Orchard and plantation	Thicker mulch
Soil solarization	Thin transparent film
Weed control though solarization	Transparent film
Weed control in cropped land	Black film
Sandy soil	Black film
Saline water use	Black film
Insect repellent	Silver colour mulch
Early germination	Thinner film

Thickness of film

In plastic mulching, the thickness of mulch film should be in accordance with type and age of crops. The thickness of mulch film for different categories of crop is as under.

Thickness (microns)	Crops recommended
20-25	Annual (short duration crop)
40-50	Biennial (medium duration crop)

50-100	Perennial (long duration crop)

Mulching, which consists of covering the soil surface with organic material and inorganic materials is a practice used to control soil moisture, soil temperature, nutrient loss, salinity, erosion soil structure etc. With the advancement of modern agriculture, this practice is now gaining importance in the wake of climate change to ensure sustainable agriculture. The need for increasing food security, while at the same time improving the quality of the environment, has prompted the search for materials that can protect and maintain the soil structure and health. The adoption of appropriate soil management practices is essential to conserve water, nutrients and soil, particularly the structure and drainage characteristics. Under climate change, additional crop water availability may be obtained by increasing the soil water storage capacity, reducing soil evaporation and increasing soil water extraction. The use of organic and inorganic mulches is one means of reducing soil evaporation through a reduction of the amount of energy reaching the soil surface.Similarly mulch cover has been positively correlated with plant cover and plant species richness.

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Effects of long term manure on soil, plants and environment.

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INTRODUCTION

The continuously growing population and increasing demand of foods create a tremendous pressure on agriculture to produce more from a limited land. Mining of nutrients from soils along with their losses due to erosion, indiscriminate use of agro-chemicals, deep tillage, and luxury irrigation have degraded soils and water. .Soil is an essential non-renewable resource with potentially rapid degradation rates and extremely slow formation and regeneration processes. There is evidence that continuous cropping and inadequate replacement of nutrients, erosion, leaching, and gaseous emissions, degrade soil physical, chemical and biological properties. Moreover, the production of urban and industrial organic wastes is increasing worldwide, and strategies for their disposal is taken so that these do not further degrade soil, contaminate water or pollute air and also improve soil fertility. Soil fertility can be define as the capacity of soil to provide physical, chemical and biological needs for the growth of plants for productivity and quality, relevant to plant and soil type, land use and climatic conditions (Abbott and Murphy. 2007). It is important to give equal consideration to all biological, chemical and physical components of soil fertility, for attaining a sustainable agricultural system. The term "sustainable agriculture" is used which means to meet current and future needs for food and feed, ecosystem services and human health and maximizing the net return. It is relevant to note that organic farming is the only sustainable form of agriculture legally defined. Soil fertility management relies on a complex long-term approach rather than the more short-term one of conventional agriculture. One of the possible main tools for the maintenance and the improvement of soil fertility in organic farming .Furthermore, organic wastes such as animal manures, by-products of several kinds and crop residues can be used as amendments to increase soil fertility, since they are important sources of nutrients for growing crops and means for enhancing the overall soil quality.

The decline in soil fertility due to imbalanced fertilizer use has been recognized as one of the most important factors limiting the crop production. Stagnation or decline in yield has been observed in many cropping systems in many parts of the country due to nutrient depletion, soil structure deterioration, and unbalanced use of plant nutrients, acidification and suboptimal addition of fertilizers to soil. Application of manures and fertilizers changes the chemical, physical and biological properties of the soil which in turn affects the availability of soil nutrients especially the secondary and micronutrients required by growing plants in minute quantities. Indiscriminate use of high analysis chemical fertilizers results in the deficiency of secondary and micronutrients in soil. Due to all these reason we again start thinking about classical manurial experiment. As this provide us valuable information on the effect of rotational cropping, use of bulk organic manures in soils, nutrition application alone or in combinations for crop yields, nutrient uptake and on changes in soil physico-chemical and biological properties of the soil.

Permanent Manurial Experiments /trial (PME):

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There are two types of field experiments, one short-term experiment and others long-term experiment. The shorts-terms experiment was conducted for short periods of times i.e. for 1-3 years. It is done to obtain an estimate of comprehensive effect for a set of treatments. In order to secure a comprehensive view of farm practices, long term field experiments are planned. It is useful to conduct a long term experiment on cropping systems, in order to comprehend the direct residual and cumulative effects of a practices and agro techniques used in crop productions.

Permanent manurial experiments are conducted to study the long term effect of continuous application of plant nutrients either singly or in combination and with or without organic manure on crop yield, nutrient uptake, and physico-chemical and biological properties of soil. The first classical field experiment was started at Rothamsted Experimental Station, Harpenden in England in 1854 by Lawes and Gilbert.

Similar to Rothamsted experiment, in India first PME was initiated at Kanpur in 1905. Subsequently, long term experiments were started at Pusa and Coimbatore in 1908 and 1909 respectfully. These are called Old Permanent Manurial Experiment (OPM). In Coimbatore experiment was being conducted in red soil (Alfisol) with cereal-cotton crop rotation under rainfed conditions. Subsequently in 1925, a second experiment was started with the same treatments and called as New Permanent Manurial (NPM) experiment to test the effect under irrigated conditions. Thereafter several more long term fertiliser experiments were initiated at Shahjahanpur in 1935, Padegaon in 1939, Indore in 1947, Muzaffarnagar in 1949, Anka Palle in 1950 and Ranchi in 1956.

Since fertiliser is a key factor for increasing crop production, need was recognised to study the effect of fertilisers not only on the improvements in crops yields but also on the change in soil and environment under intensive cropping system on long term basis using high yielding short duration varieties. Therefore, to study the effect of intensive cropping and manuring new set of experimental design was implemented all over India by ICAR by a coordinated scheme on Long Term Fertilizer Experiment (LTFE). During 1972, LTFEs were started at 11 centres and later further expanded at seven more centres.

Effects of permanent manurial experiments:

Due to permanent manurial experiments Physical, chemical and biological properties of soil get affected. In plants quality and quantity of produced get altered. Environment is affected as Ground and surface water quality and air quality get affected.

Physical properties of soil:

Mechanical composition: There is very less change in the composition of soil texture. Mechanical composition of soli is the inherent character which depends mainly on the parent materials.

Bulk density: In long term manurial experiment, continuous application of inorganic fertilizers and organic manures either alone or in combination cause reduction in bulk density. Decreased in bulk density occur due to more porous and well aggregates formation of soil.

Water holding capacity: Water holding capacity was higher in soils receiving organic manures than in those treated with inorganic fertilizers. Soil structure and humus content of soils are normally improved through continuous application of bulky organic manures. Thus, higher content of organic matter in soils due to application of FYM and compost might have modified the nature of pores in soil and brought about improvement in soil structure, thereby increasing the water holding capacity of soil.

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Soil chemical properties:

Soil reaction (pH): Long-term application of manures to soil is expected to affect changes in the soil reaction depending upon the nature of the soil, composition of manure schedules adopted in the particular cropping system, initial pH and organic residues in the soil.

Cation Exchange Capacity (CEC): CEC of soil get increased due to application of organic material as the organic carbon stocks get increased. This was due to the high negative charge of organic matter. This is important for retaining nutrients and makes them available to plants.

Soil Organic carbon content: Soil organic carbon content gets increased in long term experiments. Extent of increased in organic carbon depends on the types of manure used. The application of organic amendments at 5–10 t/ha/year, through farmyard manure or compost combined with balanced mineral NPK, for 7–36-year in different rice- based cropping systems increased organic carbon by 10.7%. In a rice-wheat system, farmyard manure application at 20 t/ha showed, after a period of 32 years, higher organic carbon concentration of 17% compared with NPK fertilizers in the 0–15 cm soil layer.

Effect of long-term fertilization on soil nutrient status:

Available nitrogen:

Application of major nutrients especially N plays a key role in determining the yields of crops. Among the major nutrients, nitrogen is universally deficient and most vulnerable to losses especially under tropical climate. Its regular supply during crop growth period is possible through release of nitrogen from organic manures. In the red loam soils of the old and new permanent manurial experiments at Coimbatore, the available nitrogen content was found to be enhanced due to continuous incorporation of organic manures. Manurial Experiment showed that the N availability was altered when apply without FYM caused depletion of available nitrogen. The increase in available N status due to organic manure application would be due to the multiplication of soil microbes leading to enhanced conversion of organically bound N into inorganic forms. Legume cropping increased the N status of the soil, which may be attributed to the litter fall and atmospheric N-fixation by legume crops.

Available phosphorus:

It was found that compost applications can increase plant available P in the soil. The biosolids municipal solid waste compost, applied once in 4 years, has also been found to effectively supply P to soil at 0–15 cm depth. (Eghball. 2002) suggested that 4 year beef cattle manure and composted manure application based on N needs of corn could eventually result in soil accumulation of P, since the manure or compost N/P ratio is usually smaller than the corn N/P uptake ratio. (Aparna. 2010) revealed that combined application of chemical fertilizers and organic manures was found to positively enhance the status of available P and K. The enhancement of available P might be due to soluble P contributed from mineral fertilizers, the mineralized P released from organic source or by the weathering of monazite mineral containing thorium phosphate. The increased availability of K might be due to the direct contribution of fertilizer K to the available pool. Moreover application of ammonium sulphate also replaces the ion from the complex thereby contributing to the pool of available K.

Available potassium:

Decline in available K status was observed in the plot receiving only fertilizer but the significant increase in available K content has been noted in the plot receiving either FYM or green manuring along with fertilizer N. This suggests that FYM and green manuring helped to maintain the supply of K by releasing the K from reserve source. The beneficial effects of FYM on the availability of K may be ascribed to the reduction in K fixation and release of K due to the interaction of organic matter with clay. Available K levels increased with time at rates ranging from 0.98 to 1.18 mg/kg/y for plots receiving manure or straw. Inputs of K with organic materials resulted in a build-up of soil available K because manure or straw generally contains high amount of K.

Exchangeable calcium and magnesium:

In a multiple cropping system, higher fertilizer levels decreased the availability of calcium and magnesium while the application of FYM increased the levels of exchangeable Ca and Mg. In the Old Permanent Manurial Experiment at the TNAU, the Ca content was lower in plots receiving continued application of nitrogen through fertiliser, which may be due to the increased uptake of Ca by crops, induced by nitrogen treatment. In case of FYM application, there was first decreased followed by an increased due to slow mineralization of organic manures. An increase in the Ca and Mg status of the soil was found due to the continued application of manure. The FYM has a positive effect on Ca and Mg content in soil because it is having high adsorptive capacity that might have adsorbed Ca and Mg which would otherwise be leached.

Available micronutrients:

The enhancement in the DTPA- Fe due to the addition of organic substances may be ascribed to their ability to form stable water- soluble complexes preventing the reaction with other soil constituents and also increasing the Fe content by releasing it from the native reserves. Lowest amounts of available micronutrients were observed in the unmanured control which was due to the continued exhaustion of micronutrients. The available Mn status increased with the addition of FYM. This may be due to the release of Mn^{2+} bound to organic ligands in the organic matter and acceleration of the reduction of $Mn^{4+}$to Mn^{2+}. (Kumar and Singh. 2010) concluded that availability of micronutrient increased with the application of FYM and green gram incorporation as they are sources of micronutrients.

Biological properties of soil:

Number of microorganism: Number of microorganism was increased in manurial treated plot as compared to fertiliser treated plots. The effect of green manure amendments was studied in a 47-year experiment (Elfstrand *et al*. 2007). The authors found a higher abundance of bacteria and fungi in the green manure treatment, i.e. 34.3 and 1.8 nmol/ g soil, respectively, in respect to the fertilizer treatment (20.3 and 0.9 nmol g/soil).

Crops yields and quality:

The yield of crops increase but it depend upon on the quality, quality and amount of manure used. As demonstrated by several long-term experiments on crop nutrition and yielding responses, the benefits of increased organic matter content will differ on the basis of the rate supplied. In a 5-year trial, (Hartl *et al*. 2003) found that every second year spreading of 40 t/ha biowaste compost, from source-separated organic household waste and yard trimmings, resulted in slightly higher (9%) rye yields than other rates of application. This result suggested that beneficial use depends on choosing the best amount and frequency of compost application.

Effects on ground water and surface water and air quality:

The main dangers of the application of manure are runoff of manure or manure components into surface water and leaching of nitrate (NO_3) and P into the ground water. Mineral N in manure is largely present as NH_3. If, upon application of the manure, it does not volatilize, it will be quickly nitrified, i.e. transformed through microbial action into NO_3. Also, N mineralized from the organic fraction of the manure, will readily be nitrified. As NO_3 is an anion that is not adsorbed by clay minerals or soil organic matter, it is easily leached in case of a precipitation surplus. This holds good for NO_3-N from manure, and for that originating from mineral fertilizers or from decomposed soil organic matter. If ground water concentrations of NO_3 become too high, it is unsuitable for drinking water. Under certain conditions, ground water can flow into surface water. In brackish and salt water in particular high NO_3 concentrations in surface water will lead to eutrophication. Under certain conditions this may lead to excessive growth of algae, causing oxygen shortage and consequently the death of fish. Phosphorus is not nearly as mobile in the soil as NO_3 and therefore much less susceptible to leaching. If P flows into the ground water and subsequently into surface water, the same problems as will nitrate but P causes eutrophication in freshwater bodies. Carbon and nitrogen cycle has a great impact on air quality. Application of nitrogenous fertiliser and liquid manure causes losses of NH_3 by volatilization. Release of ammonia causes acid deposition in the soil and decrease the soil productivity. Acidification of soil leads to mobilisation of aluminium (Al) ions which disturbs the nutrient uptake of plants and trees, and enhances sensitivity to stress factors like drought and fungi. Denitrification of NO_3 by microorganisms is possible under anaerobic conditions when N_2 is formed, but giving off a by-product N_2O, a gas that affects the ozone layer.

CONCLUSION:

Application of long term manure improves the physical physical and biological properties of the soil which increase the yield of crop and improve the ground and surface water quality. Air quality is also improved due to less use of chemical fertiliser.

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Bittergourd: A Gift of Nature

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INTRODUCTION

Bitter melon (*Momordica charantia*) is a subtropical creeping plant belonging to the family Cucurbitaceae.This is widely used as a medicinal herb. *M. charantia*, also known as bitter melon, karela, balsam pear, or bitter gourd, is a popular plant used for the treating of diabetes-related conditions amongst the indigenous populations of Asia, South America, India, the Caribbean and East Africa (Cefalu *et al*., 2008). The main constituents of bitter melon which are responsible for its antidiabetic property includes, triterpene, proteid, steroid, alkaloid, inorganic, lipid and phenolic compounds. Various glycosides are present in the fruit and stem of *Bittergourd*.These glycosidescome under genera of cucurbitane-type triterpenoids. In particular, four triterpenoids have AMP-activated protein kinase activity which is a plausible hypoglycaemic mechanism of *M. charantia*. Its fruits consist of glycosides, saponins, alkaloids, reducing sugars, resins, phenolic constituents, fixed oil and free acids.

MEDICINAL PROPERTIES

Bittergourd possesses antioxidant, anti-inflammatory, anti-HIV and anticancer activities, and has been used to treat diseases such as diabetes, liver disorders, and gastric problems. The fruit juice of bitter melon has been shown to reduce blood sugar levels and has been used in the treatment of diabetes for centuries. Among the various compounds present in bitter gourd; charantin, polypeptide-p and vicine act as hypoglycemic agent. All these three agents act as antidiabetic, a detail of which is given below.

CHARANTIN

Charantin is a typical cucurbitane-type triterpenoid in *M. charantia* and is a potential substance with antidiabetic properties (Krawinkel & Keding, 2006; Patel *et al*., 2010).Studies have reported that the compound is more effective than the oral hypoglycemic agent tolbutamide. It is a mixture of two compounds, namely, sitosteryl glucoside and stigmasteryl glucoside. Chen *et al.* (2009) isolated 14 cucurbitane triterpenoids, kuguacins, including two pentanorcucurbitacins, one octanorcucurbitacin, and two trinorcucurbitacins'.

POLYPEPTIDE-P

Among the various vegetables, Bitter gourdis used for controlling diabetes naturally,as it contains polypeptide-p. Polypeptide-p (p-insulin) is a hypoglycemic protein, which is insulin-like.On injection subcutaneously,it is observed toreduce the blood glucose levels in langurs,gerbils and humans (Tayyab *et al*., 2012). In body, the polypeptide-p mimics the action of human insulin. Therefore,this it can be used to control diabetes in patients having type-1 diabetes.

VICINE

Vicine is one of the majorglycol alkaloidcompoundswhich have been isolated from the bitter gourd seeds. This pyrimidine nucleoside has been shown to induce hypoglycemia in non-diabetic fasting rats by intraperitoneal administration (Han and Wang, 2009). However, vicine found in fava bean has been shown to induce favism, an acute disease characterized by hemolytic anemia, in individuals with a hereditary loss of the enzyme glucose-6-phosphate dehydrogenase.

OTHER COMPONENTS

Severalother constituents which have been isolated from bitter gourd through various extraction techniques.Among the variouscompounds identified and isolated, four*viz.*momordicosides K and L, and momordicines I and II, may be responsible for the bitter taste bitter gourd. The last two compounds isolated were identified as sitosterol and stigmastadienol, the aglycones of charantine. Bitter gourdcould have animmediate effect in loweringof blood glucose level. Based on the reports available it have been observed that both alcoholic andaqueous extracts of the fruit of *M. charantia* can inhibit the activities of fructose 1, 6-diphosphatase and glucose-6-phosphatase and at the same time stimulating the action of glucose-6-phosphatase dehydrogenase (Shetty *et al.*, 2005). It was previously reported that *M. charantia* and its various extracts can stimulate peripheral cell glucose uptake (Cummings *et al.*, 2004)**.**

CONCLUSION

The concept of food as medicine is a folklore both in dietetic and nutritional sciences. *M. charantia* has been used as dietary supplements and ethno-medicine throughout centuries for relieving symptoms and conditions related to what we know in modern days as diabetes. To date, in bitter gourd extensively study has beendone worldwide for its medicative properties to treat variety of diseases.Above all, itmay be a possible option for ethnic minorities who have a higher prevalence of diabetes but prefer treatment based on natural products in keeping with cultural beliefs.

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Changing Role of Millets in Food and Nutritional Security of India

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INTRODUCTION

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Millets are important food and fodder crops in arid and semi arid regions, and are predominantly gaining more importance in a world that is increasingly becoming populous, malnourished and facing large climatic uncertainties. These crops are adapted to wide range of temperatures, moisture-regimes and input conditions supplying food and feed to millions of dry land farmers, particularly in the developing world. Besides they also form important raw material for potable alcohol and starch production in industrialized countries.

The term millet includes a number of small-grained cereal grasses. Based on the grain size, millets have been classified as major millets which include sorghum and pearl millet and several small grain millets which include finger millet (ragi), foxtail millet (kangni), kodo millet (kodo), proso millet (cheena), barnyard millet (sawan) and little millet (kutki). Millets are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture and are stable yielders. India is the largest producer of millets in the world. Rajasthan is the largest producer of pearl millet whereas Karnataka is the leading producer of finger millet.

Millets for food and nutritional Security

Nutrition security implies awareness and access at affordable cost to balanced diet, safe environment and drinking water and health care outreach. Millets were indeed one of the oldest foods known to humans but they were discarded in favor of wheat and rice with urbanization and industrialization. With diabetes, hypertension and cardiovascular disease running rampant, as gifts of newly acquired life-styles, millets have returned as a viable option to live healthy life without consuming loads of anti-diabetic and anti-hypertension medicines that are not only very expansive but also have serious side-effects in the long run. Millets are a treasure-trove of micronutrients like B-complex vitamins and minerals whose deficiencies in India are rampant. Additionally millets are also rich in health promoting phyto-chemicals, and can be used as functional foods. Indeed millets act as a prebiotic feeding micro-flora in our inner ecosystem. Millet will hydrate our colon to keep us from being constipated. The high levels of tryptophan in millet produce serotonin, which is calming to our moods. Magnesium in millet can help reduce the affects of migraines and heart attacks. Niacin (vitamin B3)

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in millet can help lower cholesterol. Millet consumption decreases Triglycerides and C-reactive protein, thereby preventing cardiovascular disease. All millet varieties show high antioxidant activity. Millet is gluten free and non allergenic. They also contain fibre and health promoting phyto-chemicals which function as antioxidants, immune stimulants etc., and thus have potential to mitigate degenerative diseases such as diabetes, CVD, cancer etc. whose incidence is rising in India. Unfortunately some of these phyto-chemicals like fibre, phytates and tannins interfere with the bioavailability of micronutrients particularly minerals. Processing can improve the bioavailability of nutrients as well as functionality. Limited studies show that bioavailability as well as functionality differs with the type of processing and preparation. More work is needed to optimize both of these.

Versatility of millets

Millet cultivation is the mainstay of rain-fed farming on which 60% of Indian farmers depend. They provide food as well as fodder and can be mix-cultivated (polyculture) with pulses and vegetables. Despite these attributes, millets are losing their pride of place in production and consumption in India. In addition to being used for seed, millet is also used as a grazing forage crop. Instead of letting the plant reach maturity, it can be cut and fed to animals or grazed by stock and is commonly used for sheep and cattle. Millet is a C4 plant, which means that it has good water-use efficiency and utilizes high temperature and is therefore a summer crop. A C4 plant uses a different enzyme in photosynthesis from C3 plants, and this is why it improves water efficiency. The advantages of cultivation of these crops include drought tolerance, crop sturdiness, short to medium duration, low labour requirement, minimal purchased inputs, resistance to pests and diseases. Millets are C4 crops and hence are climate change compliant. There are varieties particularly in little millet and proso millet which mature in 60-70 days; yet providing reasonable and assured harvests even under most adverse conditions. India is a store-house of highly valuable genetic variability. Millets sequestrate carbon and thereby reduce the burden of green house gas.

Issues pertaining to production

Though India is the largest producer of millets in the world, between 1961 and 2019, there has been drastic reduction in the area under cultivation of millets but due to productivity gains in some varieties, total production of millets showed some increase despite shrinkage of area. Almost 50% area under millets has been diverted largely to soybean, maize, cotton, sugarcane and sunflower. A combination of factors like low remuneration as compared to other food crops, lack of input subsidies and price incentives, subsidized supply of fine cereals through Public Distribution System (PDS), and change in consumer preference (difficulty in processing, low shelf life of flour and low social status attached to millets), have led to shift from production of millets to other competing crops.

Strategies for increasing production

- Development of varieties/hybrids with better recovery capacity on reversal of dry spell for harsh environment/drought prone areas.
- Development of hybrids/varieties resistant/tolerant to salt/high temperature.
- Effective deployment of trait-specific germplasm available in gene banks for genetic enhancement.
- Exploration of zero tillage for millets under rice fallows particularly for southern States.

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- Better agronomic management and scientific method of cultivation giving priority to resource conservation.
- Strengthening breeding programmes through conventional breeding, marker-assisted breeding as well as biotechnology for bio-fortification.
- Validation of high productive technology under real farming situations.
- Evolving strategies for better seed production with public, private, NGO partnership and establishment of seed villages.
- Research for better post-harvest management for enhancing the shelf-life of millets and prevention of wastage.
- Promote production and consumption of millets through mixed/ relay cropping with legumes and vegetables in homestead gardens.

Demand for millets can be increased by

Estimated demand for millets by 2025 is 30 million tonnes. This has to be met by increasing productivity through choice of better varieties, good agronomic practices, effective extension activities and robust policy initiatives.

- Creating awareness regarding their environmental sustainability, nutritional and other health benefits
- Making them available through PDS
- Value addition
- Inclusion under feeding programmes like mid-day meal, Integrated Child Development Services (ICDS) feeding, and adolescent girls nutrition.

Research priorities and policy initiatives

- Awareness regarding nutritional, health and environmental advantages may be created thorough known communication strategies.
- Multi disciplinary research may be pursued for validating the advantages of millets as health and functional foods.
- Traditional and non-traditional ready to use, convenience foods and foods that can be used for complementary feeding.
- R&D on millets as fodder and forage for livestock feed security may be strengthened.

CONCLUSION

In recent years there has been some effort towards reviving millets. Millets are drought, temperature and pest tolerant and hence are grains for the future in an environment of climate change and global warming. Despite these attributes, millets are losing their pride of place both in terms of production and consumption, for a variety of reasons, including policy initiatives which favor cereals. Though they have not enjoyed technological breakthroughs like the green revolution for cereals, their productivity has increased. Confined to poor lands, productivity is further affected and there is a wide gap between potential productivity and productivity in farmers' fields. Unlike cereals, primary processing of millets poses some problems for want of proper machinery, particularly for small and medium scale enterprises. In recent years, a variety of traditional and non-traditional, millet-based processed foods and complementary foods have been developed. These can become income- generation activity for women in household industry. Even while commercialization is needed, primary effort should be to see that millets are consumed by the poor and they are cultivated as mixed/relay cropping with legumes and vegetables in homestead gardens for home consumption to ensure household food and nutrition security.

Enation Leaf Curl Virus (ELCV) of Okra

Article id: 22489

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INTRODUCTION

Okra [*Abelmoschusesculentus*(L.)Moench] is an often cross pollinated crop commonly found in tropical and subtropical parts of world. It is highly sensitive to low temperature (below 10°C), frost and water-logging as well as drought conditions.A long time ago production of okra is quite vulnerable due to high prevalence of yellow vein mosaic virus (YVMV) disease which affects crop different growth stages (Verma, 1952) and causes unaccountable losses which ranges from 50 to 90% (Sastry and Singh, 1974). Presently enation leaf curl virus (ELCV) is an emerging viral disease of Indian subcontinent, which spreads at analarming rate. Lack of resistant sources in cultivated species has enforced breeders to show keen interest towards wild species for newresistance sources. However, transfer of resistance from wild species to cultivated ones is affected by crossability barrier. Henceforth, a search for new resistant sources and its utilization in various breeding programme.

Enation leaf curl virus (ELCV)

The virus is classified under the genus *Begomovirus*of family*Geminiviridae*(Venkataravanappa*et al*., 2015). Gemini viruses are characterized by their unique geminate particle and circular single-stranded (ss) DNA genomes which transmitted by the whitefly *Bemisiatabaci*and infect dicotyledonous plants (Lazarowitz and Shepherd, 1992). Viral genome consisting of two components, DNA-A and DNA-B; each of 2.6-2.8 kb.Monopartitebegomoviruses accompanied with a class of ssDNA satellites known as betasatellites (formerly known as DNA β). Betasatellitesare approximately half of the size of the begomoviruses which is essential for insect transmission, replication and its movement inside plant system (Saunders *et al*., 2000; Jose and Usha, 2003). The full-length DNA comprises of 1,350 nucleotides and shows a typical genome organization of beta satellite. The virus is transmitted by whitefly, and these are highly active during the morning hours (Venkataravanappa*et al*., 2015).

Symptoms of ELCV

Initially this disease causes small pin-head enations on the under surface of leaves which follows a warty and rough texture and later leaves start curling in upward manner.Affected plants show a twisted stem and lateral branches with leaves become thick and leathery. Plants showed stunted growth with fruits are small in size, deformed and unfit for consumption and marketing (Singh*et al.*, 1962; Sanwal*et al.*, 2014).

Epidemiology of ELCV disease

Hot weather with lesser amount of moisture isfavorable for virus disease development and also for the development of *Bemisiatabaci*. Temperature more than 30^{o}C increases the egg laying capacity but above 40^{o}C reduces the length of life cycle of *B. tabaci*less than two weeks.

Sources of ELCV disease resistance

There is no absolute and stable resistance sources of this disease found in cultivated species. Wild species such as (*Abelmoschusmanihot*,*A. ficulneus*, *A. angulosus*and *A. crinitus.)* are sources of resistance to ELCV (Singh *et al*., 2009).

CONCLUSION

The management of ELCV faces so much difficulty as there is no direct control measure for eradication of viral disease. So,early diagnosis of disease symptoms; control of vector for virus and removal of the affected plants are the best possible solution for management of the disease.

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Medicinal properties of dragon fruit

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INTRODUCTION

Dragon fruit, botanically *Hylocereus* sp., is a recently introduced exotic fruit in India. It belongs to cactaceae family. It got the name 'dragon fruit' from its attractive peel which appears like the skin of a dragon with red or yellow with green scales. It is also known with other common names like Pitaya, Strawberry Pear, Night blooming Cereus, Conderella plant, Belle of the night etc. Dragon fruit is native to South America from where its cultivation spread to SE Asia and is now a common fruit in China, Vietnam and Thailand.Apart from its pleasing colour and captivating flavour, it has immense nutritional value, which is a major factor for its demand.It is also commercially grown in other part of the world including in Israel, Taiwan, Vietnam, Australia, the United States etc (Perween *et al*., 2018). Under Indian condition the higher demand with lower production is leading to its higher price in the market.

Multifarious Uses of Dragon fruit

Apart from the fruits, various other plant parts of *Hylocereusundatus* arealso edible.Young stems and fresh flower buds are eaten as vegetablesand the dried forms are utilized for homemade medicine.Pitaya fruits are a rich source of protein, carbohydrate, vitamins and various minerals *viz*. Ca, Fe, P, Mg, K, Na, Zn *etc*.Ruzainah*et al*. (2009)reported that the premature stem of dragon fruit ishaving higher nutritional value as compared to the mature stem.Peel of the fruitscan be used as a natural colorant (Harivaindaran *et al*., 2008).The fruit peel, flower remains and stem can beused for medical applications such as fortreatment of fire-burn, toxic removal,healing of broken bone, antioxidant effect etc (Piga, 2004).Various plant parts can be used for production of value added processed products like wine form fruit pulp, jam from peel, soft drinks from plant stems, betacyanin extraction from peel, production of flower based tea etc. These products can be industrialized and commercialized for better waste material utilization and to make the crop more promising and remunerative for the growers (Dam, 2012).

Medicinal Properties and Bioactive Compounds

Dragon fruit is having immense medicinal properties. It helps in lowering the blood cholesterol and controlling blood pressure thus improving the cardiovascular health.Apart from this, it also helps in curing a number of stomach ailments including indigestion and constipation. It also increases the excretion of heavy metal toxins. But the intake of higher amount of dragon fruit of red-flesh can cause pseudohematuria(Ruzainah*et al*., 2009).Higher nutrient content of the fruit canlead to preventionof various diseases. Aging is caused due to the cellular damage because of exposure to free radicals. Rebecca *et al*. (2010), through antioxidant analysis, observed a significant higher antioxidant activity in dragon fruit. This presence of antioxidants helps the Dragon fruit to confer the anti-aging property. They identified the presence of betanin in the red dragon fruit (*Hylocereus polyrhizus*) using HPLC analysis. The abundance of vitamin-C helps in treatment of Acne. Apart from this, combination of vitamin-C and E promotes the skin health and protectsit against the sunburns and UV rays.It acts as anti-cancerous, prevents congenital glaucoma, reduces the arthritis painand improves appetite, vision, brain function, immunity and many more (Anon., 2019).Regarding the presence of

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various bioactive compounds in Dragon fruit, only a few reports are available.Apart from its lower calorific value and richness in vitamins and minerals, it is rich in polyphenols, betacyaninsand carotenoids. Seeds of Dragon fruit are a rich source of essential fatty acids including*omega*-3 and *omega*-6 fatty acids, and tocopherols also. Seed oil also contains higher levels of linoleic acid (Akram and Mushtaq, 2019).

CONCLUSION

There is a constant uprising in consumer's awareness towards thenutritional benefits of protective fruits.Apart from the delicious taste,Dragon fruitis a source of immense medicinal value which leading to increase in its market demand. Further there is a need to characterize the diverse germplasm of Dragon fruit for their medicinal and bioactive compounds.

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Mutation breeding in fruit crops

Article id: 22491

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INTRODUCTION

Dutch botanist Hugo De Vries coined the term 'mutation'. He defined mutation in a sequence of articles during 1910s (Shu*et al*., 2012).Mutation can be defined as sudden heritable change in the genetic material and thischange is not caused by recombination or segregation.The word "sudden" differentiate between the delicate changes that might be explained by the traditional processes of recombination.Apart from the phenotypic identification, mutation can be revealed using more relevant tools like the molecular meanse.g., SNPs. The individuals carrying mutation are known as mutants.Freisleben and Lein (1944) coined the term "mutation breeding" ('Mutationszüchtung') which concern to theconscious induction and development of mutants for crop improvement. Mutation is a very useful tool in fruit breeding, owing to the perennial nature of fruit crops which is a major bottleneck of traditional fruit breeding.Apart from increasing yield, mutations can also improve thesize, quality, taste, and can impart resistance/ tolerance to biotic and abiotic factors.

General Characteristics of Mutation

In general the mutations are recessive in nature. Mostly mutations cause harm to the plant species or organism while only small portion of mutationscan bebeneficial in nature.These mutations take place randomly in the genome of the host plant. It can be on any of the gene or at any place on the chromosome. However, theintrons (non-coding region) in the eukaryotic plant genome act as buffering to the mutations. Some mutations are having recurrent nature, they occur again and again in the organism.The frequency of mutation in nature is very low. It can be one in a million.They can reduce viability in the individuals. Based on the effects a mutation can be lethal, sub-lethal orvital mutation.

Types of Mutation

Mutation can be classified into two type *viz.* spontaneous or induced mutation. A spontaneous mutation occurs naturally in plant genome without any artificial treatment.These mutations are very rare and occur at low rate in the nature.The frequency may be one in a million i.e. 10^{-6}.In fruit crops these spontaneous bud mutation are more common in nature and are known as bud sports. Amongst the fruit crops, a large number of spontaneous mutants are available in banana, *Citrus* especially in grapefruit (*Citrus paradisi* Macf.)*viz.*Water (White Fleshed), Foster (Red Fleshed), Hudson (Red Fleshed), Marsh (White Fleshed), Thompson (White Fleshed), Ruby (Red Fleshed) *etc* (Nishiura, 1968). A list of some important spontaneous mutants in fruit crops is given in Table 1.

Table 1: List of various spontaneous mutants of fruit crops(Ray, 2002).

Fruit Crop	Existing Genotype	Mutant Genotype
Banana	Gros Michel	High Gate, Low Gate
	Poovan	Motta Poovan
	Virupakshi	Krishna Vazhai
Grape fruit	Walter	Foster
	Foster	Hudson
Mango	Rosado de Ica	Rosica
Mandarin	Owari	Clausellina
	Pongan	Pongan 86-1
Navel Orange	Washington	Autumn Gold, Powell Summer, Winter Red

Induced mutations are the artificialmutations which occur in the genome by treatmentwith mutagen. Mutagens are the agents, may be physical or chemical, used for induction of mutation. Among the physical mutagens (may be ionizing or non-ionizing), X-rays were the first to be used to induce mutations, however γ-radiation is mostly used (Table 2) (Lamo*et al*., 2017).Recent;y, Rime *et al.* (2019) reported that Ethyl Methane Sulfonate (EMS) at the concentration of 0.8 per cent can be used as aneffective mutagen to induce mutation in mango to inducedwarfness.

Application of mutation in fruit crops

The improvement of fruit species by traditional plant breeding techniques has several bottlenecks which includes high degree of heterozygosity, perennial nature accompanied with long juvenile period, self-incompatibility *etc*. Mutation breeding is a of particular importance in perennial fruit breeding owing to its lower time requirement, targeting or improving a particular trait of already established genotype etc. Any mutation (either spontaneous or induced) can be easily maintained in fruit crops as most of these are vegetatively propagated. Plant architecture, sexual incompatibly, seedlessness, perennial nature, long juvenility *etc.* can be targeted through mutation breeding in fruit crops (Lamo*et al*., 2017).However, the large area and time requirement for evaluation of mutants in fruit crops is another bottleneck. This can be overcome by using the *in vitro*mutagenesis technique accompanied with biotechnological tools for early detection of mutants. Molecular markers can also be used to identify with the change occurred at molecular level which ultimately result in the phenotypic changes. Under Indian condition, a notable example of induced mutant is PusaNanha papaya. This was developed by gamma rays (150 Gy) irradiation. This is anultra dwarf variety having dioecious nature.A list of induced mutants offruit cropscollected FAO/IAEA Mutant Varieties Database (up to November, 2019)is given in Table 2 (some selective mutants are shown).

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Table 2: List of variousinduced mutants of fruit crops (Predieri, 2001).

Fruit Crop	Mutant Genotype	Release Year	Mutagen Used
Apple	Belrene	1970	EMS
	Blackjoin BA 2 520	1970	Gamma rays
	McIntosh 8F-2-32	1970	Gamma rays
	Courtavel	1972	Gamma rays
	Courtagold	1972	Gamma rays
	Golden Haidegg	1986	Gamma rays
	James Grieve Double Red	1995	Gamma rays
Banana	Novaria	1993	*In vitro* mutagenesis using Gamma rays
	KlueHom Thong KU1	1985	*In vitro* mutagenesis using Gamma rays
Ber	Ma Hong	1986	MNH
Clementine	Nero	2006	Fast neutron
Fig	Bol	1979	Gamma rays
Grape	Fikreti	1986	Gamma rays
Grapefruit	Star Ruby	1970	Thermal Neutron
	Rio red	1984	Thermal Neutron
Japanese pear	Gold Nijisseiki	1993	Gamma rays
	Kotobuki Shinsui	1996	Gamma rays
Kinnow	PAU Kinnow-1	2017	Gamma rays
	NIAB Kinnow	2017	Gamma rays
Papaya	PusaNanha	1986	Gamma rays
Peach	Plovdiv 6	1981	Gamma rays
Pomegranate	Karabakh	1979	Gamma rays
Sweet Cherry	Compact Lambert	1964	X-rays
	Burlat C1	1983	Gamma rays
	Nero II C1	1983	Gamma rays
	Ferrovia spur	1992	X-rays
Sweet Orange	IAC 2014	2016	Gamma rays
Strawberry	Himatsuri	1995	Somaclonal mutation trough meristem culture

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CONCLUSION

Mutation breeding is an important tool in fruit crop improvement. It can be used to improve various aspects like change in plant architecture, sexual incompatibly, induce seedlessness etc.Mutation breeding accompanied with biotechnological tools can be used to improve the efficiency of fruit breeding.However, till recentmutation breeding need more exploitation for efficientfruit crop improvement.

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Changing role of millets in food and nutritional security of India

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INTRODUCTION

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food. Millets are important food and fodder crops in arid and semi arid regions, and are predominantly gaining more importance in a world that is increasingly becoming populous, malnourished and facing large climatic uncertainties. These crops are adapted to wide range of temperatures, moisture-regimes and input conditions supplying food and feed to millions of dry land farmers, particularly in the developing world. Besides they also form important raw material for potable alcohol and starch production in industrialized countries.

The term millet includes a number of small-grained cereal grasses. Based on the grain size, millets have been classified as major millets which include sorghum and pearl millet and several small grain millets which include finger millet (ragi), foxtail millet (kangni), kodo millet (kodo), proso millet (cheena), barnyard millet (sawan) and little millet (kutki). Millets are hardy and grow well in dry zones as rain-fed crops, under marginal conditions of soil fertility and moisture and are stable yielders. India is the largest producer of millets in the world. Rajasthan is the largest producer of pearl millet whereas Karnataka is the leading producer of finger millet.

Millets for food and nutritional Security

Nutrition security implies awareness and access at affordable cost to balanced diet, safe environment and drinking water and health care outreach. Millets were indeed one of the oldest foods known to humans but they were discarded in favor of wheat and rice with urbanization and industrialization. With diabetes, hypertension and cardiovascular disease running rampant, as gifts of newly acquired life-styles, millets have returned as a viable option to live healthy life without consuming loads of anti-diabetic and anti-hypertension medicines that are not only very expansive but also have serious side-effects in the long run. Millets are a treasure-trove of micronutrients like B-complex vitamins and minerals whose deficiencies in India are rampant. Additionally millets are also rich in health promoting phyto-chemicals, and can be used as functional foods. Indeed millets act as a prebiotic feeding micro-flora in our inner ecosystem. Millet will hydrate our colon to keep us from being constipated. The high levels of tryptophan in millet produce serotonin, which is calming to our moods. Magnesium in millet can help reduce the affects of migraines and heart attacks. Niacin (vitamin B3) in millet can help lower cholesterol. Millet consumption decreases Triglycerides and C-reactive protein, thereby preventing cardiovascular disease. All millet varieties show high antioxidant activity. Millet is gluten free and non allergenic. They also contain fibre and health promoting phyto-chemicals which function as antioxidants, immune stimulants etc., and thus have potential to mitigate degenerative diseases such as diabetes, CVD, cancer etc. whose incidence is rising in India. Unfortunately some of these phyto-chemicals like fibre, phytates and tannins interfere with the bioavailability of micronutrients particularly minerals. Processing can improve the bioavailability of nutrients as well as functionality. Limited studies show that bioavailability as well as functionality differs with the type of processing and preparation. More work is needed to optimize both of these.

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Versatility of millets

Millet cultivation is the mainstay of rain-fed farming on which 60% of Indian farmers depend. They provide food as well as fodder and can be mix-cultivated (polyculture) with pulses and vegetables. Despite these attributes, millets are losing their pride of place in production and consumption in India. In addition to being used for seed, millet is also used as a grazing forage crop. Instead of letting the plant reach maturity, it can be cut and fed to animals or grazed by stock and is commonly used for sheep and cattle. Millet is a C4 plant, which means that it has good water-use efficiency and utilizes high temperature and is therefore a summer crop. A C4 plant uses a different enzyme in photosynthesis from C3 plants, and this is why it improves water efficiency. The advantages of cultivation of these crops include drought tolerance, crop sturdiness, short to medium duration, low labour requirement, minimal purchased inputs, resistance to pests and diseases. Millets are C4 crops and hence are climate change compliant. There are varieties particularly in little millet and proso millet which mature in 60-70 days; yet providing reasonable and assured harvests even under most adverse conditions. India is a store-house of highly valuable genetic variability. Millets sequestrate carbon and thereby reduce the burden of green house gas.

Issues pertaining to production

Though India is the largest producer of millets in the world, between 1961 and 2019, there has been drastic reduction in the area under cultivation of millets but due to productivity gains in some varieties, total production of millets showed some increase despite shrinkage of area. Almost 50% area under millets has been diverted largely to soybean, maize, cotton, sugarcane and sunflower. A combination of factors like low remuneration as compared to other food crops, lack of input subsidies and price incentives, subsidized supply of fine cereals through Public Distribution System (PDS), and change in consumer preference (difficulty in processing, low shelf life of flour and low social status attached to millets), have led to shift from production of millets to other competing crops.

Strategies for increasing production

- Development of varieties/hybrids with better recovery capacity on reversal of dry spell for harsh environment/drought prone areas.
- Development of hybrids/varieties resistant/tolerant to salt/high temperature.
- Effective deployment of trait-specific germplasm available in gene banks for genetic enhancement.
- Exploration of zero tillage for millets under rice fallows particularly for southern States.
- Better agronomic management and scientific method of cultivation giving priority to resource conservation.
- Strengthening breeding programmes through conventional breeding, marker-assisted breeding as well as biotechnology for bio-fortification.
- Validation of high productive technology under real farming situations.
- Evolving strategies for better seed production with public, private, NGO partnership and establishment of seed villages.
- Research for better post-harvest management for enhancing the shelf-life of millets and prevention of wastage.
- Promote production and consumption of millets through mixed/ relay cropping with legumes and vegetables in homestead gardens.

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Demand for millets can be increased by

Estimated demand for millets by 2025 is 30 million tonnes. This has to be met by increasing productivity through choice of better varieties, good agronomic practices, effective extension activities and robust policy initiatives.

- Creating awareness regarding their environmental sustainability, nutritional and other health benefits
- Making them available through PDS
- Value addition
- Inclusion under feeding programmes like mid-day meal, Integrated Child Development Services (ICDS) feeding, and adolescent girls nutrition.

Research priorities and policy initiatives

- Awareness regarding nutritional, health and environmental advantages may be created thorough known communication strategies.
- Multi disciplinary research may be pursued for validating the advantages of millets as health and functional foods.
- Traditional and non-traditional ready to use, convenience foods and foods that can be used for complementary feeding.
- Millet-based complementary foods such as khichdi, upma, roti etc. in feeding should be introduced in feeding programmes such as MDM, ICDS etc.
- R&D on millets as fodder and forage for livestock feed security may be strengthened.

CONCLUSION

In recent years there has been some effort towards reviving millets. Millets are drought, temperature and pest tolerant and hence are grains for the future in an environment of climate change and global warming. Despite these attributes, millets are losing their pride of place both in terms of production and consumption, for a variety of reasons, including policy initiatives which favor cereals. Though they have not enjoyed technological breakthroughs like the green revolution for cereals, their productivity has increased. Confined to poor lands, productivity is further affected and there is a wide gap between potential productivity and productivity in farmers' fields. Unlike cereals, primary processing of millets poses some problems for want of proper machinery, particularly for small and medium scale enterprises. In recent years, a variety of traditional and non-traditional, millet-based processed foods and complementary foods have been developed. These can become income- generation activity for women in household industry. Even while commercialization is needed, primary effort should be to see that millets are consumed by the poor and they are cultivated as mixed/relay cropping with legumes and vegetables in homestead gardens for home consumption to ensure household food and nutrition security.

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Multidisciplinary epidemiological approaches in plant disease management

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Plant diseases always have a serious impact on the yield of the crop and it also possesses a major threat to agriculture and world food security. Forecasting of plant disease has become considerably important in the present day situation in India and other agriculturally advanced countries due to somewhat increasing food production strategies. Significant losses in terms of both quantitative and qualitative perspective in most of the agricultural and horticultural crops as a result of an attack by the pathogens. Epidemiology of plant diseases plays a key role in plant disease management in several ways. Modern agriculture being cost oriented requires greater vigilance than before to ensure stable and good quality yields and reducing expenditure on all types of inputs including chemicals for disease management. This is possible only if reliable disease forecasting systems are developed. Plant disease epidemiology includes study of factors like temperature, moisture, humidity and precipitation *etc.* that are influencing the pathogen either positively or negatively depending on the requirement of pathogen for a particular kind of condition. These epidemiological studies are important for the management of the plant diseases as the obtained data can be processed and transformed into technologies for the management of pathogen.

Epidemiology is a science of disease in a population (Vanderplank, 1963). Plant disease epidemiology has been defined as the study of factors that affect the spread of disease in time and space (Madden *et al.,* 2007). Plant disease epidemiology is often looked at from a multi-disciplinary approach, requiring biological, statistical, agronomic and ecological perspectives. Nonetheless, some aspects of theoretical epidemiology are conceptual in nature (Jeger, 2000). Plant disease epidemics are the outcome of the interaction of host and pathogen populations, along with the favorable conditions necessary for the onset and spread of disease continuing for a certain time period. Plant diseases result in epidemics only in case if there is a favorable shift in the host pathogen environment interaction *i.e.* a shift towards the pathogen/disease. Through the study of host factors, pathogen factors and environmental factors, a lot of information can be collected regarding disease management and spread. This data can be further used for developing a suitable plant disease management strategy. Recently, epidemiology has also been used for predicting the effects of climate change on plant disease (Garrett *et al.,* 2006). Weather data generated from climate change models have been used to predict change in geographic range and/or severity of several diseases including rice leaf blast caused by *Pyricularia oryzea* (Luo *et al.,* 1998), oak disease caused by *Phytophthora cinimomi* (Bergot *et al.,* 2004), grape downy mildew caused by *Plasmopara viticola* (Salinari *et al*., 2006) and several forest diseases in France (Desprez-Loustau *et al.,* 2007)

Epidemiological approaches in plant disease management

(a) Inoculum based prediction- forecasting of many disease is based on the estimates of amount of initial inoculum likely to infect the host plant at the beginning of a crop season. In many cases there is a positive correlation between the amount of primary inoculums in vicinity of host plant and severity of infection. Disease relationship For instance, the number of primary inoculums can help us in predicting disease by disease forecasting. This inoculums density-disease relationship is more significant in case of monocyclic diseases where there exists a strong direct relationship between inoculums density and disease whereas in case of polycyclic diseases this relationship can be applied only to the initial stage, instead the overall disease development relies upon the other two factors, *viz.* infection rate and duration of disease development. Plant disease forecasting can be based on the amount of inoculum available in air, soil or planting material.

(b) Crop based modelling in Plant Pathology- computers have allowed plant pathologist to write programmes that allow simulation of epidemics of several plant disease. First computer simulation program called (EPIDEM) was developed and was designed to simulate early blight of tomato and pototo caused by *Alternaria solani*. Later on, (MYCOS) for Microspherella blight of cryanthemums, for apple scab caused by *Venturia inaequalis* (EPIVEN) and for southern corn leaf blight infected by *Helminthosporium maydis* (EPICORN). (BLIGHTCAST) in the USA is providing warnings on a short term basis for late blight attacks on potato. The computer evaluates not only the current status of the disease but also the effectiveness of applied management measures in controlling the epidemic.

(c) System approach and expert systems in epidemiology- Conceptual models are the first step in model-building and aim at sensibly arranging available information or processing thoughts for a critical analysis. System analysis in Plant Pathology has become evident as a sub-discipline of epidemiology where through system approach the goal of plant disease management is achieved. Expert systems are the systems combining plant pathology and art of diagnosis and disease management. Weather is an important factor that influences disease development. Where the host and pathogen coincide, weather is the only variable that influences epidemic development. Therefore, by monitoring relevant weather parameters and relating them to disease development, empirical prediction models can be developed. Some of those models are Van Everdingen's method (1926) was the first to base his forecasting system for late blight of potato on scientific principles. Thereafter Beaumont and Stainland's method (1934) and Cook's 7 day moving graph (1947, 1949) were implement for blight forecast of potato and tomatoes. It's suggesting site-specific recommendations ensuring judicious use of resources for optimum yields along with maintaining environmental safety.

(d) Remote sensing and its applications- The use of innovative technologies like 'Remote sensing' holds promise in agricultural crop production including crop protection. It is a rapid, non-invasive and efficient technique which can acquire and analyze spectral properties of earth surfaces from various distances, ranging from satellites to ground-based platforms. Remote sensing has emerged one of the most promising tools for disease surveys pertaining to plantation crops and forests due to their spread to a vast area. It's also suitable for other large tracts grown crops like wheat, rice and other plantation crops. The satellite technology together with image analyzing computer tool is serving as an aid for monitoring pest populations over large global areas. Plant disease surveys may serve as a basic guide to disease progress that assists in fixing priorities. Moreover, it may act as a forewarning for certain steps to be taken. It also explains the effect of varying agricultural technologies, especially management tools.

(e) Weather and host physiology based prediction- The study of the variability of the pathogen population can assist us in adopting appropriate breeding strategies and development of varieties. Padmanabhan (1965) used weather analysis for predicting outbreaks of blast of rice. Nagarajan *et al.,* 1980 correlated the epidemics of

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wheat rusts of India with the prevalence of certain environment condition at certain places in the country during crop season. Resistant crop cultivars will require lesser fungicides use as compared to susceptible ones. The study of vector behavior can be effectively utilized to manage plant diseases (e.g. Stewart's corn wilt, potato virus). There is a need-based and judicious use of fungicides when forecasting diseases making the actions biologically and economically justified and environmentally safe. Contact fungicides (sulfur dust, mancozeb, copper oxychloride etc) are effective as prophylactic while systemic ones (Tilt, Bavistin *etc.*) as eradicative and curative sprays. The overall information available about pathogen and disease should be used for developing IPM programme along with keeping local conditions under consideration.

CONCLUSION- Establishment of disease forecasting services in India is a must for important disease of vegetables, fruit and food crops. In India, priorities have to be decided on the type of disease that needs to be considered for forecasting. There is a great scope and necessity to develop this branch which is, not only useful to farmers but also intellectually stimulating. Plant disease epidemics are dynamic in nature and any change in a determinant factor like weather effect on disease development, pathogen factor, host factors etc can compromise the efficiency of management practices. Epidemiological studies provide information on various aspects of disease development. As a result, this data can be further utilized for developing a suitable strategy for disease management. So it can be concluded that plant disease epidemiology is challenging, interesting, important and worth studying in its own right and some more new insights can help in developing most suitable strategies for plant disease management.

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Potential role of humic substances in modifyingproperties of soil

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INTRODUCTION:

There is a growing awareness among farmers about the importance of soil for sustainingcrop production and soil health. A widerange of commercial humicsubstances are used as soil supplements to improve thenutrient utilization efficiency of plants as well as to increase crop production. Organic matter is defined as a grouping of carbon containing compoundswhich have originated from living beings and deposited on or within the earth's structuralcomponents. Soil organic matter includes the remains of all plant and animal bodies whichhave fallen on the earth's surface or purposely applied by man in the form of organicallysynthesized pesticides. A fertile soil should contain from 2.8% organic matter, most soilscontain less than 2% organic matter. In acid, leached soils, which are often sandy, substantial portions of theorganic matter is in the form of plant debris and fulvic acids (FAs). In neutral and alkaline soilsa large percentage of the organic matter is present in the form of humic acids (HAs) andhumin.

Humic substances:

Humic substances are the components of humus and as such are highmolecular weight compounds that together form the brown to black hydrophilic, molecularlyflexible, polyelectrolytes called humus. Many of the components of humus are heterogenous,relatively large stable organic complexes. They function to give the soil structure, porosity, water holding capacity, cation and anion exchange, and are involved in the chelation of mineralelements. The elemental analysis of humic substances reveals that they are primarilycomposed of carbon, oxygen, hydrogen, nitrogen and sulphur in complex carbon chains. Humic substances can be subdivided into three major fractions
(1) Humin (2) Humic acids (HAs) and (3) Fulvic acids (FAs).
Fourth one minor fraction i.e. Ulmic Acid which is soluble in alkaline also known as Hymatomelanic acid. These sub divisions are arbitrarily based on the solubilityof each fraction in water adjusted to different acidic and alkaline conditions.

1. **Humins:** are the fraction of humic substances which are neither soluble in alkali i.e. at high pHnor in acid i.e. at low pH.Humins are not soluble in water at any pH.Humincomplexes are considered macro organic substances because their molecularweight range from approximately 1,00,000 to 10,000,000.
2. **Fulvic acids:** A term of varied usage but usually referring to the mixture of organic substance remaining in solution upon acidification of a dilute alkali extract of soil,some other term is Fulvic acids (FAs) are a mixture of weak aliphatic and aromatic organic acids which are soluble in water at all pH conditions (acidic, neutral and alkaline). Their composition and shape is quite variable. The size of fulvic acids are smaller than humicacids,
3. **Humic acids:** Humic acid is major constituent of humic substances which are dark brown and major constituents of soil organic matter humus that contributes to soil chemical and physical quality and are also precursors of some fossil fuels.A term of varied usage but usually referring to amixture of indefinite composition of dark-coloured organic substances precipitated upon acidification of a diluted alkali extract

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of soil. Humic acids (HAs) comprise a mixture of weak aliphatic (carbon chains) andaromatic (carbon rings) organic acids which are not soluble in water under acid conditions butare soluble in water under alkaline conditions.Humic acid has the average chemical formula $C_{187}H_{186}O_{89}N_9S_1$ and is insoluble in strong acid (pH 1). A 1:1 hydrogen to carbon ratio indicates a significant degree of aromatic character (i.e., the presence of benzene rings in the structure), whereas a low oxygen to carbon ratio indicates fewer acidic functional groups than occur in fulvicacid.

Effects onsoil properties:

Physical Property

1. Very small clay particles called floccules, along with charged organic humic acids form bonds that permit greater stability and persistence within the soil matrix composed of much large aggregates leading to formation of blocks that improve the circulation of water and air around the roots.
2. As organic matter increases, which enhances water holding capacity of soil.
3. Improves the soil structure and increases aeration of soil leading to better workability.
4. The darker color imparted leads to greater absorption of solar energy providing warmer sub soil temperature.

Chemical property

1. Serves as a buffer to neutralize both excessive soil acidity and alkalinity ensuring that nutrient ions are not rendered insoluble and unavailable to the plant.
2. Serves to strongly bind aluminum to reduce toxic effects.
3. Improves both the uptake and retention of vital nutrients.
4. Accelerates decomposition of soil minerals.

Biological property

1. Various growth regulators, vitamins, amino acids, auxins and gibberellins are formed as organic matter decays just enhancing growth.
2. Stimulates root development.
3. Enhances natural resistance against many diseases.
4. Stimulates overall plant growth by increasing microbial like by up to 2000 times in just a few weeks.

CONCLUSION:

Soil is the main target for application of humicsubstance, given their well-known role as soil supplements and different soil properties. Stimulatory positive effect of humic substances on different physical, chemical and biological properties of the soil like soil aggregation,enhances water and nutrient availability, microbial biomass, formation of different vitamins and growth regulators.Humic substances maintain and enhances the soil quality.

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Major physiological disorders of Litchi (*Litchi chinensis* Sonn.)

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INTRODUCTION

Physiological or a-biotic disorders are mainly caused by changing environmental conditions such as temperature, moisture, unbalanced soil moisture, inadequate or excess of certain soil minerals, extremes of soil pH and poor drainage. The distinction between physiological or abiotic disorders from other disorders is that they are not caused by living organisms (viruses, bacteria, fungi, insects, etc.), but they are the result of abiotic situations (inanimate)i.e. their agents are non living in nature which causes deviation from normal growth. They results in physical or chemical changes in a plant which is far away from what is normal and is generally caused by an external factor. Non-infectious disorders in some cases are easy to identify, but others are difficult or even impossible to recognize. Most of them are non reversible once they have occurred. For the identification of physiological disorders it is important that one must know that:

- Physiological disorders are often caused by the deficiency or excess of something that supports life or by the presence of something that interferes with life.
- Physiological disorders can affect plants in all stages of their development.
- They are non transmissible because they occur without or in absence of infectious agents.
- Plant reacts differently to the same agent and sometimes response in seen as a little reaction to death.

1. Fruit cracking: The splitting or cracking of fruits is quite common in almost all the litchi growing areas of India, particularly under dry conditions. In severe cases; the drop losses due to this malady may be as high as 50% or even more. Skin cracking of developing fruit is a serious problem in litchi which results in impaired quality fruits unfit for consumption.

Causes: Splitting of fruits has been generally attributed to abrupt changes in atmospheric temperature, relative humidity and soil moisture conditions, following rain or heavy irrigations. The disorder is noted shortly before maturity when prolonged period of drought during which the fruit growth is checked, is followed by excessive moisture supply. Excessive soil moisture aided by fluctuations in temperature and humidity may aggravate fruit splitting. Temperature higher than 38°C in combination with relative humidity lower than 60% are very favourable for cracking of litchi fruits.

Control

- Regular irrigation in the orchard helps in maintaining growth and expression in the fruit.
- Frequent irrigation during the critical period of aril growth, spraying of zinc sulphate (1.5%) at weekly intervals, starting from pea stage of fruit to harvest reduces the incidence of fruit cracking.
- In the absence of rains during summer months, water spray may prove useful in keeping the ambient atmosphere of the fruit humid, as moisture has a good local effect on the fruit against splitting.
- The litchi plants should be trained to keep low headed. Such trained plants having dense foliage can withstand more hot and desiccating winds as compared to tall trees reducing the fruit cracking.
- Windbreak with one or two rows of tall trees e.g. Safeda alternating with small sized trees having dense foliage (mulberry, jamun etc) may be planted around the orchard.

- Early varieties like Dehradun and Saharanpur split more than mid season or late varieties. Hence, the varieties which are less prone to splitting should be planted.
- Apply some mulch to the tree basins during hot summer months to conserve soil moisture.
- Spray of NAA and 2, 4, 5-T @ 35-100 ppm has been found effective in checking fruit splitting and increasing fruit size.
- Spray of Borax (0.8%) during the fruit growth period is useful to control fruit cracking.

Fruit cracking

Fruit drop

2. Fruit drop: Fruit drop is considered one of the major bottlenecks in the expansion of litchi cultivation in our country. The initial fruit set in litchi is very high but a very small proportion finally matures. The premature fruit drop commences soon after fruit set and continues till fruit maturity, with most fruit abscising in the 2-4 weeks.

Causes: High incidence of fruit drop in litchi is mainly stated as physiological rather than a genetic problem.

- Competition among fruits for water and nutrients.
- Strong desiccating winds.
- Failure of fertilization.
- Embryo abortion.
- Internal nutrition.
- Hormonal imbalance.
- External factors like high temperature and low humidity.

Control

- Grow varieties like Seedless Late and Calcuttia which are less prone to fruit drop than Dehradun and Muzzafarpur which are more prone to fruit drop.
- Irrigation to bearing litchi trees twice a week from April onwards and good wind break minimize fruit drop to a great extent.
- Foliar spray with zinc sulphate at 0.5-1.0 and 1.5% considerably increase the zinc content of the leaves and effectively reduce fruit drop.

- Spray of NAA and 2, 4-D @ 15 ppm in combination with 1% zinc sulphate results in more fruit retention till harvest.

3. Sunburn: It is a major issue in litchi production in India which poses a threat to growers almost every year. The time of fruit colour change (about 1 month before harvest) is the most vulnerable stage for sunburn. 'Sunburn' means a condition on the surface of the skin of a litchi giving it a yellow, brown or black colour and which is caused by excessive exposure to the sun. Sunburn of the fruits can be minimized with proper water management and protecting the fruits with shade nets at least 30 days before harvesting.

CONCLUSION:

Factors responsible for physiological disorders such as relative humidity, atmospheric conditions, cold injure and frost, wind injury, chemical injury, physical soil problem, nutrient deficiency or excess, etc.

Physiological disorders are often caused by the deficiency or excess of something that supports life or by the presence of something that interferes with life.

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Pesticide Resistance and its Management in Insect Pests

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INTRODUCTION

Crop protection is an essential component of current and future food security which aims to control the pests. With the evolution of resistant insects, pathogens and weeds the effectiveness of pesticides is reduced. Insecticide resistance existsin a wide range of insects and the problem extended to all major groups of insecticides. Pesticides are novel compounds which are synthetic, yet target species are often able to evolve resistance soon after the introduction of a new compound.

Pesticide resistance: It is the ability of a particular strain of insects to tolerate pesticide toxicity which would prove lethal to the majority of individuals of the same species (WHO).

Pesticide resistance at a population level is noticed in few individual pests within a species, can occur after repeated exposure of particular compound. Some insects with resistance genes survive and pass the resistance trait on to their offspring. The proportion of resistant insects in a population continues to increase; on the other hand, the susceptible insects are eliminated by the insecticide. The new resistant biotype with the ability to survive for toxicant becomes the dominant biotype of the pest population.

Resistance is most common in Diptera (34%), Lepidoptera (15%), Mites (14%), Coleoptera (13%), Homoptera (11%). Many insects includes Western corn rootworm to cyclodienes, Indian meal moth to malathion and *Bacillus thuringiensis*, Red flour beetle to malathion, Horn fly to pyrethroids, Codling moth to the organophosphates, Corn earworm (*Helicoverpa zea*) to pyrethroids, American bollworm *Helicoverpa armigera*to pyrethroids, Diamondback moth (*Plutella xylostella*), Tobacco budworm (*Heliothis virscens*), Greenhouse whitefly, Colorado potato beetle, House fly and *Anopholes* mosquitoes to many insecticides.

Resistance factor: The intensity of resistance of a population or strain of insects to a particular insecticide is frequently quoted as the Resistance Ratio or Resistance Factor.

$$\text{Resistance factor } = \frac{\text{LD50 of field strain}}{\text{LD50 of susceptible strain}}$$

Types of resistance

Cross resistance: It involves only one mechanism which confers resistance to more than one pesticide.Example: *kdr* resistance to DDT and pyrethroids in the house fly and some mosquitoes.

Multiple resistance: It involves more than one mechanism to more than one insecticides. Examples: Colorado potato beetle, house fly, tobacco budworm, diamondback moth and certain Anopheles species are resistant by separate mechanisms to four or more classes of insecticides.

Causes of Insecticide resistance

1. **Metabolic resistance** is the most common mechanism. Insects use detoxifying enzymes or metabolizing enzymes to detoxify the insecticides. Resistant strains may possess greater levels or more efficient

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forms of these enzymes. The enzymes that detoxify pesticides include mono-oxygenases, mixed function oxidases, cytochrome P-450 dependent oxidases, hydrolases (esterases) andglutathione-S-transferase.

2. **Altered target-site resistance** is a form of resistance caused by a change in the structure of the site or the number of sites where the pesticide causes toxicity to the insect. Some DDT, organophosphate and pyrethroid failures are due to target-site resistance.
3. **Target site insensitivity:** The insecticide penetrates the insect cuticle not metabolized rapidly and does not kill the pest, but the target site is insensitive. The *kdr* gene in Diptera reduces the sensitivity of sodium channels to chlorinated hydrocarbons and pyrethroids are the known target site insensitivity in insects.
4. **Penetration resistance** can protect insects from a wide range of insecticide molecules. Generally, it reduces the penetration rate of insecticide to the insect's cuticle. It happens when insects, such as the housefly, *Musca domestica* can slowly absorb the chemicals into their bodies because their outer cuticle has developed with the barriers against the products.
5. **Behavioral resistance** occurs when insects or mites are able to evade contact with insecticides through avoidance. Insects may quit feeding if they come across certain insecticides or leave the area where spraying occurred (move to the underside of a sprayed leaf or move deeper in crop canopy or fly away from the target area).

Insecticide resistance management: Early detection and rapid assimilation of the resistance problem effectively manage the pest population.IRM aims to alter the selection pressure so that increases in the frequencies of resistance genes can be arrested or slowed.

1. Use of compounds that confer low level of resistance, especially the compound that favors low discrimination between the genotypes and delays the evolution of resistance.
2. Rotation of insecticides so that not all generations of the species are exposed to the same kind of chemical.
3. Use of short residual chemicals and avoiding slow release formulations so that only the target pest population is killed and subsequent colonizers are not affected.
4. Treatment to the most vulnerable life stage. Some resistance mechanism is poorly expressed in a particular life stage of the pest. Eg. Both pyrethroid resistant and susceptible *H.armigera* neonates killed by fresh deposits of pyrethroids.
5. Use of synergists to suppress detoxification mechanisms. It is applicable and effective only when R is due to a single mechanism. Eg. DDT + toxaphene, Chlordimeform + Pyrethroids, SP + PBO.
6. Less frequent application of insecticides, so that susceptiblehas a chance to reproduce and to dilute resistance by interbreeding with resistant individuals.

Resistance management strategies

1. Minimize the selection pressure: To keep susceptible insects alive and the genes of susceptibility are a valuable natural resource that should be maintained to reduce resistance. It includes avoiding unnecessary treatments, using the lowest possible effective rates, shortest effective residual, apply at local instead of area-

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wide treatments and use of other control measures whenever possible, it may be a cultural practiceor host plant resistance.

2. Kill the developing resistant population: It includes the high dose strategy (well-chosen dose to kill rare heterozygotes) or application along with synergists to neutralize resistance in case of metabolic resistance.

Pesticide resistance in insects is animportant concern in the agrarian country.It is necessary to understand the processes that mediate the development of resistance and there is a need forconcerned research on the mechanisms conferring resistance to novel chemical groups to combat the future threat. The combination of two or more alternative control methods or a combination of conventional chemical insecticides may be considered as a sustainable long-term strategy.

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Bioluminescence insects and its significance in entomology

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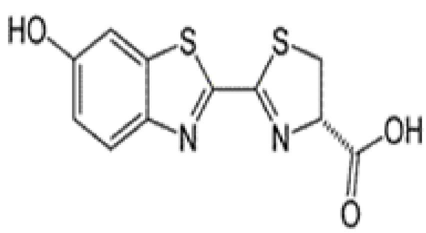
Bioluminescence

The production and emission of light by a living organism is known as bioluminescence which is known to be a one of the oldest and interesting field of scientific study. In Greek word 'bios' means life or living matter and Latin word 'lumen' means light and 'essence' means process that changes a state. It is a biological process which occurs naturally werethe energy is released by a chemical reaction in the form of light emission.The organisms like bacteria, fungi, mushroom, phytoplankton, marine protista, annelids, mollusks, centipedes, millipedes, crustacean and chordates exhibits luminescence. Apart from this, someof the unique insects also exhibits light. Though bioluminescence is generated by various organisms, it is highly developed in insects which play a significant role in courtship, predation and defense. Moreover, there are no luminous flowering plants, birds, reptiles, amphibians or mammals in nature.

Chemical reaction of bioluminescence

The chemi-luminescence or chemical reaction can occur either inside or outside the cell. Bioluminescent creatures produce the chemical luciferin (a pigment) which is catalyzed by the enzyme luciferase. Luciferases perform this reaction several hundred times per second and it continues until all the luciferin is consumed. In an ATP-dependent form, luciferin is activated by enzyme luciferase and for msluciferin-adenylyl intermediate; when oxygen is present this intermediate is rapidly converted to a peroxyluciferin product that decays to oxyluciferin with the emission of photons.One photon of light is produced for each molecule of luciferin consumed.

Structure of Luciferin



Bioluminescence in insects

The true or self-luminescence are found in some of the terrestrial arthropods groups. The order Coleoptera constitutes the largest bioluminescent group in which several hundred species are known to contain highly developed photogenic organs which includes fir fly (Lampyridae), click beetle (Elateridae), railroad worms (Phengodidae), rove beetle (Staphylinidae) and other related families, used mainly for mating and defense functions. The light emission is also best known in dipteran (fungus gnat), Homopteran (lantern fly) and Collembolan (spring tail).

The fungus gnat males orient towards adult female and pupal lights to locate mates and the maggot creates light to illuminate their habitat and attract potential food. However, the firefly luciferin is the pigment found in many lampyridae species which is responsible for the characteristic yellow light emission from fireflies. In some lampyridae species female are wingless and sedentary, light production is therefore important for attracting the winged male.

Table 1: Bioluminescent color variation in insect

Insect groups	Color variations
Phengodids (Glow worms)	Paired green lights on each segment and redlights at the end
Mycetophilidae (*Arachno campa*)	Blue green light
Fulgoridae (Lantern fly)	White light
Lampyridae (*Photinus*and *Lampyris*)	Yellow-green in color (520-650 nm)
Phengodidae (*Phrixothrix*)	Larval and adult female, thorax and abdomen produce green to orange light (530-590 nm), on head produces red light (580 nm to over 700 nm)

Bioluminescence in entomological research

This biological phenomenon has been exploited in entomological research mainly in insect pest management. It can be used as a tool for mapping insect distributional patterns. During the year 2001, the researchers from USA attempted the fluorescence technique in key pest of cotton. They modified the genetic material of the pink bollworm with green fluorescent protein (GFP) derived from the bioluminescent hydrozoan jellyfish, *Aequoravictoria.*

The modified or GFP transgenic pink bollworm strain fluoresces strongly green when observed in its larval stage which aims to be employ in the field performance studies and to map the distribution of the pest. In addition to this,they also targeting temperature-sensitive lethal gene along with the GFP gene for the effective pest management.Bioluminescence plays an integral role in the natural environment and the unique feature of light production in certain organisms may have certain implications for use in the modern world.

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Organic Farming: Problems and Prospects in Indian context

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Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity (FAO). It emphasizes, the use of off–farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.

INTRODUCTION

The Green Revolution technologies promoted input intensive approaches to achieve food self-sufficiency (Das *et al.,* 2017). This chemical intensive agriculture without adding adequate quantities of organic manures led to decline in the factor productivity, deterioration of soil health, environmental pollution, decline in biodiversity, health hazards and ultimately the ecological un-sustainability threatening the future prospects of mankind and other living being on the planet (Shetty *et al.,* 2014). There is an urgent need to re-orient agricultural production systems in ways that balance food production with environmental and resource sustainability to achieve food security and safety. Organic farming is one of the viable methods, which avoid the ill effects of chemical farming. This system maintain long term soil biological activity, ensure effective crop management, recycle wastes to return nutrients to the land provide attentive care for farm animals and handle the agricultural products without extraneous synthetic additives.

Principles of Organic Farming

The principles of organic agriculture serve to inspire the organic movement in its full diversity. They are the roots from which organic agriculture grows and develops. The International Federation for Organic Agriculture Movement's (IFOAM) definition of Organic agriculture is based on following principles:

i) Principle of health

Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out the health of ecosystems as healthy soils produce healthy crops that foster the health of animals and people. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

ii) Principle of ecology

Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help to sustain them. It states that production is to be based on ecological processes, and recycling. Organic agriculture should attain ecological balance through the farming systems, and maintenance of habitats, genetic and agricultural diversity.

iii) Principle of fairness

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Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty.

iv) Principle of care

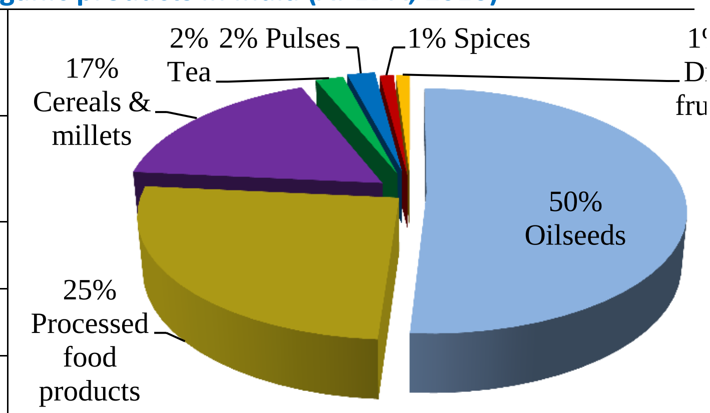
Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being.

Present status of organic farming in India

The total area under organic certification in India is 5.71 million hectare including 26% cultivable area and rest 74% forest and wild area (Table 1). Among all the states, Madhya Pradesh has covered largest area (40% of total area) under organic certification followed by Himachal Pradesh and Rajasthan. India produced all varieties of food products viz. food grains, oil seeds, commercial crops, medicinal plants, spices, fruits, vegetables, coffee, tea, dry fruits, etc. Organic products are exported to European Union, US, Canada, Switzerland, Korea, Australia, New Zealand, South East Asian countries, Middle East, South Africa etc. Oil seeds lead among the products exported followed by processed food products, cereals & millets etc.

Table 1: Area, production and export of organic products in India (APEDA, 2016)

Total area under Certification	5.71 mha
Total area under certified organic cultivation	1.49 mha
Total organic production	1.35 mt
Total volume of export	2.63 lakh MT
Total value of export	1900 crores
Domestic market (2014)	0.36 billion$



Niche areas and crops for organic farming promotion

A. Resource challenged areas

- **First tier states:** Sikkim, Arunachal Pradesh, Nagaland, Meghalaya, Mizoram
- **Second tier states:** Assam, Rajasthan, Madhya Pradesh, Odisha, Bihar, Jharkhand, Gujarat, Karnataka, Himachal Pradesh, Jammu, Uttarakhand

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B. Intensive cultivated areas

- **Towards organic approach states :** Tamil Nadu, Kerala, Andhra Pradesh, West Bengal, U.P., Punjab, Haryana

Niche crops for promotion

- ✓ **Rainfed regions:** Soybean, cotton, finger millet, durum wheat etc. can be promoted in rainfed areas of Madhya Pradesh, Karnataka Gujarat, Maharashtra and Tamil Nadu
- ✓ **Hilly regions:** Turmeric, ginger, cauliflower, cabbage, garlic, pea, capsicum, tomato, rice, potato etc. in Himachal Pradesh, Uttarakhand, J&K including NEH region
- ✓ **Tribal areas:** Rice, durum wheat, mustard, lentil, soybean, chickpea etc. in Jharkhand and Chhattisgarh
- ✓ **Irrigated region:** Basmati rice, maize, turmeric, onion, garlic, greengram etc. in Punjab, Haryana, and Uttar Pradesh
- ✓ **Kerala:** Black pepper, ginger, turmeric etc.
- ✓ **Rajasthan and Gujarat:** Coriander, fennel etc.

In addition to the organic crop production; organic livestock, poultry, apiculture and aquaculture production are also better alternative to promote organic farming.

Challenges Associated with Organic Farming

The most important constraint felt in the progress of organic farming is nutrient and pest management and the inability of the government policy making level to take a firm decision to promote organic agriculture. The following are found to be the major problems for the growth of organic farming in the country:

1. Nutrient management

One of the major inputs in organic farming required to be addressed is nutrient management as a healthy soil contains millions of organism. Farmers can improve the fertility of soil by various management practices like organic matter recycling, enrichment of compost, vermi-composting, animal manures, urine, farm yard manure, litter composting, use of botanicals, green manuring, etc. Blood meal, bone meal and human excrement may be applied with the approval of the certification agency. Biofertilizers, vermi wash sprays and liquid manures etc. can be used in crops for nourishing the soil and plant. There are certain Conditions for products used in fertilization and soil conditioning in organic farming are given below:

Items	Conditions for use
Materials from plant and animal origin	
FYM, poultry manure, composts, vermicompost and green manuring	Permitted
Matter produced outside the organic farm and by products from industries	Restricted
Mineral origin	
Basic slag, calcareous and magnesium rock, Rock phosphates	Restricted
Lime, limestone, gypsum and calcium chloride, sulphur and clay	Permitted
Microbial origin	
Bio fertilizers, biodynamic preparations, botanical extracts	Permitted

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2. Pest management:

Pest management is another major problems in organic farming as there is prohibition on the use of synthetic chemicals. Severe pest out break occur in large holdings with single crop species is a serious problem but not in small holdings. The basic principle of pest management under organic farming is based on the prevention of pest outbreak rather than copping after occurrence. According to the organic standards, insect pest may be controlled through cultural, mechanical or physical methods; augmentation or introduction of predators or parasites, use of traps, botanicals beeswax, natural acids (vinegar), plant oils, algal preparations, extracts from mushroom, Aspergilus, clay (bentonite, vermiculite, zeolite) etc (Fig 1). Use of calcium chloride, burgundy mixture and quick lime is restricted, and use of copper salts/hydroxide/ oxychloride, Bordeaux mixture are not allowed under organic farming.

Fig. 1: Pest management methods under organic farming

3. Certification

Certification requirements vary from country to country, and generally involve a set of production standards for growing, storage, processing, packaging and shipping that include avoidance of synthetic chemical inputs and genetically modified organisms. The farmland should be free from chemicals for ≥3 years. There are following constraints in certification process:

- High certification cost and quality standards
- Lengthy procedure
- Availability of services is poor
- International validity

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4. Problems in marketing of organic products

The marketing of organic products face following problems in domestic and international markets.

Domestic market	International market
No separate market for organic products	High price expectations
Unavailability of suitable market place	Delayed delivery
Lack of packaging and infrastructure facilities	Quality restrictions
Lack of technical support to the producer	Lack of certification and marketing network

5. Conversion period

The establishment of an organic management system and building of soil fertility requires an interim period between the start of organic management and certification of crops or livestock, known as the conversion period. Generally, low yield recorded during conservation period and it is a time consuming process. The whole farm, including livestock, can be converted according to the standards over a period of three to five years. Annual and biennial crops, plant products can be certified organic after two years under organic management, while for perennial crops it is three years. The conversion period can be extended by the certification programme depending on the past use of the land and environmental conditions.

Benefits of Organic Farming

Organic farming utilizes the biological means of cultivating crops with coordination to the nature. The benefits of organic farming are enormous and some of the major are listed as:

1. Ecological Sustainability

- Recycling nutrients avoiding use of external inputs and promoting use of renewable energies
- Improving soil fertility, buildup of humus and promotion of biological diversity
- Preventing the chemical pollution of soil, water and air
- Preventing soil erosion and compaction

2. Social Sustainability

- Supporting sufficient production for subsistence and income earning for small farmers
- Providing safe and healthy food
- Supporting the adoption of good working conditions
- Building on local knowledge and traditions

3. Economic Sustainability

- Helping farmers to achieve satisfactory and reliable yields
- Providing higher premium price and a lower reliance external inputs
- Promoting crop diversification to improve income security
- Promoting product value addition through quality improvement and on farm processing
- Promoting the adoption of efficient farming systems to improve overall profitability.

Future Strategies Needed

- Refinement of customary practices and ITKs for large scale application under organic farming.
- Exclusive plant breeding programme with specific purposes of yield, quality, low input etc.
- Support for research, extension and marketing infrastructures.
- Government support is required for cheaper access to organic certification.

CONCLUSIONS

Organic farming is an environment-friendly and economically viable system, have the potential to achieve sustainability of agricultural systems. Organic farming has potential benefits in comparison to conventional farming in improving soil quality, enhancing soil biodiversity, protecting environment, food quality and safety and ensuring premium price.

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Role of Machine Learning in Agriculture

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I. INTRODUCTION

Agriculture plays a critical role in the global economy. Pressure on the agricultural system will increase with the continuing expansion of the human population. Agri-technology and precision farming, now also termed digital agriculture, have arisen as new scientific fields that use data intense approaches to drive agricultural productivity while minimizing its environmental impact. The data generated in modern agricultural operations is provided by a variety of different sensors that enable a better understanding of the operational environment (an interaction of dynamic crop, soil, and weather conditions) and the operation itself (machinery data), leading to more accurate and faster decision making. Machine learning (ML) has emerged together with big data technologies and high-perform computing to create new opportunities to unravel, quantify, and understand data intensive processes in agricultural operational environments. Machine learning (ML) is a set of methods for getting computers to recognize patterns in data and use these patterns to make future predictions. For shorthand, you could think of ML as "data-driven predictions." The usual method is to first develop a model based on mathematical rules and then apply this model to data. ML approaches flip this process (Figure- 1). TML begin by finding patterns in training data and return a model that can make predictions for new, unseen data. ML techniques can be especially effective at finding complex, nonlinear relationships, and for making sense of large amounts of unstructured image, audio and text data (Liakos, et al. 2018). Smart farming is the need of the hour of the Indian economy. Machine learning is an imminent field of computer science which can be applied to the farming sector quite effectively. It can facilitate the up-gradation of conventional farming techniques in the most cost-friendly approach. The purpose of this paper is to broaden the farming horizon by listing and evaluating the different applications of machine learning in Indian agriculture and to help the farmers advance their work.

II. Machines learning models

Prediction of crop can be performed by using various machines learning algorithms such as mathematical and statistical method etc. Some of the methods those are already studied are presented here.

1. **Regression**: Regression constitutes a supervised learning model, which aims to provide the prediction of an output variable according to the input variables, which are known. Most known algorithms include linear regression and logistic regression, as well as stepwise regression. Also, more complex regression algorithms have been developed, such as ordinary least squares regression, multivariate regression algorithms have been developed, such as ordinary least squares regression, multivariate adaptive regression splines, multiple linear regression, cubist, and locally estimated scatter plot smoothing.
2. **Clustering:** Clustering is a typical application of unsupervised learning model, typically used to find natural groupings of data (clusters). Well established clustering techniques are the k-means technique, the hierarchical technique, and the expectation maximization technique.

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3. **Bayesian Models:** Bayesian models (BM) are a family of probabilistic graphical models in which the analysis is undertaken within the context of Bayesian inference. This type of model belongs to the supervised learning category and can be employed for solving either classification or regression problems. Naive bayes, gaussian naive bayes, multinomial naive bayes, bayesian network are some of the most prominent algorithms in the literature.
4. **Instance Based Models:** Instance based models (IBM) are memory-based models that learn by comparing new examples with instances in the training database. They construct hypotheses directly from the data available, while they do not maintain a set of abstractions, and generate classification or regression predictions using only specific instances.
5. **Decision Trees:** Decision trees (DT) are classification or regression models formulated in a tree-like architecture. With DT, the dataset is progressively organized in smaller homogeneous subsets (sub-populations), while at the same time, an associated tree graph is generated. Each internal node of the tree structure represents a different pair wise comparison on a selected feature, whereas each branch represents the outcome of this comparison. Leaf nodes represent the final decision or prediction taken after following the path from root to leaf (expressed as a classification rule). The most common learning algorithms in this category are the classification and regression trees, the chi-square automatic interaction detector and the iterative dichotomies.
6. **Artificial Neural Networks**: Artificial neural networks (ANNs) are divided into two categories; “Traditional ANNs” and “Deep ANNs”. ANNs are inspired by the human brain functionality, emulating complex functions such as pattern generation, cognition, learning, and decision making. The human brain consists of billions of neurons that inter-communicate and process any information provided. Similarly, an ANN as a simplified model of the structure of the biological neural network consists of interconnected processing units organized in a specific topology.

   ANNs are supervised models that are typically used for regression and classification problems. The learning algorithms commonly used in ANNs include the radial basis function networks, receptors on algorithms, back-propagation, and resilient back-propagation. Also, a large number of ANN-based learning algorithms have been reported, such as counter propagation algorithms, adaptive-neuro fuzzy inference systems.

   Deep ANNs are most widely referred to as deep learning (DL) or deep neural networks (DNNs). They are a relatively new area of ML research allowing computational models that are composed of multiple processing layers to learn complex data representations using multiple levels of abstraction. One of the main advantages of DL is that in some cases, the step of feature extraction is performed by the model itself. DL models have dramatically improved the state-of-the-art in many different sectors and industries, including agriculture. DNN’s are simply an ANN with multiple hidden layers between the input and output layers and can be supervised, partially supervised, or even unsupervised. A common DL model is the convolutional neural network (CNN), where feature maps are extracted by performing convolutions in the image domain.
7. **Support Vector Machines:** Support vector machines (SVMs) were first introduced in the work of on the foundation of statistical learning theory. SVM is intrinsically a binary classifier that constructs a linear separating hyper plane to classify data instances. The classification capabilities of traditional SVMs can be substantially enhanced through transformation of the original feature space into a feature space of a higher dimension by using the “kernel trick”. SVMs have been used for classification, regression, and clustering. Based on global optimization.

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8. **Ensemble Learning:** Ensemble learning (EL) models aim at improving the predictive performance of a given statistical learning or model fitting technique by constructing a linear combination of simpler base learner. Considering that each trained ensemble represents a single hypothesis, these multiple-classifier systems enable hybridization of hypotheses not induced by the same base learner, thus yielding better results in the case of significant diversity among the single models. Decision trees have been typically used as the base learner in EL models, for example, random forest , whereas a large number of boosting and bagging implementations have been also proposed, for example, boosting technique, adaboost, and bootstrap aggregating or bagging algorithm.

III. Applications of Machine Learning in Agriculture

1. **Crop Selection and Crop Yield Prediction:** To maximize the crop yield, selection of the appropriate crop that will be sown plays a vital role. It depends on various factors like the type of soil and its composition, climate, geography of the region, crop yield, market prices etc. Machine learning provides many effective algorithms which can identify the input and output relationship in crop selection and yield prediction. A plant nutrient management system has been proposed based on machine learning methods to meet the needs of soil and maintain its fertility levels and hence improve the crop yield. A crop selection method called CSM has been proposed which helps in crop selection based on its yield prediction and other factors. Machine Learning based software tool named 'Crop Advisor' has been developed as an user friendly web page for predicting the influence of climatic parameters on the crop yields (Veenadhari, et al..2014).
2. **Weather Forecasting:** Indian agriculture mainly relies on seasonal rains for irrigation. Therefore, an accurate forecast of weather can reduce the enormous toil faced by farmers in India including crop selection, watering and harvesting. Artificial Neural networks have been adopted extensively for this purpose. Likewise, weather prediction based on machine learning technique called Support Vector Machines had been proposed. These algorithms have shown better results over the conventional algorithms and hence have a bright future for acceptance. The relation between the temperature and latitude for a different region that affect the weather that causing heavy rainfall, flood and disturbance in the atmosphere. (Kumar, et al. 2019). Biradar, et al. 2017 proposed the use of K-medoids and Naive Bayes algorithm for weather forecasting system with parameters such as temperature, humidity, and wind. It would forecast weather based on previous record therefore this prediction would prove reliable.
3. **Smart Irrigation System:** Farming sector consumes a huge portion of water in India. The levels of ground water are dropping day-by-day and global warming has resulted in climate changes. To combat the scarcity of water, many companies have come up with sensor based technology for smart farming which uses sensors to monitor the water level, nutrient content, weather forecast reports and soil temperature. These smart devices are being designed on the principles of machine learning, working with the sensors‟ data and improving the system over time all by itself. The nutrient content of soil can also be recorded using the sensors and hence used for supplying fertilizers to the soil using smart irrigation systems. This will also reduce the labor cost in the fields, which is a huge crisis being faced by the Indian farmers these days. According to this study by applying machine learning in agriculture it enhances the irrigation system. The integration process of automated data analysis, data recording, and decision making with the machine learning implementation is completely knowledge based system (Janani and Jebakumar, 2019; Balducci et al. 2018).

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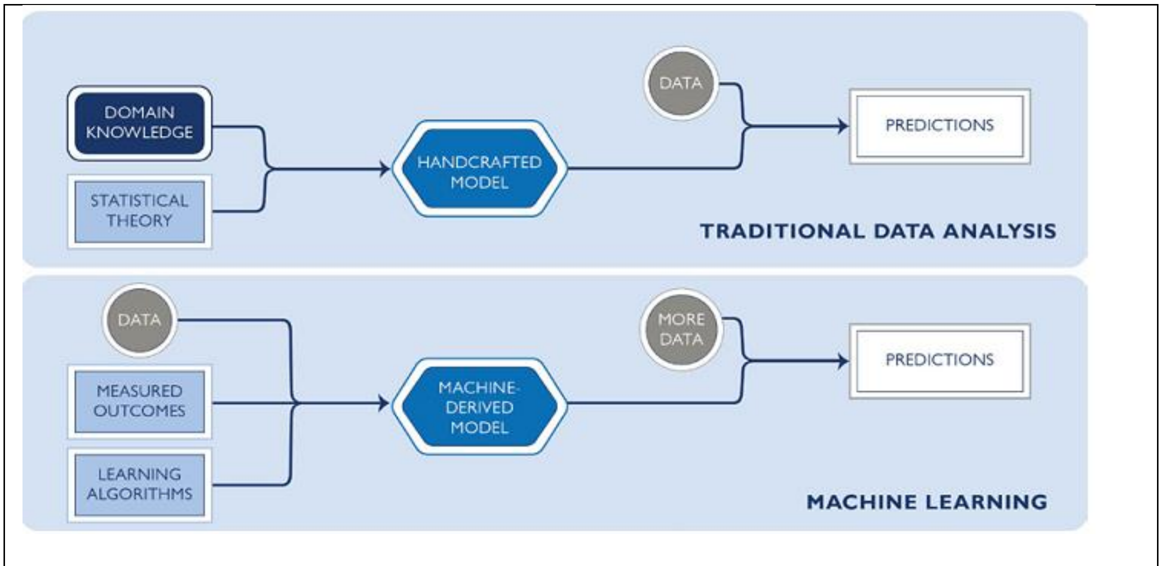
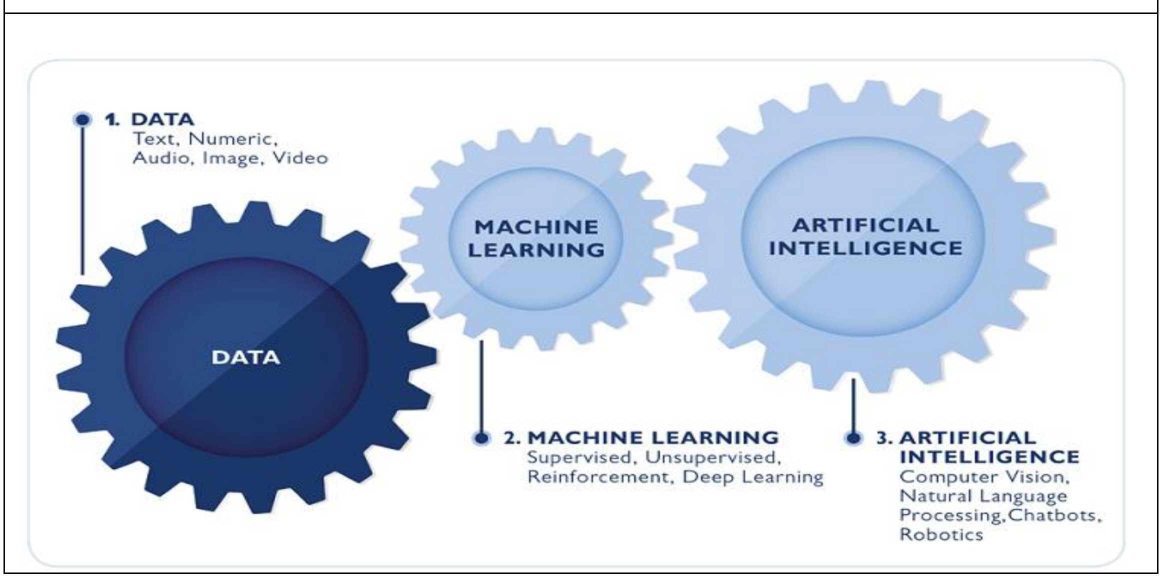
4. **Crop Pest and Disease Prediction:** Machine learning methods have been used in the recent years for crop disease prediction and these efforts have been proved worthwhile. Machine learning gives higher accuracy compared to the traditional statistical methods like regression analysis. These methods deal well with noisy and multifaceted data. Early crop disease detection and classification has been done using Support Vector Machines. There are several factors like soil quality, crop rotation cycle, seed quality etc which can lead to poor health and diseases in crops. Machine learning algorithms effectively take into consideration all the possible factors, historic data as well as satellite/sensor data of fields to provide valuable disease classifiers. Disease detection using images of crop leaves has been implemented using pattern recognition branch of machine learning. The pest detection and pest identification system introduced by applying the color histogram and contour detection technique with image processing by SVM model based on the machine learning models (Ashok et al., 2019).





IV. CONCLUSION

Recent development in the technology has a great impact on agriculture. The integration of computer science with agriculture helps in forecasting agricultural crops. It is required to build on objective methodology for pre-harvest crop forecasting. Building up a suitable model will have certain merits over the traditional forecasting method. Present adoption and development of the machine learning technology in agriculture sector is nascent stage. There is a need to further enhance adoption and technology development of the machine learning techniques to improve effective and accurate prediction of the agricultural farm production and production activities.

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Role of hyperspectral and multispectral images in agriculture

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1. INTRODUCTION

Crop monitoring for nutrients, water-stress, disease, insect attack and overall plant health is a vital aspect of successful agricultural operations. Traditionally this has been carried out by visual examination of crops on the ground or sometimes from the air. However these methods are limited by the ability of the human eye to discriminate various kinds of stress. Often a specific condition must be well-advanced before visual symptoms become noticeable even to experienced observers. Modern precision agriculture relies on site-specific management tactics to maximize yield and resources while reducing environmental impacts such as over-fertilization and the broad applications of pesticides. Pin-pointing areas requiring attention be it water, weed or pathogen treatment, or nutrient adjustments allows for spot application rather than whole-yield treatment. The collection of key data at a sufficient level of accuracy depends on the availability of equipment that can be operated at a cost-effective level. Plants respond to pest and disease stress in a number of ways, including leaf curling, wilting, chlorosis or necrosis of photosynthetically active parts, stunted growth, or in some cases reduction in leaf area due to severe defoliation. Many of these plant responses are difficult to visually quantify with acceptable levels of accuracy, precision and speed. These responses also affect the amount and quality of electromagnetic radiation reflected from plant canopies. Recent advances in the field of spectroscopy and other remote sensing techniques offer ample scope for their exploitation in developing alternate techniques that can enhance or supplement traditional crop management approaches.

2. Hyperspectral and Multispectral Images

Hyperspectral imaging, like other spectral imaging, collects and processes information from across the electromagnetic spectrum. The goal of hyperspectral imaging is to obtain the spectrum for each pixel in the image of a scene, with the purpose of finding objects, identifying materials or detecting processes. There are three general branches of spectral imagers. There are push broom scanners and the related whisk broom scanners (spatial scanning), which read images over time, band sequential scanners (spectral scanning), which acquire images of an area at different wavelengths and snapshot hyperspectral imaging, which uses a staring array to generate an image in an instant. Spectral imaging divides the spectrum into many more bands. This technique of dividing images into bands can be extended beyond the visible. In hyperspectral imaging, the recorded spectra have fine wavelength resolution and cover a wide range of wavelengths. Hyperspectral imaging measures continuous spectral bands, as opposed to multispectral imaging which measures spaced spectral bands (Figure-1).

A multispectral image is one that captures image data within specific wavelength ranges across the electromagnetic spectrum. The wavelengths may be separated by filters or by the use of instruments that are sensitive to particular wavelengths, including light from frequencies beyond the visible light range, i.e. infrared and ultra-violet.

Hyperspectral imaging is part of a class of techniques commonly referred to as spectral imaging or spectral analysis. Hyperspectral imaging is related to multispectral imaging. The distinction between hyper and multi-spectral is sometimes based incorrectly on an arbitrary "number of bands" or on the type of measurement. Hyperspectral imaging (HSI) uses continuous and contiguous ranges of wavelengths (e.g. 400-1100nm in steps of 0.1 nm) whilst multispectral imaging (MSI) uses a subset of targeted wavelengths at chosen locations (e.g. 400 - 1100 nm in steps of 20 nm). Multispectral imaging deals with several images at discrete and somewhat narrow bands. Being"discrete and somewhat narrow" is what distinguishes multispectral imaging in the visible wavelength from color photography. A multispectral sensor may have many bands the spectrum from the visible to the longwave infrared. Multispectral images do not produce the "spectrum" of an object. Landsat is an excellent example of multispectral imaging. Hyperspectral deals with imaging narrow spectral bands over a continuous spectral range, producing the spectra of all Pixels in the scene.

3. How hyperspectral and multispectral images will detect the plant stress?

The ability of hyperspectral imaging to provide valuable data on the condition and health of crops is predicated on the interaction and relationship between electromagnetic radiation (EMR) and foliage. EMR may be absorbed, transmitted or reflected and although the internal and external physical structure of vegetation affects this, the primary influences on EMR are the various photosynthetic pigments

In the red and blue parts of the visible spectrum, reflectance is primarily a result of absorption by the photosynthetic pigments. Water content is the primary influence on reflectance in the mid-infrared (MIR) while reflectance in the near-infrared area (NIR) is influenced by the shape and condition of air spaces in the spongy mesophyll. Senescence, nutrient stress, pathogen and insect infestation have all been shown to significantly reduce reflectance in the mid- infrared spectral region. It has been well recorded that a vegetation index of NIR and red wavelengths can monitor a range of plant-health issues including fungal pathogens, excess salt and nutrient deficiencies.

One of the most powerful techniques for the measurement of overall photosynthetic efficiency and thus of plant productivity, is the fluorescence of chlorophyll a in photosystem II. The indexes produced give a good measure. Besides the photosynthetic pigments, reflectance is also influenced by the presence of zeaxanthin. This pigment is produced by plants to safely remove excess photons when light intensity exceeds the ability of photo system II to absorb photons without becoming over-energized. Zeaxanthin accumulation can therefore be used as a quantitative indicator of non-photochemical energy dissipation and therefore of light-use efficiency. A standard Photochemical Reflectance Index (PRI) has been developed which serves as a measure of photosynthetic light use efficiency.

4. Vegetation Indices

Vegetation Indices enables the analysis of several proprieties in leaf area index (LAI) and the assessment of biophysical, physiological, or biochemical crop parameters. In VIs were classified as broad and narrow bands, being the latter group considered more proper for hyperspectral data. Some of the addressed narrowband indices include chlorophyll absorption ratio index (CARI), greenness index (GI), greenness vegetation index (GVI), modified chlorophyll absorption ratio index (MCARI), modified normalized difference vegetation index (MNDVI), simple ratio (SR, including narrowband variants 1–4), transformed chlorophyll absorption ratio index (TCARI), triangular vegetation index (TVI), modified vegetation stress ratio (MVSR), modified soil-adjusted vegetation index (MSAVI) and PRI.

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In India under joint collaboration of ISRO, (NASA), Jet Propulsion Lab (JPL), an airborne campaign was organized to perform spectroscopic imaging of selected agricultural sites of India. In this campaign, Airborne Visible/Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG) sensor was flown aboard on ISRO B200 aircraft. AVIRIS-NG is an imaging spectrometer having around 425 contiguous narrow spectral bands in range of 380–2500 nm with high spectral resolution of about 5 nm and Instantaneous Field of View (IFOV) of 1 m rad (https://aviris-ng.jpl.nasa. gov/). In this study, data acquired over different agricultural sites in India from AVIRIS-NG have been used to classify crop types, and for the retrieval of biophysical and biochemical parameters, and generation of abiotic and biotic stress maps.

5. Where can we use the hyperspectral and multispectral images in agricultural sector?

Originally Hyperspectral and Multispectral Images used for detecting and mapping minerals, is increasingly needed to characterize, model, classify, etc. Further, hyperspectral and multispectral images agricultural crops and natural vegetation studies , specifically in the study of:

1. Species composition
2. Vegetation or crop type
3. Biophysical properties (e.g., LAI, biomass, yield, density),
4. Biochemical properties (e.g, Anthrocyanins, Carotenoids, Chlorophyll),
5. Disease and stress (e.g., insect infestation, drought),
6. Nutrients (e.g., Nitrogen),
7. Moisture (e.g., leaf moisture),
8. Light use efficiency,
9. Net primary productivity and so on.
10. Biomass: wet and dry (kg\m^2),
11. Leaf area index (LAI),
12. Green LAI (m^2\m^2),
13. Plant height (mm),
14. Vegetation fraction (%),
15. Total crop chlorophyll content (g\m^2).

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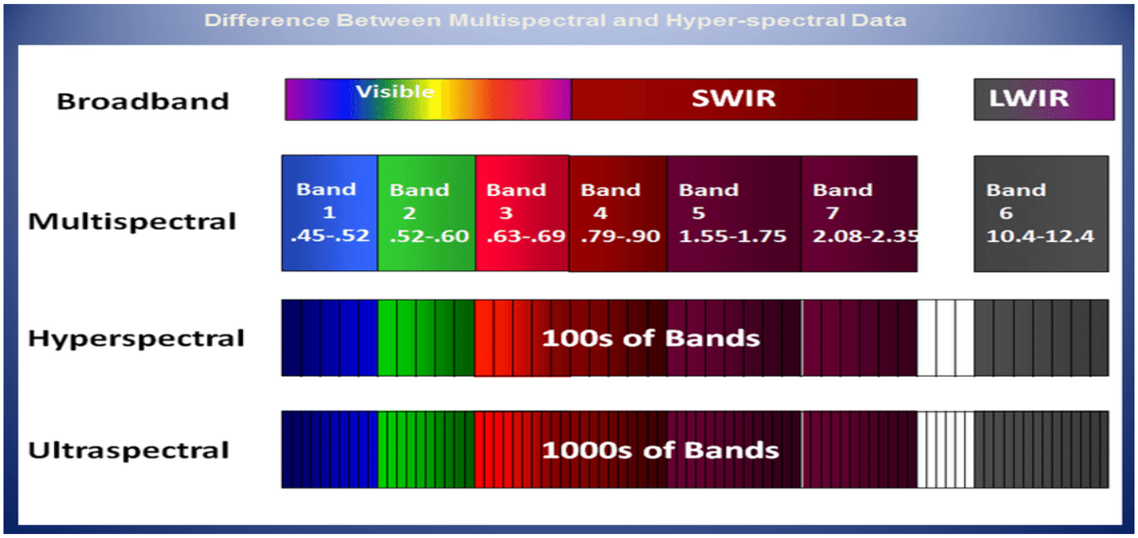

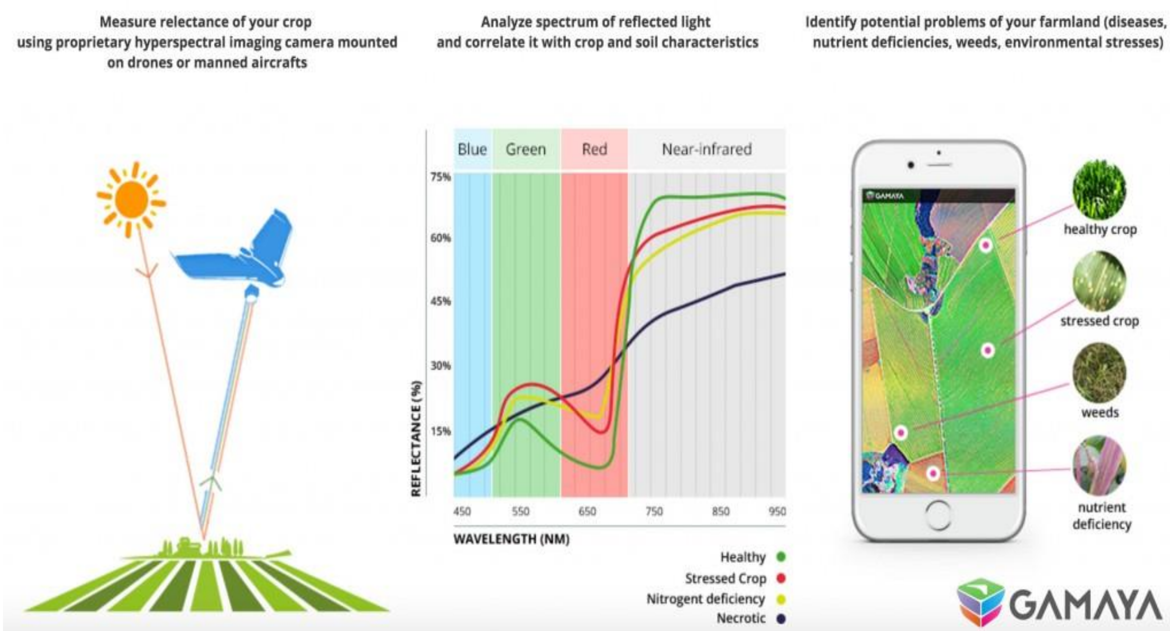

6. CONCLUSION

Over the past decades, hyperspectral and multispectral images technique has been rapidly developing and widely applied in agriculture. The possibilities for these types of studies related to precision agriculture are virtually endless as indexes for each species, nutrient or soil property continue to be developed and improved. Currently, many other applications of hyperspectral and multispectral imaging are being tested in agriculture sector. The ability of these images to enhance and enable day-to-day monitoring promises to create a new paradigm of agricultural efficiency

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Powdery mildew of *Cucurbitaceous* Vegetable Crops: Biology, Epidemiology and IDM

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Vegetables are the most important constituent of our diet. Total area under vegetables cultivation in India was 9396 Thousand ha. with production of 62897 MT. (Anonymous, 2014). The family *Cucurbitaceae* contains at least 118 genera and 825 species are cultivated as vegetables. In India cucurbits like Ash gourd (*Benincasa hispida*), bitter gourd (*Momordica carantica*), cucumber (*Cucumis sativus*), bottle gourd (*Lagenaria siceraria*), sponge gourd (*Luffa cylindrica*), pumpkin (*Cucurbita maxima*), red pumpkin (*Cucurbita peopo*), ridge gourd (*Luffa acutangula*L.), round gourd (*Citrullus fistulosus*), pumpkin (*Cucurbita moschata*) and watermelon (*Citrullus lanatus*), musk melon (*Cucumismilon*), round melon (*Praecitrullus fistulosuos)*, sweet gourd (*Momordica cochinchinensis)* are cultivated round the year in one or the other region of the country (Rai*et al.,*2008).

Powdery mildew is the most destructive disease of *Cucurbitaceaous* vegetables. It is well defined group of fungi belongs to family *Erysiphaceae* of sub-division Ascomytina. There are 28 genera and more than 100 species infecting the vegetables.Powdery mildew fungi are host specific. Lot of biodiversity is observed amongs the species. The host plant of *Erysiphe cichoracearum* DC and *Spherotheca fuliginea* are cucurbits, ridge gourd, cucumber, pumpkin , bottle gourd, bitter gourd, sweet gourd *etc*.

Yield losses due to powdery mildew in some *Cucurbitaceous* vegetables reported were 80-100% in Brazil(Barbara *et al*.,2012),>30% in Bangaladesh(Yasmin*et al*., 2008),and sever yield in India losses (Wani 2011).

Powdery mildew symptoms on*cucurbitaceous* crops are initially small, circular, white, powdery growth appear on upper leaf surface and white colonies occasionally appear on lower surface of leaves and also on steams. Severely infected leaves gradually turn yellow, wither and finally became brittle.Severe epidemicsreduced both size and number of fruits **(**Li., 2012,Behera*et al*2008.). Powdery mildew are disease development is favoured by hot and dry weather(Agrios, 2005) andthe temperature at 25 ^{0} C favours the highest conidial germination(Gupta *et al.* 2001).

In ridge gourd (*Luffa acutangula* L.), among these diseases, powdery mildew (*Erysiphe cichoracearum, Leveillula taurica and Sphaerotheca fulginea*) is of common occurrence throughout globe. In India, ridge gourd powdery mildew has been reported to be caused by three different fungal genera *viz*. *Sphaerotheca, Erysiphe*and *Leveillula* (Khan, 1989; Sharma and Khan, 1991). However, *Sphaerotheca fuliginea* and *Erysiphe cichoracearum*are of common occurrence, causing about- 50-60% yield losses (Sharma and Khan, 1991, Gupta *et al.,* 2001; Pawar*et al*., 2009; Bharat 2013).

Cultural Practices

Plant in sunny areas as much as possible, provide good air circulation, and avoid applying excess fertilizer. A good alternative is to use a slow-release fertilizer. Overhead sprinkling may help reduce powdery mildew because spores are washed off the plant. However, overhead sprinklers are not usually recommended as a control method in vegetables because their use may contribute to other pest problems.

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Powdery mildew of ridge gourd can be managed by early planting coupledwith application of leaf extractDashparni ark @ 15%, bio-organic Cow urine @ 15 %(Pawar and Chavan, 2010.,Pawar, 2015)

Fungicide Application

In some situations, especially in the production of susceptible cucurbits, fungicides may be needed. Fungicides function as protectants, eradicants, or both. A protectant fungicide prevents new infections from occurring whereas an eradicant can kill an existing infection. Apply protectant fungicides to highly susceptible plants before the disease appears. Use eradicants at the earliest signs of the disease. FungicidesAzoxystrobin@ 125 g a.s./ha, Hexaconazole@ 0.2%, Propiconazole@ 0.2%,Thiophanate methyl @ 0.2% etc were reported most effective for management of powdery mildews of cucurbits.

CONCLUSION:

Powdery mildews of cucurbits can be managed by cultural, biological, physical and chemical disease management practices. Use of biocontrol agents and phyto-extracts in vegetable crops could reduce problem of environmental pollution chemical, and human health hazards.

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Nutritional outlook of rice

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INTRODUCTION

Rice is the staple food crop in India whose estimated production has reached to 115mt from 43mha area in 2019. There are mostly two species of rice cultivated in the world e.g. *Oryza sativa* and *Oryza glabberiama*among which *Oryza sativa* is cultivated in Asia and America and *Oryza glabberima* is confined to Africa. *O. sativa* has three sub species i.e. Indica, Japonica and Javanica among which Indica sub species is confined to India. There were thousands of rice varieties of nutritionally superior quality grown in India, but after green revolution due to mono cropping and drastic reduction in crop diversification their cultivation was limited to a greater extent and maximizing the yield became the prime goal. Continuous consumption of white rice as staple food grain resulted in malnutrition, iron deficiency anemia and aggravated diabetes. Though there are certain technologies have developed to fortify rice with targeted nutrient i.e. biofortification (Jena *et al*., 2018), traditional forbidden rice varieties i.e. brown rice, black rice, red rice, green rice, etc. have tremendous potential to solve these nutritional issues.

Different types of rice

There are more than 40000 cultivated rice varieties exist worldwide. Over 90000 samples of cultivated and wild rice species are stored in the International Rice Gene Bank among which, some special rice types are explained here;

White rice: Here the husk, bran layer and the germ are removed hence is less nutritious than brown, red and black rice. Easily digested as low in fiber content hence recommended for children and older one. It provides lots of energy and relieves from morning sickness and digestive disorders i.e. dysentery, diarrhea and colitis. It has soothing power and can be helpful in curing skin inflammation caused by burns, prickly heat, measles, small-pox etc. Polished white rice is nothing more than refined starch and nearly all of the nutrients and vitamins are removed during its processing.

Brown rice: Partially milled rice where bran layer is retained. This rice though has a lot of health benefits i.e. high fiber content, high nutrient retention, increases good cholesterol and lowers blood pressure, has lower glycemic index; it is being neglected for consumption due to its higher price, ignorant of its health benefits and unpleasant aroma as well as texture. It is also a good source of Mg, P, Vitamin B6, fiber and Se but due to proven presence of arsenic, doctors recommend its lesser usage.

Red rice: Red rice is rich in iron and vitamin B6. Consumption of red rice prevents malnutrition i.e. iron deficiency anemia.Vitamin B6 balance the formation of red blood cells and serotonin, controls blood sugar level and helps in DNA production. It also encounters the risk of cancer. Therefore, to stay fit and active, red rice consumption is a good choice even if you don’t get appealing taste.

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Black rice: Black rice is also called as "emperor's rice" or "forbidden rice". The black color is due to high level of anthocyanin content. Black rice is rich in iron, vitamin E and anthocyanin antioxidants. It is helpful for people suffering from diabetes and Alzheimer's disease. It has rich source of protein and fibers but costlier than both white and brown rice.

Basmati rice: The unique aroma in basmati rice is due to compound 2-acetyl-1-pyrroline. It has higher fiber content, low in glycemic index and hence safe for diabetes patients.

Jasmine rice: Originates from Thailand, so called Thai fragrant or Thai sticky rice. This rice is popular in South East Asia for its long grain and floral aroma. This can be used as substitute for basmati rice. It helps in lessening muscle pain in the body due to high amino acid content.

Matta or rosematta rice: This is a medium grainred colored rice and its bran layer is rich in natural nutrients. This variety calls for meaty accompaniment and known for its robust earthy flavor.

Sticky glutinous rice: It doesn't contain dietary gluten but due to higher starch content, results in sticky, glue like textured after cooked. The copper content in this rice strengthens the connective tissue, supports immune system and promotes brain function.

Green rice: This is the forbidden, organic, short grain, bamboo extract infused brown rice which have green tea like aroma, leafy green colored when cooked and mild nutty textured. It works well with sushi or risottos due to its sticky nature. These are organic, rich in fiber, rich in chlorophyll, gluten free, non-GMO products with superior quality in terms of aroma, texture and nutrition.

Sushi rice: This is short grain, white or brown Japanese rice. Like sticky rice, it has also more stickiness due to higher starch content which make it suitable for different types of sushi.

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Valencia rice: It is short grain, high in starch content, tender, sticky and absorb more liquid, making it ideal for soups and stews.

CONCLUSION

Post green revolution targets emphasizedonly on yield maximization, but achieving food security with sustainable goals should be the prime focus. Due to lower productivity and higher price tag, the nutritionally enriched rice i.e. brown rice, black rice, red rice, green rice etc. cannot be accessed by everyone especially the targeted community or economically backward section. Therefore, their introduction as main crop and awareness to people about their health benefits may eradicate the problems of malnutrition to some extent. Though they cannot be afforded to take as that of white rice, they may be consumed with white or brown rice to have some additive health benefits.

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Nutritive Aspects of *Moringa oleifera* - A Miracle Tree

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INTRODUCTION

Moringaoleifera, a plant of Indian origin, belongs to Moringaceae family. It is perennial in nature. Genus *Moringa*is comprised of 13 other species (Nadkarni and Nadkarni, 1976;Farooq*et al*., 2012). Dry sandy or loamy soil having slightly alkaline nature is optimum for plant growth. It can be able to grow in a range pHof 4.5 to 8.0. However, it cannot tolerate any freezing (frost) and water logging condition (Asante *et al*., 2014;Radovich, 2011).Generally, it is a fast growing tree of 10m height and a diameter of 2.04m. The trunk is soft, white and corky with presence of gummy bark bearing branches. The pinnate compound leaf bears small leaf lets which are arranged in a spiral manner. Flowers are pleasingly fragrant having whitish colour.Seeds are winged, which are usuallydisseminated by the winds. Plant parts such as tender leaves, flowers and pods are eaten as vegetables. India is the chief producer of *Moringa*, with an annual production ranging between 1.1 to 1.3 million tonnes (Rajangam*et al*., 2001).

Nutritional Value of *Moringa*

Bureau of plant industry epitomizes that itis an ideal source of various nutritional compounds. The leaves have three times morepotassiumas compared with bananas. Similarly, calcium contentis four times that of milk and vitamin C is seven times more as compared to oranges.The amount of vitamin A of pods is four times than spinach and amaranthus. Leaves of *Moringa*contain minerals such as Ca, Mg, K, Mn, P, Zn, Na, Cu, and Fe (Aslam*et al*., 2005).The leavescan reduces bloodchloestrol level and saves life from various coronary heart diseases. Generally, it contains 25.45 mg of vitamin C, 61.23 g of carbohydrate, 28.22 g of protein and 4.91 g of fat.Due to presence of various compounds such as phenolic, flavonoids, carotenoids and ascorbic acid; it acts as a good source of a natural antioxidant. The antioxidants acts as scavenger of free radicals and enzymatic activityinhibitor thus have substantial role in checking stress that may be responsible for causing several neurodegenerative diseases. It has great potentialto supply the proper nutrition to poor and malnourished people,specifically among infants, pregnant andnursing mothers. One round tablespoon (10 g) of dried leaf powder will fulfill about 15% of protein, 50% of calcium, 26% ofiron and nearly all vitamin A requirements for a child of age between 1-3 years. Six round spoonful of dried leaf powder will satisfy approximately dailycalcium and iron requirements duringprenatal and breast-feeding period.*Moringa*leavesand fruits contain various compounds havingantioxidantsand antispasmodic activities. Thus, for combating gastrointestinal motility disorder it has been used(Gilani*et al*., 1994).There is presence of various compounds having antitumor activity. Abioactive compounds Niazimicinis present inleaves, has anticancer property, whileseedexcerpts have carcinogenic metabolizing enzymatic activity(Guevaraa*et al*., 1999).The alcoholic fraction of leaf juice having antimigraine potential and should be used in the treatment of migraine.Study revealed that *Moringa*can be effectively used inmanagement and curing of migraine (Upadhye*et al*., 2012). Deficiency of vitamin A is the chief cause of blindness inIndia. Regular intake of*Moringa*leaves and pods (powder form) can avert all eye related problems including night blindness in children. Bioavailability of vitamin A can be increased by up taking of oil fried drumstick leaves, which also subsequently interrupt in the

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advancement of cataract (Pullakhandam, 2007). Due to its high vitamin A enrichment quality, it can be utilized as supplementary food. A study revealed its retinol protective action by various mechanism *i.e*. anti-angiogenic, anti-inflammatory and anti-oxidant like activity in diabetic rats, and itcan be used for prevent ofdiabetes(Kumar *et al*., 2013). The plant extractsalso slow down the development of *Bacillussubtilis*and *Mycobacterium phle*. Leaf extract have antifungal action against *Basidiobolusranarums*and*Basidiobolushaptosporus* (Nwosu, 1995). Its bark contains analkaloid moringinine which modulates sympathetic neuron activity and stimulates heart function (Duke, 2001). Thiseffect also results in reduction of hyperlipidemia. On comparing leaf extract with atenolol (antagonist drug, for various cardiovascular diseases), it was observed that leaf extract have various effects like hypochlosterolmic, hypolipidimic, reduction of body weight, serum cholesterol andtriglyceride level.

CONCLUSION

India is rich in various unexplored species of *Moringa*. Whole plant parts are the reservoir of nutrients, so proper utilization of all parts is necessary for well being of people. However,due to various agro climatic condition, its growth and development in particular area is hampered. So, for its proper acclimatization a proper cultivation practices need to be established. India is a developing country, alarge portion of people are still in below poverty line, suffered with various under-nutrition related disorder. Infant mortality due to deficiency of vitamin A during pregnancy period can be avoidedby consuming its leaves regularly. Instead of focusing various advanced breeding techniques such as bio-fortification of vegetables, we have to really explore and popularize our various indigenous vegetable like *Moringa*.

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Biofumigation: A novel approach as part of integrated nematode management

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Biofumigation is an agronomic practice that consists of finely grinding a plant cover set up during the fallow period and incorporate the chopped biomass into the soil. This practice is of interest because it releases organic compounds which are naturally produced during the development of certain plant species as a defense mechanism (allelopathic effects), and which are likely to reduce the biotic pressure of certain pests on the next crop.

Plant parasitic nematodes and biofumigation

Plant parasitic nematodes(PPNs) are quite diverse and omnipresent in every cropping system due to their wider adaptability to various agro-climatic zones. In addition, intensification of agriculture to meet the burgeoning demands of ever growing population and changes in agronomic approaches for efficient water utilization and global climate change have led to emergence of PPN problems in new crops and newer geographical localities. Integrated use of chemical nematicides, resistant crop cultivars, biological control agents and cultural methods have been tried and tested extensively to manage the PPN incidence in various cropping systems. Many traditional soil fumigants are damaging to the environment, are toxic to humans, and have negative effects on beneficial soil organisms (Ibekwe, 2004). Biofumigation is an agronomic lever in crop protection which could reduce the use of certain pesticides or even be a substitute. By bringing other benefits to the plot but also to the ecosystem (input of organic matter, improve soil structure, refuge for auxiliaries), these intermediate crops which are used for biofumigation have a major part to play in the conception of innovative farming systems and in the transition to agroecology. However, there are many obstacles to such cultivation (possession of specific material, duration of the fallow period). Setting up a plant cover must therefore be accompanied by practical changes at the farming system level (Annonymous, 2019). The impact of biofumigation technique in managing PPNs in various crops and explore the employability of this technique in integrated nematode management (INM) practices (Dutta *et al*., 2019).

Biofumigants properties of plant

Mustard crop:

The use of mustard green manures and seed meals provide promising alternatives to synthetic chemical fumigants (Brown and Morra 1997). The plants mainly used in biofumigation are from the Cruciferae family (mustard, radish, *etc*). They produce glucosinolates which are sulfur-containing carbohydrate compounds, whose degradation in the presence of the myrosinase enzyme releases substances that have biocidal properties and help limit the proliferation of certain pathogens (bacteria, fungi, nematodes) and weeds. The production of glucosinolates reaches its peak at flowering. This is why the plant cover must be finely ground at this stage and immediately buried in order to release these substances into the soil. Re-compacting the soil in arable crops as well as mulching or covering in horticultural crops are tasks that, when carried out after the burial of crop residue, enable to limit the volatilization of the compounds.

Forage sorghum

Plants from the grass family, such as forage sorghum, also have biofumigant properties that can be found through the release of dhurrin which degrades to a hydrocyanic acid, a gas that is toxic to certain soil pathogens.

Marigold

The allelopathic plant marigold is known to produce α-terthienyl, which has shown potential biofumigation effect against PPNs.

Biofumigation by different agronomical practices (Case studies)

1. Biofumigants crop as green manure

The greatest reduction in nematode population density was attained by cropping rapeseed for 2 months and incorporating it into the soil as a green manure (Mojtahedi *et al.*, 1991).

2. Biofumigants crop part as soil amendment

Leaves of the rapeseed (*Brassica napus*) cultivar Jupiter used as a soil amendment effectively reduced *Meloidogyne chitwoodi* population densities at the zone of incorporation and second-stage juveniles were more sensitive than egg masses, with ED50 of 10 and 23 mg of green leaves of 4-mo-old rapeseed per gram of soil, respectively (Mojtahede *et al.,* 1993).

3. Suppressive impact of glucosinolates in *brassica* vegetative tissues on root lesion nematode *pratylenchus neglectus*

The potential of tissue amendments from a variety of wild and cultivated *Brassica* spp. to kill the root lesion nematode (*Pratylenchus neglectus*) in soil was assessed in laboratory experiments. Soil amended with leaf tissues was highly nematicidal, killing 56.2–95.2% of exposed nematodes (Potter *et al.*, 1998).

4. Biofumigants crop as a green manure

Brassica green manure crops used as a biofumigation process are likely to be most useful in ginger industry as they can be grown like winter crop between ginger crops and fields can be irrigated before Brassica crop incorporated into the soil. (Sterling and Sterling, 2003).

5. Effect of broccoli (*Brassica oleracea*) tissue, incorporated at different depths in a soil column, on *Meloidogyne incognita*

Roubtsova *et al.* (2007) studied on effect of broccoli (Brassica oleracea) tissue, incorporated at different depths in a soil column, on *Meloidogyne incognita* at San Joaquin Valley, CA, USA and conclued that Brassicas have been used frequently for biofumigation, a pest-management strategy based on the release of biocidal volatiles during decomposition of soil-incorporated tissue and strong direct effect was much stronger than indirect effect of volatiles.

6. Interference between biofumigation and biocontrol agents in the soil

Henderson *et al.* (2009) was carried out in the Columbia Basin of east-central Washington State, USA. They observed the effectiveness of soil incorporation of *Brassica carinata* seed meal both in controlling the plant-parasitic Columbia root-knot nematode (*Meloidogyne chitwoodi*), and on the biological control exerted by the entomopathogenic nematodes *Steinernema feltiae* and *Steinernema riobrave* on root-knot nematodes and the Colorado potato beetle (*Leptinotarsa decemlineata*). Singly, both the seed meal and Steinernema spp. reduced root-knot nematode damage to potato tubers and increased marketable tuber yields. They revealed that there was a significant interference between biofumigation and biocontrol agents in the soil, presenting challenges in combining these two environmentally friendly approaches to managing plant-parasitic nematodes and other pests.

CONCLUSION

The different crops were taken as an alternative source of the biofumigant which were mustard, forage sorghum and marigold. Which have potential to suppress the activities of nematode in the soil. It is novel approach as a part of integrated nematode management which is eco friendly as well as low cost technology which is beneficial for the farmers.

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Application of RNAi in Fruit Crops

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INTRODUCTION

Apart from the perennial nature, there are several other limitations of traditional fruit breeding, which includes long juvenile period, self incompatibly, high heterozygosity, limited number of morphological markers etc. Biotechnological tools like RNA Interference (RNAi) are playing a vital role in fruit crop improvement. This technique was first discovered in *Petunia hybrida* L. plants through overexpression of *chalcone synthase* gene to increase anthocyanin pigment (Napoli *et al*. 1990). RNAi is a post-transcriptional gene-silencing process which occurs naturally to "switch off" specific targeted gene (nucleic sequences), or to regulate gene expression before its translation. RNAi can be used to suppress the expression of specific genes through the use of double-stranded RNA (dsRNA) (Kour and Gupta, 2019). It identifies and destroys specific RNA structures (Baum *et al*., 2007). Among the fruit crops, RNAi has been exploited in Apple, Strawberry, Plum etc.

Application of RNAi in Fruit Crops

In fruit crops, RNAi has been used for various purposes including inducing disease resistance, for quality enhancement, for functional genomics, virus-inducing gene silencing etc. One of the best examples of this is non-browning apple. Some of these are given as follows:

RNAi for Quality Improvement

Recently in 2015, the US Department of Agriculture (USDA) has approved the non-browning Arctic apple developed by Okanagan Speciality Fruits (OSF). When an apple is damaged by slicing or biting; enzymatic action of polyphenol oxidase (PPO) results in the apple's flesh turning brown. Although, the damage is occurring on the surface, it can also lead to change in taste and texture of the apple. Apart from apple, browning due to action of PPOs is also a concern in some other fruits and vegetables like potato, brinjal etc. Scientists at OSF developed the non-browning apples by blocking the activity of PPOs through RNAi mediated post-transcriptional gene silencing (Waltz, 2015).

RNAi for Disease Resistance

Another remarkable example of the utility of RNAi is 'HoneySweet' plum. Plum pox virus(PPV) causes the Sharka disease which is among the most destructive diseases of plum worldwide. PPV resistance has been achieved in 'HoneySweet' plum using RNAi. Field trails and demonstration have shown that the resistance is highly stable, effective, durable, and can be transferred to the next generation (i.e. heritable) as a dominant trait. This 'HoneySweet' plum was also approved for cultivation in the USA (Scorza *et al*., 2013).

RNAi for Functional Genomics

Hoffmann *et al*. (2006) reported that RNAi technique with metabolite profiling can be used for study of gene function of unknown genes related to ripening and development of fruit of strawberry. They used the constructs encoding self-complementary 'hairpin' RNA (ihpRNA) and demonstrated the silencing of *chalcone synthase* (*CHS*) gene (a ripening related gene) in fruits of strawberry. The reduced levels of *CHS* mRNA and enzymatic activity led to decreased anthocyanin levels, which in terms led to increase in level of cinnamoyl glucose esters.

RNAi for Agronomic Traits

Szankowski *et al*. (2009) used the RNAi technique for inducing post-transcriptional gene silencing in apple to induce early flowering. They targeted the *MdTFL1* gene to reduce the juvenile phase in the apple plants. Apple MdTFL1 protein is homologous to TFL1 of *A. thaliana* which maintains the inflorescence meristem by suppressing the floral meristem identity genes *LFY* and *AP1*. There was significant reduction in *MdTFL1* expression in the transgenic lines as compared to control (non-transformed) plants. This regenerated transgenic apple plants were observed to flower in only 6 months after the transformation under *in vitro* conditions.

CONCLUSION

RNA interference is one of the best biotechnological tools which can be used to overcome the bottlenecks of the perennial fruit breeding. As compared to annual crops, application of RNAi in fruit crops is limited in number. This may be due to some of other factors like lack of standardized protocol for *in vitro* regeneration of fruit crops. However, RNAi need more exploration for the improvement of fruit crops.

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Vertical Farming Management by Internet of Things (IoT)

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1. INTRODUCTION

The global population is set to touch 9.6 billion by 2050. So, to feed this much population, the farming industry must embrace vertical farming management by IoT. Against the challenges such as extreme weather conditions and rising climate change, and environmental impact resulting from intensive farming practices, the demand for more food has to be met.

Vertical farming is the practice of growing produced in vertical stacked layers. The practice can use soil, hydroponic or aeroponic growing methods. Vertical farm attempt to produce food in challenging environment, like where arable land is rare or unavailable. The method helps mountainside towns, dessert and cities grow different types of fruits and vegetables by using skyscraper like designs and precision agriculture methods (Kalantari *et al.,* 2017). Most vertical farms use enclosed structures similar to greenhouse that stack vertically, either directly above each other or staggered for better natural light exposure. If saving space is utmost importance, hydroponic methods as a growing medium as a soil allow for reduce weight and lower water up by to 70%. The use of aeroponics further reduces weight and water requirements. Most vertical farms are either hydroponic or aeroponic and do not have run off, which would make the potted plants heavier (Touliatos *et al.,* 2016). Vertical farming typically uses the mix of natural lights and artificial lights. Artificial lights are often LED based and may be driven by a renewable power source such as solar power or wind turbines.

Vertical farming based on IoT technologies will enable growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized. With the help of sensors (light, humidity, temperature, soil moisture, etc.) and automating the irrigation system. The farmers can monitor the field conditions from anywhere. This type of farming is highly efficient when compared with the conventional approach (Ismail *et al.,* 2017). The applications of IoT-based vertical farming not only target conventional, large farming operations, but could also be new levers to uplift other growing or common trends in agricultural like organic farming, family farming (complex or small spaces, particular cattle and/or cultures, preservation of particular or high quality varieties etc.), and enhance highly transparent farming. In terms of environmental issues, IoT-based vertical farming can provide great benefits including more efficient water usage, or optimization of inputs and treatments. Now, let's discuss the major applications of IoT-based vertical farming that are revolutionizing agriculture.

2. History of Vertical Farming

Although vertical farming have only begun to appear on the agricultural scene in the last decade and the historical theories, discoveries, inventions, and prototypes that have led to the evolution of the modern vertical farm are listed below.

a) **600 BC — The one of the best** and earliest example of a "vertical farm" is the legendary Hanging Gardens of Babylon, built by King Nebuchadnezzar II more than 2,500 years ago.

b) **1909 —** Life Magazine publishes the earliest drawing of a "modern" vertical farm. The sketch shows that the open-air layers of vertically stacked homes set in a farming landscape, all cultivating food for consumption.

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c) **1915 —** The term "vertical farming" is coined by American geologist Gilbert Ellis Bailey in his book of the same name. Interestingly, Bailey focuses primarily on farming "down" rather than "up." That is, he explores a type of underground farming in which farmers use explosives to be able to farm deeper, thus increasing their total available area and allowing for larger crops to be grown.

d) **1937 —** The term "hydroponics" is coined in an article published in Science magazine. Derived from the Greek words "hydro," or water, and "ponos," or labor, the term was suggested to Gericke as an alternative to "aquaculture" (which was already in use to describe fish-breeding techniques) by his University of California associate, botanist William Albert Setchell.

e) **1940 —** World War II sees hydroponic growing systems used on a large scale for the first time in modern history. More than 8,000 tons of fresh vegetables are produced hydroponically on South Pacific Islands to feed the Allied forces stationed there.

f) **1999 —** The concept of the modern vertical farm is developed in a class led by Columbia University environmental health sciences professor Dr. Dickson Despommier. Despommier and his students developed the idea of a multi-story building in which layers of crops could be grown on each floor:

g) **2006 —** The Japanese company Nuvege develops one of the essential ingredients for indoor vertical farms: a proprietary light network that balances light emissions in order to increase the return rate of vegetables.

h) **2009 —** The first modern vertical farm is built. Sky Green Farms' Singapore facility consists of more than 100 towers, each of which is 9 meters tall, that grow green vegetables using sunlight and captured rainwater.

3. Benefits of vertical farming:

There is a wide range of possible benefits when farming vertical. Due to the closed system pests and diseases have less chance causing damage to a crop. Another advantage is that produce can be produced year round and can be produced close to its market, avoiding high transport costs and related CO_2 emissions. Newest developments show the integration of small vertical farming systems into supermarkets.

Environmental benefits:	Environmental benefits:	Social benefits:	Economic benefits:
Reduction of Water Demands	New Landscape Opportunities	Job Opportunity	Economic Opportunity For Land Scarcity
Energy Saving	Reduction of Urban Head Island	Greater Community	Return of Investment
More Productivity Per Unit of Area	Protect From Natural Disease	Visual Amenity	Minimization of Energy Cost
Healthy Food Provision	Reduction of Herbicide and Pesticide Manufacture	Education	Low Price of Food

Reduction of Carbon Footprint And The Effect of Air Quality	More Productivity Per Unit of Area	Improved Food Security	Community Economic Growth
Reduces Fossil Fuel	Resilient to Climate Change	Leisure	Economic Opportunity For Land Scarcity
Recycling of Organic Waste	Acting As a Sound Insulator	Psychological/Spiritual Health	Return of Investment

(source: Sankar *et al.,* 2015/ Opportunities and challenges in sustainability of vertical eco-farming: a review)

4. Systems for Vertical Farming

There are three systems that can provide the nutrients for the plants in vertical farming:

a) Hydroponic:

The predominant growing system used in vertical farms, hydroponics involves growing plants in nutrient solutions that are free of soil. Th e plant roots are submerged in the nutrient solution, which is frequently monitored and circulated to ensure that the correct chemical composition is maintained.

b) Aeroponics.

The term "aeroponics," defined as "growing plants in an air/mist environment with no soil and very little water." Aeroponics systems are still an anomaly in the vertical farming world, but they are attracting significant interest. An aeroponic system is by far the most efficient plant-growing system for vertical farms, using up to 90% less water than even the most efficient hydroponic systems.

c) 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. Although aquaponics is used in smaller-scale vertical farming systems, most commercial vertical farm systems focus on producing only a few fast-growing vegetable crops and don't include an aquaponics component. This simplifies the economics and production issues and maximizes efficiency.

5. IoT

Internet of Things (IOT) is a global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. It will offer specific object identification, sensor and connection capability as the basis for the development of independent cooperative services and applications. These will be characterized by a high degree of autonomous data capture, event transfer, network connectivity and interoperability. The IOT system architecture is generally divided into three layers: the perception layer, the network layer, and the service layer (or application layer), as shown in Fig.

Perception layer: It is the information origin and the core layer of IOT. All kinds of information of the physical world used in IOT are perceived and collected in this layer, by the technologies of sensors, wireless sensors network (WSN), tags system (GPS), intelligent terminals, electronic data interface (EDI), objects, and so like.

Network layer: This layer, also called transport layer, including access network and core network, provides transparent data transmission capability. By the existing mobile communication network, radio access network, wireless sensor network (WSN) and other communications equipment, such as global system for mobile communications (GSM), general packet radio service (GPRS), worldwide interoperability for microwave access (WiMax), wireless fidelity (WiFi), Ethernet, etc., the information form perception layer can be sent to the upper layer. At the same time, this layer provides an efficient, reliable, trusted network infrastructure platform to upper layer and large scale industry application.

Service layer: This layer, also called application layer, includes data management sub-layer and application service sub-layer. The data management sub-layer provides processing complex data and uncertain information, such as restructuring, cleaning and combining, and provides directory service, market to market (M2M) service, Quality of Service (QoS), facility management, geomatics, etc. by service oriented architecture (SOA), cloud computing technologies, and so on (Jia *et al.,* 2012). The application service sub-layer transforms information to content and provides good user interface for upper level enterprise application and end users, such as logistics and supply, disaster warning, environmental monitoring, agricultural management, production management.

The entire controlling service is performed automatically without any human intervention for developing the IoT based vertical farming.

The process is based on the following steps:

1. The sensed data from the sensor such as temperature sensor, humidity sensor or light sensor are sent to the sink (wireless sensor node) through the wireless communication protocol.
2. The sensed values are stored in the server data base.
3. The values are then sent to the actuator through the wired communication protocol.
4. PLC decides on the action after analyzing the values for the corresponding crop.
5. The control action is performed on the corresponding control equipment to maintain the optimal condition in the environment.

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Normalized Difference Vegetation Index (NDVI) and its role in Agriculture

Article id: 22507

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INTRODUCTION

Agriculture is the backbone of Indian economy providing food security to nearly 1.3 billion of people and it also provides about 55% of employment generation. The growth of agricultural and horticultural crops is often limited by different biotic and abiotic factors which limits the productive potential of the system. Precision agriculture is an innovative tool that has the components i.e. GIS (Geographic Information System), GPS (Global Positioning System) and RS (Remote Sensing) which use variable rate technology (VRT) for agro-inputs, increasing their efficiency and productivity of the system. There are different indexes used in agriculture to access field variability and track the vegetation health i.e. Normalized Difference Vegetation Index (NDVI), Enhanced Normalized Difference Vegetation Index (ENDVI), Visual Atmospheric Resistance Index (VARI), Green Difference Vegetation Index (GDVI), Normalized Difference Red Edge (NDRE), Soil Adjusted Vegetation Index (SAVI) etc. NDVI is one of the indexes used in remote sensing that mainly differentiate vegetation from non-vegetation and also used to differentiate healthy and stressed vegetation.

What is NDVI?

Normalized difference vegetation index (NDVI) is widely used to quantify the vegetation health by measuring index of plant greenness. It is simply is an indicator of plant's health based on how does plant reflect different wavelength of light. Mathematically, it is the combination of reflectance data in red and near infrared region which differentiate sick plant from healthy or non-plant. Healthy vegetation is abundant in chlorophyll which absorbs more wavelength of blue and red region of visible spectrum and reflects more wavelengths of green and near infrared region.

$$NDVI = \frac{(NIR - Red)}{(NIR + Red)}$$

NDVI value ranges from -1 to +1. The healthier the plant, the more near infrared wavelength it reflects, more red wavelength it absorbs and the NDVI value will be nearer to +1. The unhealthier plants or place having scarce vegetation reflects more wavelength in red region which declines the NDVI value to 0.5 in scarce vegetation or nearly 0 in bare soil. *In case of active vegetation, NDVI cannot be zero or less than that, because reflection of red spectrum is always lower than near infrared due to red light absorption by chlorophyll.*

Table 1: NDVI values and health rating of plants

NDVI of plant	Health rating
- 1 to 0	Dead plant or inanimate object, red
0 to 0.33	Unhealthy or stressed plant, orangish red and yellow
0.33 to 0.66	Moderately healthy plant, plant looks tint green
0.66 to 1	Very healthy plant, green

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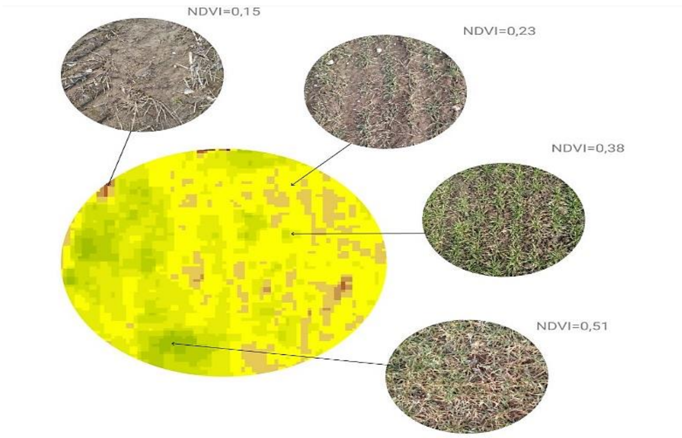

Figure 1: Status of vegetation, NDVI value and sensor visualization

Use of NDVI in agriculture

There are different instruments working on the principles of NDVI are used in precision agriculture i.e. Green seeker. Some of the use of NDVI data in agriculture and crop husbandry are;

1. Study in field heterogeneity i.e. healthy and unhealthy vegetation
2. Early assessment of plant stress because the sensor can detect what the human eyes can't
3. Quicker and labor-saving technique for monitoring variability in vegetation health
4. Can distinguish between cropped field and bare field for the ease of crop insurance
5. LAI estimation and crop acreage estimation
6. Efficient application of agri-inputs using VRT applicator
7. Tracking in-season crop growth and crop growth between seasons
8. Tracking pasture growth and its utilization
9. Identifying resistant weeds
10. Creating variable rate map
11. Targeted fertilizer application and irrigation management
12. Understanding crop dynamics and tracking hail, storm, drift or frost events
13. Tracking previous crop performance when purchasing agricultural lands

NDVI users can estimate a large number of vegetation properties from derived NDVI values i.e. leaf area index, biomass, leaf chlorophyll concentration, crop productivity, vegetation cover etc.

Limitations of NDVI

Despite of several widespread and useful application, NDVI has certain limitations i.e. saturation, soil background, angular effects, reduced efficiency in cloud weather, cannot differentiate vegetation heterogeneity when the growth is fast and index losses sensitivity when the plant reaches a certain developmental threshold.

To address these limitations of NDVI, numbers of derived alternative indices have been developed i.e. Perpendicular Vegetation Index (PVI), Soil Adjusted Vegetation Index (SAVI), Atmospheric Resistant Vegetation

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Index (ARVI), Enhanced Vegetation Index (EVI), Ratio Vegetation Index (RVI) and Global Environment Monitoring Index (GEMI).

CONCLUSION

NDVI principle is used widely in sensors like UAVs, green seeker, VRT applicators and different satellites. Though NDVI is a great tool to access the heterogeneity in crop field remotely and quite earlier, only the NDVI data is not enough to get precise information about the reason behind the vegetation status or stress condition. To get the precise information as far the precision agriculture is concerned, NDVI information comparing with some correlated parameters i.e. soil, climate, yield etc. using multivariate geostatistics can be more effective and useful.

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Ecosystem services provided by the Pollinators

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INTRODUCTION:

Any unit that includes all of the organisms (i.e. the community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e. exchange of materials between living and nonliving parts) within the system is an ecological system or ecosystem (Odum, 1971). Human derive benefits from ecosystem, which are termed as ecosystem services. Ecosystem services are the many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems. Such ecosystems include, for example, agro ecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. These ecosystems functioning properly provides such things like agricultural produce, timber, and aquatic organisms such as fishes and crabs. Collectively, these benefits are becoming known as **'ecosystem services'**, and are often integral to the provisioning of clean drinking water, the decomposition of wastes, and the natural pollination of crops and other plants.

What are the ecosystem services?

A wide range of conditions and processes through which natural ecosystems and the species that are part of them, help sustain and fulfill human life (Daily *et al*., 1997)

Provisioning services are the products directly obtained from ecosystems (e.g., food, fiber, timber), Regulating services are the benefits obtained from the regulation of ecosystem processes (e.g., climate regulation, water regulation, pest and disease regulation), supporting services are indirect services, as they are necessary for the production of provisioning, regulating or cultural services (eg., soil formation, nutrient cycling, photosynthesis), and cultural services are nonmaterial benefits people obtain from ecosystems (eg., aesthetic values, recreation and ecotourism cultural diversity)

Pollinators: Animals that transfer pollen from the anthers to the stigma of a flower, enabling the flower to set seed and fruit (fertilization and, through cross-fertilization, they play an important role in maintaining plant diversity. Eg; bees, flies, butterflies, moths, wasps, beetles, thrips

In the higher plants, sexual reproduction and perpetuation of species are brought about through pollination. These plants may be self-fertile or self-infertile, which require cross pollination. The good example of the dependence of plants upon insects for pollination is Smyrna fig that is dependent on agaontid fig wasp, *Blastophaga psenes* that transfers pollen from Capri fig. The process of fertilizing figs with fig wasps is called caprification. To aid the cross pollination for effective seed/fruit set, pollinators are required. There are different species of pollinators that are found in the nature. The important one being honey bees. The practice of rearing bee colonies for pollination service started in USA by about 1910. The number of colonies to be kept in a field for obtaining maximum yields also matters and it is generally recommended that five colonies are required for two hectares of crop.

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Pollination Syndromes

Pollination syndromes are suites of flower traits that have evolved in response to natural selection imposed by different pollen vectors, which can be abiotic (wind and water) or biotic, such as birds, bees, flies etc. These traits include flower shape, size, colour, odour, reward type and amount, nectar composition, timing of flowering, etc. For example, tubular red flowers with copious nectar often attract birds; foul smelling flowers attract carrion flies or beetles, etc.

Two basic types of pollination exist: abiotic pollination and biotic pollination. Abiotic pollination occurs without intervention from another living organism. Biotic pollination occurs with the help of insects or other living creatures. Abiotic and biotic pollination may occur through different methods.

Pollination syndromes are

1. **Abiotic pollination syndromes**

Anemophily: The process of pollination by wind (wind pollination)

Hydrophily: The process of pollination by water is referred to as hydrophily

2. **Biotic pollination syndromes**

Mostly biotic pollination is due to insects

Cross pollination aided by

Bees (Honeybees, bumble bees, Orchid bees, etc)	Melittophily
Hawk moths	Sphingophily
Small moths	Phalaenophily
Flies (Syrphid flies)	Myophily
Butterflies	Psychophily
Beetles	Cantharophily
Ants	Myrmecophily
Wasp	Sphecophily
Ant	Myrmecophily
Carrion fly	Saprophily

Table 1: Different pollinators which play vital role in pollination (Abrol, 2009)

Bees	73%
Flies	19%
Bats	6.5%
Wasps	5%
Beetles	5%
Birds	4%
Butterflies	4%

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Animal pollination plays a vital role as a regulating ecosystem service in nature: Globally 90 % of wild flowering plants depend on animal pollination

>3/4th of global food crops rely on animal pollination for yield and/or quality: Pollinator dependent crops contribute to 35% of global crop production volume

Determination of economic value of pollination

- Economic value (EV)= Production x Price of commodity
- Economic Value of Pollination Service(EVP)= EV x DR
- DR- dependence ratio (Klein *et al.*, 2007)
- Vulnerability to pollinator decline = EVP/ EV

Table 2: Economic value of animal pollination services to Indian agriculture

Crop/ Commodity	Crop product value (crores)	Economic value of pollination (crores)	Increase due to animal Pollination (%)
Cereals	365 793.00	0.00	0.00
Oilseeds	129 143.00	43 993.08	34.07
Fruits	129 030.05	17 142.27	13.29
Vegetables	175 777.81	1 9498.20	11.09
Fibers	73 917.05	17 290.66	23.39
Condiments and spices	39 684.57	10 121.19	25.47
Pulses	67 574.00	1 236.13	1.83

(Modified from Chaudhary and Chand, 2017)

CONCLUSION: Pollination is one of the important component of regulating ecosystem services provided by pollinators. Pollinators can be of managed or wild type, managed pollinators are mainly Italian bees, Indian bees and Bumble bees, wild pollinators ranges from invertebrates to vertebrates viz., wild bees, butterflies, moths, birds, bats. Environmentally, 66 % of angiosperms require animal pollination for sexual reproduction. Most of the food crops need insect (mainly bee) pollinators for sufficient successful pollination. Oil seeds, vegetables and many fruit crops are profoundly reliant on pollinators. Recent past bee population has declined drastically, which had a negative impact of 30-90% on bee keeper's economy. Major reasons for this decline are habitat destruction, fragmentation and degradation, intensive agricultural practices, climate change and colony collapse disorder. Thus, considering the worth of ecosystem services provided by pollinators, it is high time to protect, conserve and augment them.

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Mechanism of stress tolerance in vegetable crops with reference to frost and heat stress

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Frost stress

- ✓ Higher crop losses occur in tropical highlands and subtropical plains where frosts can occur any time during the crop growth period. Temperatures below –2°C in the field can produce partial or complete loss of the crop.
- ✓ In temperate zones, frosts can occur during spring when the crop is establishing itself, or during autumn when the crop is maturing.
- ✓ Low temperatures can damage plants both by a chilling effect, leading to physiological and developmental abnormalities, and by freezing, causing cellular damage directly or via cellular dehydration.
- ✓ Low temperature affects plants by causing dehydration of the cells and tissues through the crystallization of the cellular water. Under low temperature, a decrease in the conductivity of membrane, an increase in viscosity of water, and the stomata regulation would result in water stress.

Table 1.0 Plants can be categorized into the following responses with respect to low temperature

Sn.	Sensitivity	Temperature
1	Chilling sensitive	Sensitive to low temp. Above 0°C
2	Tender	Light frost or near temp. 0°c
3	Slightly hardy	Survive freezing temp. To -5°C
4	Moderately hardy	Survive freezing temp. Within -5°C to -10°C
5	Very hardy	Survive freezing temp. Within -10°C to -20°C
6	Extremely hardy	Most tolerant species, characterized largely by the ability for super cooling

Mechanism of resistance to low temperature stress

- ✓ Needle like leaf structure - prevent freezing and transpiration
- ✓ Terpenes and alcohol - anti freeze factor
- ✓ Anti-freezing protein e.g. - Production of Dehydrins (stress protein)

Cold Acclimation

- ➢ Increasing the amount of phospholipid.
- ➢ Metabolic alterations -osmotic adjustment through - osmoprotectants.
- ➢ Exploiting cryoprotective and antifreeze proteins – e.g. fish anti-freeze proteins
- ➢ Manipulation of signal pathways leading to expression of tolerance genes.
- ➢ Calcium level- inside the cell - lead to expression of genes
- ➢ Level of ABA will decrease the GA_3, ethylene and cytokinin signalling - super cooling, depression of the freezing point and reduction in freezable water amount. At any rate, the condition for internal freezing is that the temperature of the cell sap falls below its freezing point. Ice first starts to form on the cell walls outside the cells, where it normally grows at the expense of water which diffuses from cells. If this keeps pace with the fall of temperature, the resulting increase in its concentration will prevent the sap from freezing.

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Resistant to frost in vegetable crops

The optimum temperature for watermelon (*Citrullus lanatus)* growth ranges from 20 to 32°C*.* Exposure to chilling temperatures may stunt the plant's growth, induce wilting and necrotic lesions on leaves, and increase susceptibility to diseases and pathogens.

- ✓ Pre-treatment of watermelon seedlings with Salicylic acid enhances the chilling tolerance through activations of antioxidative capacity*.*
- ✓ Interspecific hybrid between *Cucurbita maxima x C. moschata or fig leaf gourd* can be used as rootstocks for watermelon and melon against low soil temperature in winter greenhouses.
- ✓ The watermelon genotypes most tolerance to chilling were PI 244018 and 'Charlee'. a single dominant gene (*Ctr)* governs the resistance against cold temperature suitable low temperature is 10℃ and suitable exogenous Salicylic acid (1.0 mmol/L) enhances the cold tolerance of watermelon seedlings through activations of ant oxidative capacity.

Plant growth and development of tomato is severely affected by cold. For example, delayed onset, decreased rate of seed germination and poor crop establishment and performance are observed. At later stages, cold stress results in reduced plant growth and development, poor flower development and fruit set and substantial reduction in fruit yield. *Solanum habrochaites* has the ability to sustain chilling stress due to its inherent characteristics. Lower temperatures of less than 20 C also reported to reduce the growth-related traits in capsicum. In Onion the cardinal temperatures for optimum seedling growth, vegetative growth, before bulbing and bulb development are 20–25, 13–24, 15–21 and 20–25 C, respectively. Very low temperatures at bulb development stage favour bolting. Sudden rise in temperature results in early maturity of the crop during winter season, thereby reducing bulb size. Carrot - poor root colour in 10-15.6 °C (15-21 °C opt).

Table 2.0 Varieties developed in vegetable crops for resistance of abiotic stress

Sn.	Crop	Variety/ species	Tolerance for
1	Tomato	IIHR 14-1, 146-2, *L. pennelli, L. chilense*	Drought tolerant
		Sabour Suphala, L. cheesmanii, L. galapagense	Salt tolerance
		Phillipines, Punjab Tropic, Pusa Hybrid 1, EC 130042, EC 162935, L. cheesmanii	Heat tolerance
		Fire ball, Red Cloud, Pusa Sheetal, Tempo, *L. Pimpinellifolium, L. habrochaites*	Cold tolerance
2	Brinjal	PKM-1, *S. macrocarpum, S. gilo*	Drought tolerant

Table 3.0 List of transgenic research for various stresses

Sn.	Gene	Gene action	species	Phenotypic expression by transgenic plant	Reference
1	Hsp17.7	Heat shock protein	*Daucus carota L.*	Increased and decreased thermotolerance	Malik *et.al.,* 1999
2	DcHSP17.7	Heat shock protein	*S. Tuberosum L.*	Improved cellular membrane stability and enhanced in vitro tuberization	Ahn and Zimmerman, 2006

Table 4.0 Breeding approaches

Sn.	Crop	Method	Species / cultivar	Effect	Reference
1	Tomato	Selection and backcross	*Lycopersicon pimpinellifolium* X *L.esculentum*	Salt tolerance (Na2So4)	Lyon ,1941
2	Tomato	Pedigree	*L. cheesmani* X *L. esculentum*	Increased salt tolerance	Rehman *et.al.,* 2005
3	Tomato	Pedigree	'LA1777' *(Solanum habrochaites)*	Cold Stress Tolerance	Cao *et al.,* 2014

Table 5.0 Abiotic stress tolerance through grafting

S. No	Scion plant	Rootstock	Effect
High temperature			
1	Tomato	*S. laciniatum*	Resistant to water logging
2	Brinjal	*S. integrifolium*	Tolerant to high
Low temperature			
1	Tomato	*S. lycopersicon x S. habrochaites*	Higher yields even at 10˚C to 13˚C
2	Brinjal	*S. integrifolium x S. melongena*	Higher yield even at 18˚C to 21˚C
Water logging			
1	Pepper	'PP0237-7502', 'PP0242-62' & 'Lee B'	Flooding tolerance

CONCLUSION

Crop production faces many challenges, due to changing environmental conditions and evolving needs for new plant-derived materials. No one approach will provide all the solutions. Rather, progress will be made by combining the existing approaches of breeding, Plant breeders need to translate these findings into stress-tolerant crop varieties by using all tools available that include germplasm screening, marker-assisted selection, plant transformation, and conventional breeding methods, which are enhanced by molecular markers linked to traits of interest, mining of novel alleles from germplasm collections, and introduction of novel alleles or variants of existing alleles from mutant populations.

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Agronomic managements for efficient utilization of water resources to augment sustainable production in rainfed agriculture

Article id: 22510

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INTRODUCTION

About eightieth of worldwide agriculture is underneath rainfed agriculture and it plays a major role for achieving universal food security. The percentage of rainfed agriculture is 60% in South Asia, 95% in Sub-Saharan Africa, 65% in East Asia, 90% in Latin America and 75% in North and Near East Africa (FAO, 2003). Indian agriculture virtually relies on the arrival the monsoon. Dry land and rainfed agriculture has a distinct place in Indian agriculture, occupying around 108 m ha area (75%) out of 143 m ha net cultivated area. Despite considerable progress in irrigation development since 1950s, 86% of coarse cereals, 84% of pulses, 42% of rice, 74% of oilseeds and 65% of cotton are still cultivated as rainfed. Rainfed and dry land agriculture contributes 40% of food grain production and supports half of the human and two-third of the livestock population. In rainfed areas, all the rainfall received is not available for the crops and a significant part is lost as run off. Moisture stress further affects the nutrient availability to the crop since nutrient mobility depends on optimum soil moisture. In fact, successful rainfed farming chiefly depends upon the success with which the rains that fall during any season of the year may be stored and kept in the soil until needed by plant for their growth. In the coming future, India will have to produce 300 million tonnes of food grains to feed her burgeoning population. This target cannot be realized from irrigated areas alone. An appropriate technology has to be evolved for rainfed and dry land farming. On the other hand, it can be said that second 'green revolution' in Indian agriculture can be done in rainfed or dry land agriculture. This can be necessary to boost the quality of living of the farmers residing in these areas, further it's predicted that even when full irrigation potential is utilised by 2030 more than 50% of area will still stay rainfed.

Problems of rainfed areas

The cropping in the semi-arid and arid regions still continues to be under rainfed situation. The soils of dry land areas are not only thirsty but also hungry. The poor resource base of small farmers in this region permits only low input subsistence farming with low and unstable crop yields. The low productivity of agriculture in dry land farming regions is because of the accumulative impact of the many constraints for crop production *viz*. frequent drought, very little or no biomass recycling, low soil organic matter (SOM), multi-nutrient deficiencies, depletion of nutrients by crops, sub-optimal nutrient application, low nutrient use efficiency etc. being the key constraints in enhancing productivity within the rainfed and dry land areas. Attributable to the above mentioned reasons at current times, three ha of dry land crop produce cereal grains equivalent to that produced in one ha irrigated crop. Increase within the intensity or extended length of drought could lead to a big decline in food production. The soils of dry lands are extremely degraded and have low soil organic carbon concentration attributable to a high rate of oxidation and accelerated erosion (Srinivasarao *et. al.*, 2011). The magnitude of soil loss ranges from five to hundred and fifty Mg ha^{-1} year^{-1} relying upon soil category, vegetation, and slope gradient (Maji, 2007). About 30% of farmers in remote rainfed areas of the country don't

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use any chemical fertilizers or pesticides (Venkateswarlu, 2008). The information in Figure 1 compares the chemical fertilizer consumption in rainfed and irrigated areas in high grain producing states of India.

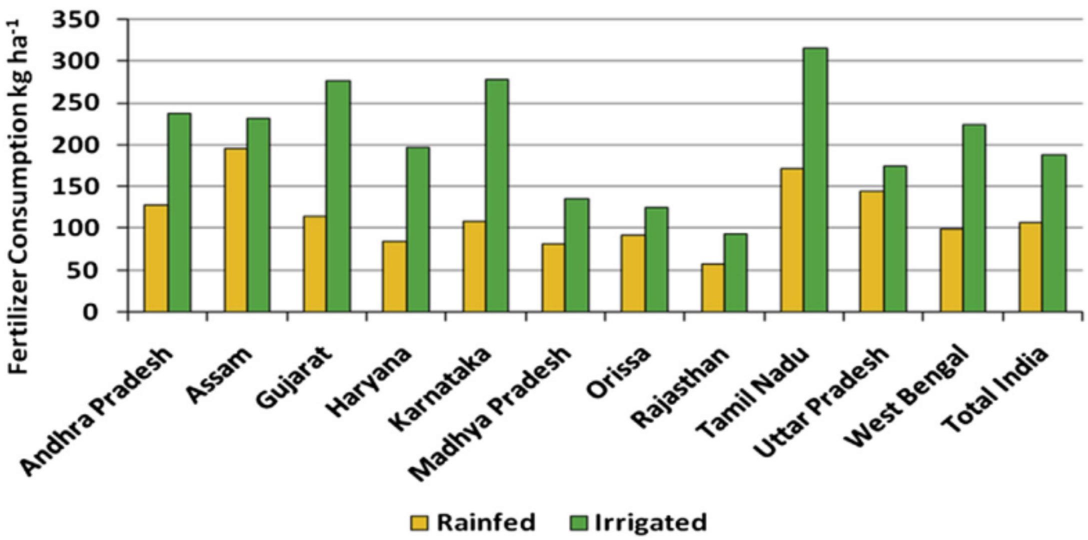

Fig 1: Comparative consumption of fertilizers (NPK) in rainfed and irrigated farming areas (Source: Srinivasarao *et. al*., 2014)

Why the focus is on rainfed agriculture?

The productivity of grains already showed a highland in irrigated agriculture thanks to issues associated with nutrient exhaustion, salinity build up and raising water table. Since crop productivity in irrigated areas has reached a plateau it's argued that bulk of future increases in food production have to come from rainfed areas. Agriculture in India has been a mainstay for growing population over millennia. Nonetheless, there is no substitute to agriculture to feed and fulfil the requirements of growing population. The population of India may reach 1.34, 1.39 and 1.81 billion in 2020, 2025 and 2050 respectively (Srinivasarao *et. al*., 2014). India is facing the biggest challenge of meeting the food demands by increasing the production (per unit land) simultaneously without degrading the soil and water resources and maintaining a favourable ecological balance. The demand for cereals is projected to grow from 185 million metric ton in 1944-1995 to 270 million metric ton in 2024-2025. Therefore, the challenges of the present millennium would be to produce more from dry land while ensuring conservation of existing resources, the soil and water. Hence, new strategies ought to be used which would conserve the water and the fragile soil of dry land ecosystems.

Major factors/ water saving methods contributing to successful rainfed agriculture

Land configuration and tillage management are the practices of manipulating or managing the soil surface for the purpose to retain the maximum rain water in the soil profile while providing optimum conditions for growth of plant.

- ***Ridge and furrow***

Furrows of 30-45 cm width and 15-20 cm height are shaped across the slope. The furrows collect and store water when rainfall intensity is less and guide runoff water safely when rainfall intensity is high and avoid water stagnation. It is appropriate for medium deep to deep black soils and deep red soils. It is not fitted for shallow red soils, shallow black soils and sandy gravelly soils. It is not suitable for broadcast sown crops and for crops

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sown at closer row spacing less than 30 cm. It has also been reported that planting of pearl millet and mustard under ridge and furrow system recorded significantly higher grain yield, consumptive use and water use efficiency as compared to their flat sowing.

- ***Broad Bed and furrows***

It implies shaping of land into alternate beds and furrows. This practice has been recommended by ICRISAT for Vertisols or Black soils in high rainfall areas (>750 mm). Here beds of 90-120 cm width, 15 cm height and convenient length are formed, separated by furrows of 60 cm width and 15 cm depth. When runoff happens, its speed is reduced by the beds and infiltration opportunity time is amplified. Crops are sown on the broad beds and excess water is drained through number of small furrows which may be connected to farm ponds. Planting of sunflower under BBF method registered higher soil moisture content and seed yield as compared to flat sowing.

- ***Dead furrows***

Dead furrows (idle furrow) are laid across the land slope in rolling lands to intercept the run off. At the time of sowing or after sowing, deep furrows of 20 cm depth are formed at intervals of 2 to 5 m or 6 to 8 rows of crops. This system worked well with Alfisols. No crop is raised in the furrow. The dead furrow reduces velocity of runoff and increases the infiltration opportunity time.

- ***Tie-ridging***

The practice of tie-ridging, where adjacent ridge are joined at regular intervals by barriers or ties of the same height, allows the water to infiltrate and prevent runoff except during intense storms. This technique is satisfactory in moderate rainfall areas, except on extremely steep slopes.

- ***Compartmental bunding***

This method is one of the cheapest rainwater conservation techniques suitable for rainfed vertisols having slope of less than 1%. By this method the entire field is divided into small sections, which helps in storing the initial rainfall and permitting increased infiltration rate. This ensures rational moisture distribution as well as optimum better germination of seeds. In *kharif* fallowing, this practice enhances enough rain water inventory in the soil profile for raising *rabi* crops on the conserved moisture.

- ***Tillage***

Tillage is a well-known soil and water conservation practice which makes soil surface more permeable to increase infiltration of rainwater into the soil, which in turn reduces runoff, soil and nutrient losses and enhance crop yields. Deep ploughing is taken up to break hard pan and it also improves physical characteristics of black soils. It has to be done to a depth of 22 cm (tractor plough) in Vertisols once in 3 years with faster penetration of rain water, eradicate pernicious weeds and results in higher crop yields. In dry farming, the soil becomes vulnerable for hardness when kept fallow during summer months. At the instance of rainfall, the raindrops beat the top surface of soil and make them split and cause heavy loss of top soil transported along with the runoff waters. To prevent loss of top soil and runoff, off-season or summer ploughing is done which helps the soil to absorb the rains during monsoons and conserve the same as soil moisture for crop growth. Conservation tillage, which ensures at least 30% coverage of the soil surface with crop residue amuses extremely vital role in organic carbon build up and soil and moisture conservation under dry land. Conservation tillage is an umbrella term and it envisages stubble mulch tillage, minimum tillage and no tillage. Low intensity tillage favours consolidation of soils and imparts erosion resistance through better consolidation, structure, infiltration, and pore distribution and depression storage.

- ***Soil conditioners***

Soil conditioners are materials which when added to the soil help in improving or maintaining its physical conditions with improved physical and chemical health of soil. Under different soil conditioners hydrophilic polymers are used to improve the moisture holding capacity of soil. Pusa Hydrogel is an indigenous product designed and developed by scientists of Indian Agricultural Research Institute, New Delhi to enhance the crop productivity per unit available water and nutrients, particularly in moisture stress agriculture. Pusa Hydrogel remains stable in soil for a minimum period of one year and less affected by salts.

- ***Mulching***

Mulching is the process of applying any material (organic or inorganic) on the soil surface to check evaporation and improve soil water. Mulches in addition to reducing evaporation losses of moisture also bring about conspicuous effect on numerous soil properties and conditions directly and indirectly such as runoff control, increased infiltration, erosion control regulation of soil temperature, improvement of soil structure, control of weeds and reduction in salinity. Dust mulches are formed by intensively hoeing the soil surface. It creates a finely textured layer of soil. It breaks the soil capillarity, reducing the evaporation loss of soil moisture. Stubble mulch is done by leaving the organic residue of the crop on the ground. Crop residues like wheat stubble or cotton stalk etc. are left on the soil surface as stubble mulch. It prevents soil erosion from wind and water. Straw or stover mulching involves application of straw or stover to create a protective cover over the entire surface or part of the soil surface. It helps in reduction of evaporative losses of water and conserves soil moisture. It also helps in reduction of soil erosion, suppresses weed growth. Live mulch is mix of fast growing plants that are planted around the main crops. Live mulch is an excellent way to rejuvenate arid land or fill areas which don't have plans to be cultivated. Live mulch with ground cover crop suppresses weed. Plastic mulch is completely impermeable to water. It prevents evaporation of moisture. It helps in moisture conservation. Plastic materials like Polyethylene, PVC of 25-50 micron thickness are used as mulching materials. Different plastic mulches are selected based on the situation e.g. rainy season – perforated, orchard and plantation – thicker, soil solarisation – thin transparent film, and summer cropped land – White film.

- ***Vertical mulch***

An excellent technique used in black soil to improve infiltration and storage of rain water in soil. Trenches of 40 cm wide, 15 cm deep are dug at 2-4 m interval across the slope and filled with stubbles or organic waste to a height of 10 cm above soil surface. Runoff is checked, collected in trenches and redistributed to adjoining soil layers.

- ***Transpiration suppressant***

Any material applied to transpiring plant surfaces with the aim of reducing water loss from the plant is called transpiration suppressant. The best anti-transpirant reduce transpiration by 30 to 40% without causing much effect on CO_2 diffusion and photosynthesis rate. Benefits of anti-transpirant are, optimized yield levels under infrequent rainfall conditions, improved seed quality (so that manufacture may be used for seed purpose), saving of crops with marginal crop productivity under drought, reducing irrigation especially in post-rainy long duration crops like cotton and pigeon pea, minimizing irrigation frequency and saving water through drip irrigation, monitoring / managing drought etc.

- ***Ex-situ water conservation***

Ex-situ water conservation is the process of collecting and concentrating runoff water during periods of peak rainfall into an on-farm water reservoir such small farm pond, tank etc. for future productive uses. Harvested water is used to provide protective/supplemental irrigation for survival of crops in drought prone areas with erratic rainfall. Critical irrigation with a small quantity of water harvested in a pond is of immense value to improve and stabilize the dry land crop production and to build up confidence in farmers of dry land areas. Such irrigation when provided at critical growth stage or as pre-sowing irrigation can increase crop yield many folds. The following pictures show some *ex-situ* water harvesting and conservation structures.

- ***Watershed development***

Watershed is a Geo-hydrological unit that drains at a common point. Watershed management is relevant to low rainfall areas focusing on Conservation of Water. The watershed development approach in India has evolved over time, based on the knowledge gained from various programmes. For ensuring tangible economic benefits to individual farmers, women and vulnerable group members, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed an effective consortium approach for integrated watershed development (Wani *et. al.,* 2003) and the approach is used for up scaling in India and other Asian countries (China, Vietnam, Thailand and Philippines) (Wani *et. al.,* 2006). The public–private partnerships (PPP) in the area of integrated watershed development and management are emerging (Wani *et. al.,* 2007) and are also encouraged by the Government of India. For monitoring the impact of watershed programmes on various aspects, appropriate indicators are being evaluated (Shah, 2007). At the micro-level, a number of detailed case studies (Shiferaw *et. al.,* 2006) were evaluated and analysed to observe the micro-level impacts of different watershed programmes in the country.

- ***Choice of crops***

The suitability of the crop in the region depends on many factors like a. rainfall pattern, b. onset of rainy season, c. length of the rainy season, d. soil type, and e. socio-economic conditions of the farmers. The criteria for choice of crops for rainfed farming regions may be followed to have better yield potential of the areas e.g. tolerance to drought, fast growth during initial period to withstand harsh environment, genetic potential for high yield, short or medium duration to escape terminal drought, adaptability to wide climatic variations and responsive to fertilizers. In rainfed areas farmers still are growing the traditional local varieties of most of the crops. The choice for these native varieties is based on their prominent drought tolerance. But they are typically longer in duration which makes them vulnerable to moisture stress at maturity. The criteria for selection of crop varieties for rainfed areas should include drought tolerance, short or medium duration, high yield potential, response to nutrient supply, high water use efficiency and moderate resistance to pest and diseases.

CONCLUSION

Presently, with the rapid escalation of population, the pressure towards land enhanced and therefore the size of holdings considerably diminished in spite of extending the cultivation to marginal and sub-marginal lands. Due to continuous erosion, the productivity of all lands decreased, whereas the demand for agricultural produce enhanced. As a result of all these factors, the practice of storing surplus grain and fodder in villages is bit by bit disappearing. This demands a heavy review of our research and developmental strategies in rainfed areas for creating them sustainable. Since the productivity in irrigated areas is ceaselessly plateauing, bulk of rising food demand is to be met by rainfed areas. Similarly, the livestock population is probably going to cross 650 million by 2020 AD. This leads to greater demand for fodder. Further, over-exploitation of natural resources is likely to worsen social inequality and build a bunch of socio-economic issues, such as unemployment and food and livelihood insecurity. Thus, maintaining food security in future may be a difficult task demanding intensive and extensive research and development efforts to fulfil the targets and to make rainfed agriculture viable (Sharma *and Singh*, 2006). The question presently being asked is “can we meet the recent challenges on sustainable rainfed farming which raises the worth of life and is pro-nature?” The recent past trends in Indian agriculture imply that it can be achieved, provided we tend to adopt land use diversification with multidisciplinary and holistic approach. This could embrace interactions among climate, soil, water, vegetation, and livestock, human and socio-economic dimensions in devising most effective, remunerative, eco-friendly and environmentally sound land use. Within the era of “Population Boom", to feed the increasing population of the nation, we have to relinquish our attention to the rainfed areas. Soil and water management holds the key for enhancing the productivity and bridging the yield gaps of rainfed areas. Water is a critical natural resource and managing rainwater *in-situ* or harvesting runoff water and recycling is the key to sustain rainfed farming.

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Germination and seedling establishment in cashew: Key factors for enhancing productivity

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INTRODUCTION:

Cashew is one of the major foreign exchange earning horticulture crops of India. Though India exports annually about 84,353 metric tonnes of cashew kernels worth about 5,870.97 crores (Anonymous, 2019), shortage of raw nuts still remains to be the major problem in the cashew industry and export earnings. India with the largest share of land under cashew (24.0%) produces only 19% of the world's total produce. One of the major production constraints in the country is that most of the plantations are senile and unproductive which has to be replaced with clones of high yielding variety (Huballi, 2009). To boost the cashew production and become self sufficient, there is a need to produce quality planting materials since large planting materials is needed for area expansion and replanting of senile and unproductive cashew orchards. Good germination and vigorous seedlings are important factors that determine the successful establishment of cashew orchards. Many of the existing cashew plantations established from nuts today exhibit delayed maturity with attendant poor early nut yield. These undesirable traits have been found to result from poor plant vigor of cashew transplants. While vigorous cashew transplants attained first flowering at 18 months after transplanting, first anthesis could be delayed until 30 months or more when plants are raised from poor planting materials (Hammed, 2008).

Factors influencing germination and seedling establishment in cashew:

Storage period and nut size:

Cashew orchards are predominantly established through seed propagation, probably because of a low success rate of field establishment of vegetative propagules. Besides, seed propagation is considered to be simple, cheap, and the root holds firmer in the soil than clones derived from vegetative methods (Hartman and Kester, 2000). Sowing of mixed seeds gives rise to non-uniform density of nursery stock. Many times, this results in the production of unhealthy and heterogeneous seedlings in the nursery. One of the reasons for the heterogeneity in the nursery stock is the high amount of variation in size and weight. Variation in the seedling size could be avoided to a great extent if the seed of uniform grade could be used for nursery sowing. Studies by Ajeesh *et al*. (2014) have shown the benefits of grading of seeds based on size and weight which in turn has regulative influence on seed germination and growth of the seedling growth in many plant species. Nut size and period of storage are an indication of the critical nature of the factors to germination and seedling development in cashew and possible room for selection of appropriate good planting materials for seedlings production in cashew orchading. Aliyu et al (2007) reported the influence of seed size and storage period on germination and seedling establishment in cashew. Germination rate (period) ranged from 17.46 to 19.41 days for large and small sized nuts. This however confirms that large nuts have higher germination rate than the smaller ones. Current season nuts germinated with average of 2 days earlier than a-year-old nuts. In terms of viability (percentage germination) of the nuts measured as a germination ratio, large nut were found to be more viable (about 87%) than the other two sizes. This observation has been attributed to the presence of large food reserve and advance embryological development in large nuts. The results also indicated that 94% of the current season nuts were viable against 38% recorded for a-year-old. Percentage germination clearly showed that cashew nut loses its viability over a long period of storage. Drastic reduction in germination percentage in old nuts can be attributed to moisture loss and increased temperature during the storage period which may result into the activation of the lipid metabolism within the nuts that eventually result into the death of embryo.

Cultivar Type and Nut-Sowing Orientation

In tropical tree crops, such as cashew with a wide variability cultivar nut size that often ranged from 2.00 to 30.00 g, the size and sowing orientation of planting nuts are very important for the recovery of uniform and vigorous plants. The efficiency of emergence of the radicle and plumule (germination) from the cashew nut depend on the degree of resistance imposed by its protective hard shell as a result of orientation at point of sowing and the property of soil medium. A wrong sowing orientation hinders emergence and results in poor germination. Studies by Hammed et al (2013) shown that cashew nuts sown with stalk-end facing down had the least chance of germination, while nuts sown on nut-side and/or stalk-end facing up had better germination rate (days and percentage). Nuts sown at nut side and stalk-end up place the micropyle in the most suitable position, i.e., pointing downward, and therefore require less germination energy for the radicle to emerge from the embryo. Hammed and Adeyemi (2005) reported that side-positioning of Indian cultivars with medium nuts resulted in higher germination and improved seedling performance.

Sowing depth, soaking of seeds in water and seed cracking

The germination of cashew is affected by several factors, particularly depth of sowing and soaking seeds in water prior to sowing (Ohler, 1979). However, information on the effect of these factors on the initial seedling development is limited. Cashew seeds may require more than ten days to germinate (Ohler 1979), a delay that is often attributed to the thick, hard shell which impedes the emergence of the plumule. Such seeds need some treatment such as heat, acid or mechanical scarification such as cracking to facilitate germination and rapid seedling development. The optimum nursery stage for cashew is 6 weeks to 3 months (Ohler 1979), and younger seedlings establish better in the field, so any delay in germination could prolong the nursery stage and adversely affect field establishment.

Several studies have shown the influence of sowing depth on germination and seedling establishment in cashew. Seeds sown at 4 cm had significantly higher germination rate after 4 weeks than those at 8 cm depth, which were also significantly higher than those sown at 12cm (Amoah, 2005). These results agree with those of Rao et al. (1957), who found the highest germination rate at 5 cm. Ohler (1979) stated that cashew seeds germinated only with difficulty if sown below 10 cm. As germination in cashew is epigeal, deeper sowing will increase the time taken for the plumule to emerge. Soaking the seeds prior to sowing had a favourable effect on seedling development, but it was less clear than that on germination. There was little significant difference between soaked and unsoaked seeds for any of the parameters. Seed cracking adversely affected germination. Soaking softens the hard, thick shell, making it easier for the plumule to emerge and enhancing germination (Auckland, 1961). Cracking should reduce the physical impendence of the cashew shell but it may also damage the cotyledon and plumule, which would reduce the germination rate. Also with seed cracking, the exposed cotyledons, which are very soft, may rot with the frequent watering of the seeds (Hartman and Kester 1983).

Bio regulators

Plant bio regulators have a marked influence on germination of cashew seed (Singh et al, 2011). GA_3 40 ppm recorded the shortest duration (9.0) and maximum germination (82.0 %). The results reported by

Shanmugavelu (1963) suggest that the seed of cashew contain sufficient quantity of auxin and hence they respond well to gibberellins than to auxin. This contention also seems to be supported by the results obtained from his studies on the natural occurrence of auxin in the seeds. It is also possible that complex interaction of gibberellins and auxin might probably regulate the seed germination. The property of GA_3 to induce better seed germination has already been reported. According to Duarte *et al.* (1991) they observed 79 - 84 % germination in cashew when seeds were soaked with GA_3 for 24 hours.

The responses of shoot and root growth in cashew due to different concentration of bio - regulators shows that, seed treated with GA3 induced better shoot growth than other treatments and the shoot growth were also found to increase with increased concentration. GA3 40 ppm produced maximum shoot growth like plant height, number of leaves, leaf length and leaf area.

Bio fertilizers

Application of bio fertilizers viz., *Azospirillum* and Vesicular Arbuscular Mycorrhizae (VAM) showed increased germination percentage of nuts and plant growth and reduced the incidence of fungal diseases in the nursery (Kumar et al, 1998). Studies by Prashikhan et al (2018) revealed that pre-sowing treatment with 48 hrs water soaking + 100 ppm GA_3 + VAM recorded minimum days for germination, maximum germination percentage, number of leaves, intermodal length, seedling height and seedling girth. Sivasubramaniam et al (2012) also reported the same where cashew seeds treated with water soak for 48 hours and GA_3 at 100 ppm gave better germination and growth. Trisilawati et al (2011) reported that inoculation of VAM significantly increased the root of cashew seedlings compared to its counterpart without VAM inoculation. Similar result was also reported by earlier findings of Ananthakrishnan et al (2004), Shankarappa et al (2017) and Sivaprasad et al (1992) in cashew.

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Drivers of methane gas emission from rice fields

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INTRODUCTION

Agricultural lands occupying 37% of the earth's land surface are a major contributor of the three major greenhouse gases (GHGs), viz, Carbon dioxide (CO_2), methane (CH_4) and Nitrous oxide (N_2O) to the atmosphere, having global warming potentials of 1, 24.5 and 320, respectively. Globally, agriculture accounts for 10–12% of total anthropogenic emissions of GHGs, estimated to be 5.1–6.1 Gt CO_2 -eq yr^{-1} in 2005, accounting for 52% of global anthropogenic CH_4 emissions. The amount of CH_4 emission from paddy fields (about 50 to 100 Tg yr^{-1}) accounts for about 10% to 30% of total global CH_4 emission. It is projected that the CH_4 emission from rice fields may increase to 145 Tg yr^{-1} by 2025. Methane concentration in the atmosphere has increased more than doubled during the last 200 years; its current atmospheric concentration of 1.8 ppm by volume, increased from 0.7 ppm in pre-industrial times, is much lower than the 345 ppm of CO_2, up from 275 ppm (Table 1). But one molecule of CH_4 traps approximately 25 times as much heat as does CO_2. Comprising 51% of the global harvested rice area, rice fields in China and India emit CH_4 at a rate of only 26-37 Tg/yr.

Table 1: Pre-industrial and present concentration of atmospheric GHGs

Gas	Pre-1750 tropospheric concentration	Recent tropospheric concentration	GWP(100-yr time horizon)	Atmospheric lifetime (years)	Increased radiative forcing (W/m^2)
Concentrations in parts per million (ppm)					
CO_2	~280	399.5	1	~ 100-300	1.94
CH_4	0.72	1.834	28	12.4	0.50
N_2O	0.27	0.328	265	121	0.20

Methane production and emissions from Rice fields

Methane production is biogenic; occurs by reduction of organic matter by methanogens in anoxic flooded rice having redox potential of less than -150 mV by the process of methanogenesis. Three processes that govern the CH_4 release into the atmosphere from rice fields (Fig. 1) are: i) Diffusion loss of CH_4 across the water surface which is the least important process. Large portions of CH_4 formed in an anaerobic soil may remain trapped in the flooded soil. Entrapped CH_4 may be oxidized CO_2 when the floodwater is drained during the rice growing

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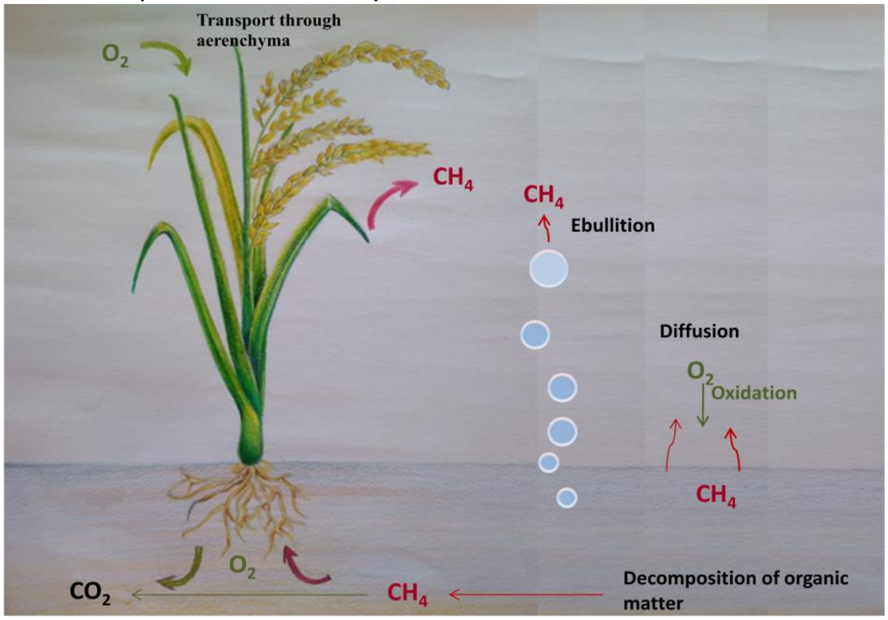
season or when the soil dries at the end of or after the rice growing season. But large amounts of entrapped CH_4 may escape to the atmosphere immediately after the floodwater recedes.



Methane oxidation:
$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Methanogenesis:
$CO_2 + 4H_2 \longrightarrow CH_4 + 2H_2O$: Hydrogenotrophic
$CH_3COOH \longrightarrow CO_2 + CH_4$: Acetrophic

Fig. 1: Methane production and emission from the rice field.

The low solubility of CH_4 in water is the limiting factor for its diffusive transport in the flooded soil, and most CH_4 is oxidized to CO_2 via methanol, formaldehyde, and formate as it passes the aerobic soil-water interface. The release of CH_4 by diffusion through the wet soil column is negligible in clayey soil, however, in sandy soils it may become significant due to bigger pores between soil particles prevail; ii) CH_4 loss as bubbles (ebullition) from paddy soils is a common and significant mechanism, especially if the soil texture is not clayey. During land preparation and initial growth of rice, ebullition is the major release mechanism. iii) The third process is CH_4 transport through rice plants, contributing around 90% of total CH_4 emitted during the cropping season and is released by diffusive transport through the aerenchyma system of the rice plants and is has been reported as the most important phenomenon.

Emission through rice plant may be expected to show great seasonal variations as a function of changes in soil conditions and variations in plant growth. Soil fauna, especially aquatic earthworms, increase emission through diffusion and ebullition when they dig into the topsoil. At the same time, oxidation of CH_4 is enhanced. In deepwater rice fields, diffusing CH_4 may only be oxidized in the upper water column, because the soil-water interface and the lower water column may be anaerobic.

As with CH_4 production, its emission rates are highly variable. A distinct diel and seasonal pattern is observed. Emission rates mediated by rice plants are highest in the early afternoon and lowest late at night, following the diel pattern of air and topsoil temperature and pH as well as oxygen concentrations in the floodwater and soil-water interface. The basic level and the diel amplitudes of CH_4 emission increase with addition of organic matter.

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In irrigated rice fields, 2-3 maxima of plant mediated emission rates are generally observed during the whole cropping season. Emission increases during the vegetative phase, sometimes with an early intermediate peak; decreases after panicle initiation and increases again after flowering, before declining at the end of the season. For irrigated rice, CH_4 emissions calculated as a function of rice produced are higher in the dry season than in the wet season. Various climatic, soil, water, and culture factors can modify this general pattern.

Drivers of Methane Emission

Methane production and emission from soil, being biologically mediated, are affected easily by the prevailing weather conditions, crop management practices, water regime and management, soil tillage, root material, fertilizer application, and organic additives;, plant physiology and soil physical, chemical and biological properties. Therefore, changes in these management practices would also offer possibilities for mitigation options. Following are some factors that govern the emission of GHG from rice fields;

a) **Temperature:** Higher soil temperature has been widely reported to increase CH_4 emissions besides other environmental factors like hours of sunshine and water levels. It regulates the rate of soil microbial activities, influences the CH_4 production by regulating anaerobic carbon mineralization, availability of alternative electron receptors and methanogenic activities. Most of the methanogenic bacteria display optimum rate of CH_4 production at around 30°C. Temperature also affects CH_4 transport through rice plant by increasing the CH_4 conductance.
b) **pH**: the activity of methanogens is very sensitive to variations in soil pH. Since most of the methanogens are neutrophils, CH_4 production is most efficient in a pH rangebetween 6.5 and 7.5.
c) **Redox Potential (Eh):** Methanogenesis can occur only in anaerobic condition. A sufficiently low redox potential is required for CH_4 production and Eh is negatively related to CH_4 emission. Flooded rice soils may have Eh values as low as -250 to -300 mV while Eh values of -150 mV to -190 mV are needed for CH_4 formation.
d) **Agronomic practices:** Improved agronomic practices like using improved crop varieties; extending crop rotations, etc that increase yields and generate higher inputs of residue C lead to increased soil C storage. Addition of more nutrients, when deficient can also promote soil C gains while the benefits from N fertilizer can be offset by higher emissions of N_2O from soils. Catch and cover crops add C to soils and may extract plant-available N unused by the preceding crop, thereby reducing N_2O emissions.
e) **Water regime:** Flooding is the key driver of soil anaerobic conditions, which results in CH_4 emission. However, it doesn’t immediately result in significant CH_4 production due initially to the reserves of trapped molecular oxygen in soil pores and then to the existence of alternative electron acceptors that allow aerobic respiration, so the length of flooding and drying periods are critical. A short drainage prior to transplanting reduces total CH_4 emissions. Similarly during rice growth, a single drainage will reduce CH_4 emissions, but two drainages will reduce emissions even further. In summary, longer and more frequent field drainage results in lower CH_4 emissions.
f) **Tillage management:** Conservation tillage practices, direct drilling and strip cropping are some of the mitigation alternatives suggested to reduce GHG emissions from agriculture. Results from several field experiments under various climatic conditions revealed that crop rotations, in combination with tillage, sequestered more soil carbon emitting less CO_2. Potential CH_4 fluxes were generally positive and higher from tilled soils compared to zero tilled soil. Considering the GHGs together, tilled soil produced 20% greater net global warming than zero tilled soil indicating potential areas for mitigation.

g) **Organic amendments:** Application of organic matter such as manure and crop residues enhances methanogenesis. Organic matter incorporation favoured more CH_4 emission during the dry season when rice biomass is higher, than during the wet season. Application of chemical fertilizer improves plant growth and therefore increases CH_4 emission and probably its production. Fertilizer containing sulfate may enhance growth and reduce CH_4 production even if the emission apparently increases, because of better plant growth.

h) **Puddling and soil texture:** Soil texture and mineralogy through their effect on puddling can affect percolation rate thereby net emission of CH_4 in submerged rice fields. Clay soils form cracks when dried and facilitate the emission of the entrapped CH_4 to the air. Methane emission decreased in the order of peaty soils > alluvial soils > andosols.

i) **Cultivars:** Plants influence CH_4 flux by i) providing channels (aerenchyma) for the transport of CH_4 from soil to the atmosphere, ii) releasing root exudates or root autolysis products to methanogenic bacteria, and iii) creating oxic environment in the anoxic soil through the transport of O_2 into the rhizosphere which stimulates the oxidation of CH_4 and inhibits methanogenesis. Researchers have found different emission rates for different cultivars which may be attributed to the difference in the amount of root exudates from the plants, the oxidizing capacity of the roots and the population of methanogenic bacteria in the roots.

Mitigation technologies sought an immediate, integrated, and interdisciplinary research approach, including application of socioeconomics and participation of farmers, to understand the complex interactions among CH_4 formation, CH_4 oxidation, rice growth and cultivation, and CH_4 emission. Mitigation technologies that either stabilize or reduce the CH_4 emission while increasing rice production, without dramatically compromising culture practices are the need of the hour.

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Realize the importance of soil microbes

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Soil is a complex dynamic system supporting the life of numerous flora and fauna. Soil provides a vital habitat for various organisms including microbes such as bacteria and fungi. Although, soil organisms comprise less than 1% of the total mass of a soil, they have a vital role in supporting all plants and in turn animals. The soil ecosystem derives energy input from the microbial decomposition of dead plant and animal organic residue. Soil microbes play crucial role in regulating various soil reactions, organic matter decomposition, nutrient recycling and soil health improvement thereby, influencing crop quality and productivity. The organic residues are converted into biomass or mineralized to CO_2, H_2O, inorganic nitrogen, phosphorus and many other nutrients including trace elements. Soil microorganisms also benefit soil–plant system in several ways through production of various bio–molecules like enzymes, vitamins, antibiotics, hormones, organic acids, etc. that have ability to bind soil particles leading to aggregate formation and improved soil structure. Soil microbes such as *Rhizobium*, *Azotobacter*, etc. associated with legume roots or free living in soil supplements N supply to plants through biological N_2 fixation; while phosphate solublising bacteria, mycorrhizal fungi, etc., enhances the P availability and other nutrients especially the immobile ones from the soil. Likewise, above microorganisms there are numerous microbes' group in soils that benefit soil-plant system in several ways directly or indirectly. Several researchers have evaluated that utilization of soil microbes as biofertilizer in crop production not only improve crop quality and production, but also exhibit significant influences on soil physical, chemical and biological properties.

Important role of soil microbes

- Primarily, soil microbes are responsible for organic matter decomposition. Several group of soil microbes works on organic matter decomposition to humus formation, which is very fine material having very high surface area, possesses the ability to hold positively charged nutrients and retains soil moisture.
- Soil microbes play a crucial role in conversion of organic forms of nutrients in inorganic ones (mineralization). These inorganic or mineral forms of nutrients are then easily absorbed by growing plants.
- Certain soil microbes secrete polysaccharides and glycoproteins that have ability to bind soil particles leading to aggregate formation, thus improvement in soil structure and overall soil physical properties. Moreover, hyphae of AM fungi, develop an extensive extra-radical hyphal network that grows into the soil matrix and holds primary soil particles together via physical entanglement. Above network makes a significant contribution to improvement of soil texture and water relations.
- Nitrogen fixation is an important process carried out by soil microbes i.e. bacteria especially by *Rhizobium* (symbiont) and *Azotobacter* (free living). Above bacteria has ability to convert atompheric nitrogen to ammonical form. Thereby, enriching soil with plant available nitrogen.
- Soil microorganisms also benefit soil–plant system in several ways through production of various bio–molecules like enzymes, vitamins, antibiotics, hormones, growth regulators, organic acids etc. that have ability to bind soil particles leading to aggregate formation and improved soil structure.

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- Certain soil fungi (*Trichoderma)* serve as biocontrol agents against fungal root diseases of plants. Moreover, some genera of fungi are utilized to control insect pests.
- Use of soil microbes as biofertilizer not only enhance nutrient and water use efficiencies of the crops, but also improve overall soil health, crop quality and productivity in long term.

Beneficial microorganisms in soil

Bacteria

Bacteria are the smallest and most abundant microorganisms in the soil ecosystem. *Pseudomonas, Arthrobacter, Clostridium, Bacillus, Achromobacter, Micrococcus* and *Agrobacterium* are the most common bacterial genera occurred in soil. Due to rapid multiplication and large number, they play significant role in various biochemical reactions and plant nutrient availability. The soil bacteria are involved in N-fixation, ammonification, nitrification, denitrification, phosphate synthesis of humus, protein decomposition, etc.

Actinomycetes

Actinomycetes are bacteria like microorganisms that possess hyphae similar to fungi. Actinomycetes are commonly found in dry soils, undisturbed pastures and grasslands. *Streptomyces, Micro-monospora, Nocardia* and *Thermo-actinomyces* are the most common actinomycetes genera occurred in soil. Above microbes play vital role in humus synthesis and produces number of colour pigments that contribute dark colour to soil humus.

Fungi

Fungi are filamentous organism and filaments are called as hyphae. The hyphal network is termed as mycelium. Amongst a variety of fungal group in soil, arbuscular mycorrhizal fungi (AMF) are highly useful from agricultural point of view. AMF forms a symbiotic association with majority of terrestrial plants and involves an intimate relationship between plant roots and fungal hyphae. The AM fungi receive carbon compounds/ nutritional requirements from host plant roots and in turn, supply nutrients viz. phosphorus, zinc, nitrogen, potassium, calcium, copper, etc. to plants. AMF also enhance water uptake. This is possible due to the fact that it extends root system into the soil through ramifying hyphae thereby increasing its exploratory area for harnessing nutrients and water.

Algae

Soil algae are chlorophyll containing organisms. They are abundant in habitats exposed to light and have sufficient moisture. One form of algae i.e. blue green algae (cynobacteria) is important from agricultural point of view as it fix atmospheric nitrogen and contribute towards nitrogen fertilizer economy in soils. *Anabaena, Nostoc, Phormidium, Aulosira*, etc. are important cynobacteria species dominant in rice field. Anabaena azollae not only contributes towards soil nitrogen but also adds organic matter.

Protozoa

Soil protozoa are single cell organisms and are larger in size than most microorganisms present in soil. Protozoa influence the organic cycle. Predatory nature of protozoa on bacteria contributes to the turnover of available nutrients and prevents immobilization of nutrients by keeping a check on bacterial population. Soils with high clay content dominate with number of smaller protozoa, while coarser textured soils contain more large flagellates.

Impact of conventional agricultural practices on soil microorganisms

Conventional agricultural practices affect the soil quality including structure and function of soil microbial communities. Actually, conversion of native ecosystems to agricultural uses can strongly affect microbial community structure, composition and diversity. Land use systems alter the soil microbial community structure through changes in carbon availability, pH, nutrient availability, changes in temperature, soil moisture or other physical and chemical parameters. Tillage have a severe disturbance to fungi by severing hyphal connections, however, no-till systems favour fungi over bacterial community components. Moreover, indiscriminate use of agrochemical during past few decades has reduced the biodiversity and soil organic matter. Decreasing organic matter levels in soil are drastically reducing the microbial population in soil. Besides above factors, residue burning after crop harvest by the farmers exerted negative influence on soil and causes severe loss of agriculturally beneficial microbes.

Keeping in view the role and importance of microorganisms in soil-plant system, there is need to develop/maintain conditions conducive for rapid multiplication and growth of these organisms. Retaining organic residue over soil surface, use of organic manure, biofertilizers and compost/vermicompost, conservation tillage are some option that may favour soil microbial activities and polulation in soil. Studies have shown that soil microbial population and enzymatic activities improved significantly following organic farming systems as compared to conventional ones. Microbial population levels in soil may further be sustained through the use microbial inoculants (biofertilizers). There is dire need to create awareness regarding beneficial effects of soil microbes on soil health and crop productivity.

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Hydroponics - A Sustainable Approach

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INTRODUCTION

Hydroponics is a specialized technique of cultivating plants in solution of various nutrients in soluble form. Use of inert medium such as coconut fibre, coir dust, saw dust, rockwool, vermiculite, peat moss and gravel etc. can be done to provide mechanical support. This system of cultivation also can be ensured without using of an inert medium (only use of liquid nutrient solution). The term 'Hydroponics' was derivative of two Greek words '*hydro*' and '*ponos'*; among which first one refers to water work and the second one is labour. In early 1930s, Hydroponics word was devised by Professor William Gericke, which describes the cultivation of plants having their root submerged in nutrient solution. In 1940, first nutriculture system was developed in Purude University. As world's population is increasing in a tremendous rate, the land area is shrinking day by day, so it really creates a trouble to feed a huge a population. So development of alternate growing method without harming the natural sources is ought most important. This hydroponics also focuses on utilization of recyclable water for improving water use efficiency of crop. In whole some, this approach is a sustainable management of all natural resources. In this era, growing of various nutritious vegetable can be possible by adopting this type of cultivation practices (Maboko *et al*., 2011). This soil less cultivation method is also consists of cultivation of plants along with fish i.e. (Aquaponics) aqua agriculture, growing of plants in air medium i.e. (Aeroponics) aerobic agriculture and other than that substrate culture. Among all cultivation methods hydroponics is ahead due to its easy methodology and practices. Various types of high value low volume crops can be grown, such as parthenocarpic cucumber, strawberry, coloured capsicum, tomato, lettuce, parsley and most of leafy vegetables. Hydroponics can be devised into different types on the basis of growing media and reuse of recycled nutrient solution. Commonly used systems are nutrient film technique (NFT), ebb-flow, drip, deep water culture and wick system. A brief description about these systems is given below.

Nutrient Film Technique (NFT) System

This was established in mid 1970s in England with the assistance ship of Dr. Alen Cooper. Here, nutrient solution or water circulate all through the whole system; and enters the plant tray with the help of a pump (Domingues *et al.,* 2012). This system is positioned in slightly slanted manner, so that nutrient solution should back into a reservoir. Roots are mainly affected by fungus and bacteria because of its constant immersion in nutrient solution. Basically, it is used for leafy green and exotic vegetable production.

Ebb and Flow System

This is the first commercial popularized hydroponic system; mainly works on the basis of flooding and draining of water. Water and nutrient solution are allowed to flow in the growing tray and to be up hold for some time, for maximum absorption of nutrients by root hairs (Resh, 2013). This method is suitable for cultivation of various types of crops. However, various types of fungus and bacteria check the growth of plant growing in the nutrient medium (Nielsen *et al.,* 2006).

Drip System

This type of system is highly practiced in home and commercial basis by the farmer. Nutrient solution or water from the water tank is provided to all plant roots in right quantity with the assist of water pump (Rouphael and Colla, 2005). Plants are normally placed in fairly absorbent supporting growing medium , in order that nutrient solution drip slowly. It mainly focuses on conservation of water.

Deep Water Culture System

In this type of system, plant roots are overhanging in nutrient solution and air is provided to the root with the help of an air stone. Typical example of this system is Hydroponics bucket type. Plants are positioned in pots with roots are hanging in water solution where they develop quickly in a subsequent manner. It is obligatory to observe the nutrient and oxygen concentrations, salinity and pH since algae and moulds can grow up quickly in the water (Domingues *et al.,* 2012). Plants produce larger fruits such as cucumber, capsicum and tomato are basically suitable for this type of system.

Wick System

It is the simplest type of system among all, as it does not rely on electric system, aerators and pump (Shrestha and Dunn, 2013). Plants are positioned in a water absorbent medium like perlite, vermiculite and coco coir. A nylon wick passed through the plant roots to a reservoir of nutrient solution for nutrient circulation through capillary motion those plant which require lesser quantity of water can be grow well in this type of system.

CONCLUSION

Hydroponics has the potentiality to produce qualitative produce, which not only emphasizes on nutritional attributes, but also fetches higher remuneration to farmers in terms of economic return. The marginal farmer in Indian condition mainly lacking behind the awareness and start-up cost for installation of various modern cultivation systems. Simplification of system during installation and proper maintenance is necessary. Major focus on breeding for changing of root architechure is also ought most important, so that deep rooted crops can also be taken into consideration. The modern technology should be such that it should not lie in the book chapter proceedings and workshops; however it must be farmer oriented; which can lead ro increase in economic condition of farmers and the nation.

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Live Fencing: Introduction and Importance

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Living Fence

A Living Fence is a fence made of living trees and shrubs. Made from thorny or non-thorny plants, it can also be called a green fence, or hedge.

There are many ways of using a barrier to prevent harmful pests from coming onto the land. Everyone knows that stone and mud, bricks, barbed wire, bamboo, or even cut branches can be used to make a fence. But the most productive form of barrier is the living fence, because as well as being a barrier, it can also produce many other benefits for the home.

This consists in raising rows of live plants on the boundaries of the area to be fenced. It is called live fence to differentiate it from the fences raised with thorns, wood, stones or barbed wire. The species commonly used should be fast growing and which can be easily propagated by cuttings. The species should be good coppice and those which are not browsed by the cattle. The thorny species should be preferred. Some of the species are *Agave americana, Acacia catechu, Euphorbias lpomeas, Jatropha* etc. as it takes time to establish the live hedges, it should be either raised in advance or in combination with barbed wire fence which can be removed after the hedge has established.

Benefits of the Living Fence

- Crops are protected against harmful pests.
- The living fence can act as a windbreak.
- As well as protecting the land, various products such as fodder, firewood, medicines, timber, nectar, etc. can be taken from the living fence.
- Beneficial animals such as predator insects can also find a place to live in the living fence.
- The living fence saves money.
- It prevents soil erosion.
- It can prevent terraces from collapsing
- It can be used where materials for fencing are not found, e.g. plentiful rocks, barbed wire, large branches or trees, etc.
- It provides shade and a windbreak for the compound.
- Control movement of cattle.
- It Provide protection for chickens against birds of prey.

So, as well as using the live fence for protection, it can also be used to increase farm production. If a fence has tree cotton in it, for example, this is even a cash crop. Citrus varieties such as orange, lime, lemon, etc. can make very good fences. They also produce valuable fruit, and are good for bees.

There are few risks. Live fences require labor for maintenance, and if they are not maintained they lose their intended function and begin to compete with crops. *Caesalpinia decapetala* may be too thorny to have near houses as children may suffer. The latex of *euphorbia tirucalli* is very poisonous and dangerous for the eyes. Fences and hedges may harbor snakes, and some shrub species may turn into weeds, e.g. *Lantana camara*. *Thevetia peruviana* is also very poisonous.

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Site for make a living fence

According to your location and its climate, landscape, soil, etc. there are many plants that can be used for a living fence. Planted on the edges of the land, the living fence protects against harm from the outside, including the wind. Within the farm, living fences are useful along edges such as pathways and edges of fields or terraces. They can give shade and shelter, as well as other useful farm produce. The kitchen garden can be protected by a living fence, and even separate vegetable or nursery beds can have their own small living fences.

Choosing what to plant in the living fence

Many types of plant can be grown in home-made nurseries and planted in the fence when they are large. Many species grow from burying branches in the soil like cuttings. The fence can also be planted with suitable seedlings collected from the forest.

By collecting seed and cuttings from around the community and local forest, and making home nurseries, we can grow small, large, climbing vine, or any type of seedling. In the living fence it is good to have as many thorny plants as possible, such as blackberry, *Berberris,* babool *(Acacia nilotica),* baer *(Aeglis),* blackthorn, hawthorn, honey locust, mesquite *(Prosopis),* khayer *(Acacia catechu)*, etc. Thorny plants are mainly useful around the boundary of the farm.

Maintenance of Living Fence

Things to consider when making a living fence

After planting seed, seedlings or cuttings in the living fence, mulch thickly with straw, leaf litter, etc. This controls the weeds, and allows the plants to grow well. Weeds need removing, and the plants should be watered if possible. Replace any plants that die. Once the plants have grown, there is not much maintenance. Well planned harvesting of products from the fence is the only maintenance that is needed. Cutting or pruning branches will give yields of fodder, firewood, mulch material, etc. If there is too much shade, branches can be cut to let in more sun.

The kitchen garden needs a good fence around it to protect against strong sun and wind, livestock, weeds and other harmful things. Inside the kitchen garden, each vegetable bed can be surrounded by small fences of comfrey, lemon grass, basil, marigold, wormwood, and *Adhatora* which protect against invasive weeds and even flying insect pests. There are other beneficial yields of mulch material, fodder, flowers, etc. This can also be called edge farming or companion planting.

Fences and hedges need regular trimming so as not to overgrow. Some species which are very thorny, e.g. *Caesalpinia decapetala* are sometimes regarded as too difficult to manage and should be avoided if the thorniness is not really needed as a deterrent to cattle. Live fences are often combined with trees for the production of wood. Either some stems of the fence species can be allowed to grow large, e.g. cypress, or trees of another species can be planted in the fence and allowed to grow well protected by the fence. If live fences are to be introduced it is essential to consider the land-use pattern throughout the year. Fires are a hazard for many species, and livestock may be a threat in the initial stages.

Examples of species

Acacia brevispica, Acacia nilotica, Acacia tortilis, Agave sisalana, Albizia amara, Balanites spp., Caesalpinia decapetala, Calliandra calothyrsus, Carissa edulis, Croton dichogamus, Croton megalocarpus, Cupressus lusitanica, Casuarina spp., Dovyalis caffra, Euphorbia tirucalli, Gliricidia sepiunt, Morus alba, Lantana camara, Parkinsonia aculeata, Pithecellobium dulce, Prosopis spp., Psidium guajava, Thevetia peruviana, Ziziphus spp.

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Biofortification: a new approach to reduce micronutrient deficiency

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INTRODUCTION:

Micronutrient deficiency is a global health problem contributing to high rate of children and women's mortality. About 2 billion people around the world suffer from micronutrient deficiencies, also known as "hidden hunger" which results in poor growth and compromised psychomotor development of children, reduced immunity, fatigue, irritability, weakness, hair loss, wasting of muscles, sterility, morbidity and death. In India micronutrient malnutrition has been a persistent problem with alarmingly high deficit among children, women of reproductive age, pregnant and lactating women. This lack of critical vitamins and minerals can have long-term, irreversible health effects that affect well-being and long-term development prospects. Among micro elements, iron and zinc mineral deficiency are the most common and widespread, affecting more than half of the human population. Fe, Zn etc. micronutrients are serves as an important cofactor for various enzymes performing basic functions in humans. To address this problem, biofortification is advantageous for people who experience difficulty in changing their dietary habits because of financial, cultural, regional, or religious restrictions. Biofortification is also advantageous for governments because it is inexpensive and sustainable compared to nutritional supplement programs.

Bio fortification:

Bio fortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology. These advanced techniques are used for biofortification when micronutrient content cannot be significantly increased through conventional practices. Biofortification differs from conventional fortification in that biofortification aims to increase nutrient levels in crops during plant growth rather than through manual means during processing of the crops. Biofortification may therefore present a way to reach populations where supplements and conventional fortification activities may be difficult to implement and/or limited. Biofortified crops already contributing to healthier diets in Asia and Africa include vitamin A sweet potatoes, zinc rice, and iron beans. IFPRI's Harvest Plus program leads this work. To be successful in reducing micronutrient malnutrition in developing countries, a biofortified crop must be high yielding and profitable to the farmer, be shown to be efficacious and effective at reducing micronutrient malnutrition and be acceptable to both farmers and consumers in target regions. Success stories of biofortification include lysine and tryptophan rich quality protein maize (World food prize 2000), Vitamin A rich orange sweet potato (World food prize 2016); generated by crop breeding, oleic acid, and stearidonic acid soybean enrichment; through genetic transformation and selenium, iodine, and zinc supplementation.

Goal of Bio fortification:

1. The goal of bio fortification is to contribute to reducing the high prevalence of specific nutritional deficiencies, especially of iron, zinc and vitamin A, which commonly occur in low income populations.

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2. This is to be achieved by improving the micronutrient density of staple food crops that are produced and consumed by these populations and hence, if bioavailability is demonstrated, increasing the adequacy of micronutrient intakes.
3. Bio fortification is intended to contribute to the prevention of micronutrient deficiencies by reaching all household members.

Methods of bio-fortification

1. **Agronomic Bio-fortification:** Agronomic biofortification of food crops is a strategy for increasing micronutrient concentrations to reduce dietary deficiencies. Soil and foliar application of micronutrient fertilizer can be used for several different mineral micronutrients to varying effectiveness. Agronomic biofortification, especially in the case of foliar application, is highly effective for zinc and selenium, while also effective for iodine and cobalt. Foliar fertilization has many advantages over soil application due to lower requirement and immediate crop response.

2. Microbial Bio-fortification: With the advent of metagenomic and next-generation sequencing tools and the development of the "holobiome" concept, the significance of microbiome in the productivity of soil and crops is becoming more evident. Plant growth-promoting rhizobacteria (PGPR) and plant growth-promoting fungi (PGPF) represent a wide variety of microorganisms, growing in association with plants. They lead to stimulation of growth of the host, due to the increased mobility, uptake, and enrichment of nutrients in the plant. Their significance in improving nutrient use efficiency of applied fertilizers and improving nutrient uptake in problematic soils or denuded lands is well established. However, they are less explored options in biofortification strategies and need to be included in agronomic and breeding approaches to develop effective biofortification strategies for the staple crops.

3. Genetic Bio-fortification: Conventional breeding and genetic engineering techniques are the two approaches that may be used to biofortify the crops with minerals like iron and zinc. Both the techniques involve changing the genotype of targeted crops with the aim of developing plants carrying genes that support the accumulation of bio-available minerals. The way of reaching this goal differs between the two approaches (Gomez-Galera *et al*., 2010). Most of the work is currently done on traditional plant breeding techniques, exploiting the variability of mineral concentrations found in different germplasm. Not all crops have the genetic potential to meet desired micronutrient levels with traditional plant breeding and therefore genetic engineering has to be applied to achieve sufficient improvements. A positive factor with genetic engineering technique is its high precision, fast development and stable expression. In addition very fewer breeding generations are needed with genetic engineering compared to traditional plant breeding.

4. Seed Priming

Seeds are considered to be an important part of crop life cycle as it influences the propagation of critical phases like germination and dormancy. Seed priming before sowing is considered to be one of the promising ways to provide value-added solutions to maximize the natural potential of seed to set the plant for maximum yield potential with respect to both quality and quantity. Positive effect on the shoot and root growth of seedlings of wheat (*Triticum aestivum* L.) when treated with iron-oxide nanoparticles. This innovative cost-effective and user-friendly method of biofortification has proven to increase grain iron deposition upon harvesting. Hence, the intervention of nanotechnology in terms of seed priming could be an economical and user-friendly smart farming approach to increase the nutritive value of the grains in an eco-friendly manner.

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Harvest Plus:

It is the part of the CGIAR Research Program on Agriculture for Nutrition and Health. It was launched in 2004 with funding from Bill and Melinda Gates foundation, the UK Department for International Development and others. The mission of Harvest Plus is to tackle the hidden hunger on a global scale by breeding vitamins and minerals into everyday food crops. Harvest plus is focusing on increasing levels of iron, zinc and beta-carotene in seven staple crops namely; sweet potato, bean, pearlmillet, cassava, maize, rice and wheat with a goal to reach 20 million farming households with biofortified nutritious foods by 2020. The Harvest Plus program is coordinated by two of these centres, the International Centre for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI).

Advantages:

- Reaching the malnourished in rural areas
- Cost-effectiveness and low cost
- Sustainability of biofortification

Disadvantages:

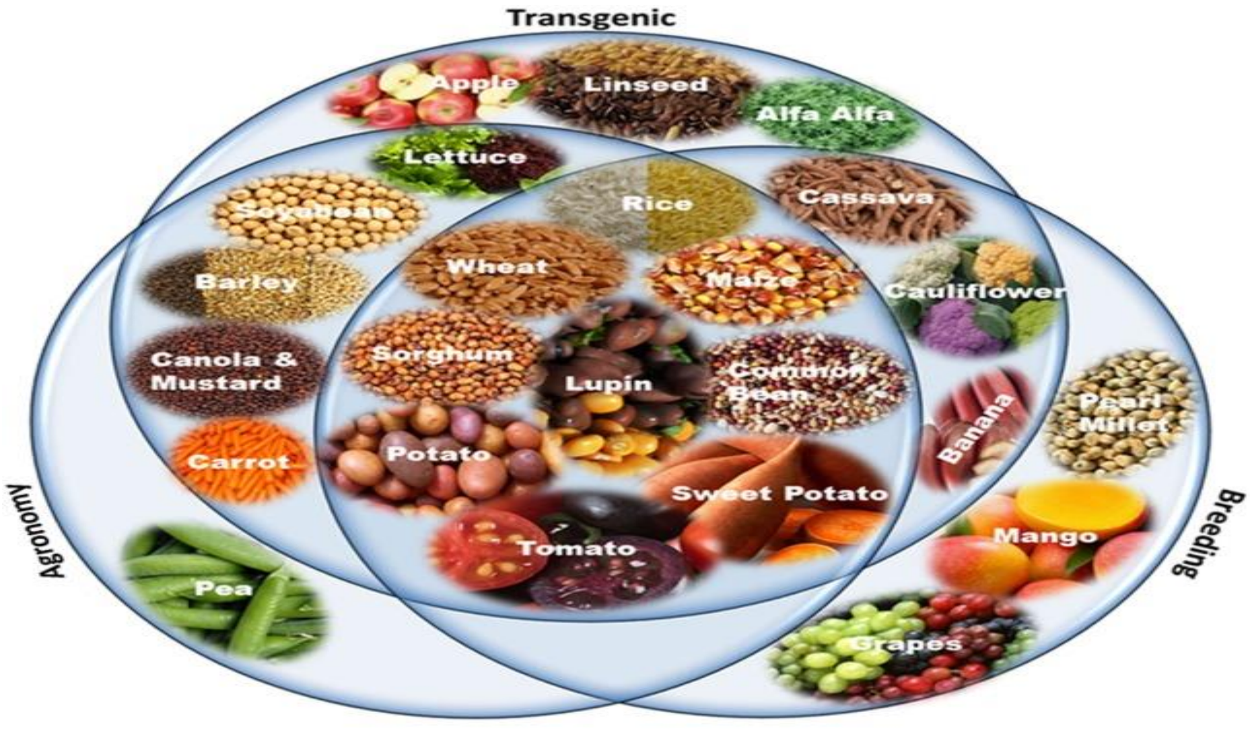
- Varying impact throughout the lifecycle
- Time dimension to deliver biofortified crops and to build up and maintain body stores

Achievements:

Crop	Property	Example	Country
Beans	High Iron	Pigeon Vert (Bush), PVA 1438 (Bush), COD MLB 032 (Bush), Cuarentino (Climber), Nain de Kyondo (Climber), RWR 2245 (Bush)	Africa
Pearl millet	High Iron	ICTP8203-Fe, Hybrid7, Dhanshakti	India
Maize	Vitamin- A	GV662A, GV664A, GV665A, Ife maize hyb-3, Ife maize hyb-4	Zambia
Rice	High Zinc	BRRI dhan 62, BR7840- 54-3-1, BR7840-54-2-5- 1, BR7840-54-1-2-5.	Bangladesh
	High Zinc	Chattisgarh Zinc Rice-1 DRR dhan45, CR dhan 310	India
Wheat	High Zinc	BHU1, BHU3, BHU5, BHU6, BHU17	India and Pakistan

CONCLUSIONS:

The bio-fortification strategy seeks to take advantage of the consistent daily consumption of large amounts of food staples by all family members, including women and children, who are most at risk for micronutrient malnutrition. Initial investments in agricultural research at a central location can generate high recurrent benefits at low cost as adapted, biofortified varieties become available in country after country across time at low recurrent costs. Human nutritionists need to be informed, for example, about the extent to which the vitamin and mineral density of specific foods, as well as compounds (e.g., pre-biotics) that promote and inhibit their bioavailability, can be modified through plant breeding. Plant breeders need to be aware of both the major influence that agricultural research



Biofortified crops generated by different approaches: transgenic, agronomic, and breeding. Staple cereals, most common vegetables, beans, and fruits have been targeted by all three approaches. Some crops have been targeted by only one or two approaches depending on its significance and prevalence in the daily human diet.

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Foods to help fight the negative effects of pollution

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The World Health Organization estimates that 7 million people die yearly as a result of air pollution. News coverage of pollution issues has significantly increased; resulting in more awareness of the impact pollution can have on your and your loved ones health. It is possible to protect yourself from such illnesses by eating the right foods. Once seen as localised problems of developing countries, air pollution has become a global phenomenon that is hard to shake. Even in areas with 'safe' levels of pollution, your occupation could put you at risk. For instance, dock workers, truck drivers and other workers who are constantly exposed to high levels of diesel emissions, are more susceptible to respiratory illnesses.

Load up on these powerful nutrients to combat the effects of air pollution:

1. Vitamin C

A powerful antioxidant, Vitamin C helps lessen oxidative stress on the body. From preventing colds and flu, rebuilding tissue, bones and blood vessels, to boosting the body's ability to synthesize calcium, this water soluble vitamin is something we need on a daily basis. A Vitamin C rich diet could do your lungs a favor when exposed to air pollution, so remember to super-charge your diet with a major serving of this essential nutrient. Eat Oranges, grapes, guava*, amla* , kiwi, strawberries, papaya, lemons, red and green peppers**.**

Vitamin C: It is the single most potent antioxidant for our body.

- Vegetables like coriander leaves, *chaulai ka saag*, drumsticks, parsley**,** cabbage and turnip greens are good sources that you should load up on.

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- Fruits like *amla,* orange and guava are rich in vitamin C.
- The easiest way to get your daily dose of vitamin C is to include the juice of two lemons in your daily diet.
- Citrus fruits also add to the vitamin C content of food.

2. **Vitamin E:** This fat soluble vitamin is the first line of defence against injury to human tissues. Vitamin E is a powerful, fat-soluble antioxidant that helps protect cell membranes against damage caused by free radicals and prevents the oxidation of LDL cholesterol. This essential vitamin also plays a role in the healthy functioning of your immune system and the well being of your skin, hair and blood vessels. Plant based cooking oils are the most common source of vitamin E in our diets. Almonds, pumpkin seeds, sesame seeds, plant-based oils (sunflower, safflower, soybean, olive, wheat germ), avocado, herbs (oregano, basil, parsley), leafy greens.

Nuts and oilseeds

- **Beta Carotene**: This plays a very important role in controlling inflammation because of its antioxidant activity. It is also converted to vitamin A in our body.
- Leafy vegetables like amaranth (*chaulai ka saag*), coriander, *methi (fenugreek)*, lettuce and spinach are the richest sources of Beta Carotene.
- Radish leaves and carrots are good sources too.

Carrot and green leafy vegetables

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3. Omega-3 Fats: These protect the body against the detrimental effects of air pollution on one's heart health and lipid profile. Sources of these heart healthy oils are:

- Nuts and seeds like walnuts, chia seeds and flax seeds. Add them to yogurt, make a smoothie or just have them as is.
- Methi seeds, mustard seeds, green leafy vegetables, kala chana, rajma andbajra are common foods which provide omega -3.

3. **Ayurveda Solutions:** Certain herbs and spices have been suggested in Ayurvedic medicine for curing common respiratory ailments.

- Turmeric is a well-known antioxidant and is said to help protect the lungs from the toxic effects of pollutants.
- Mix turmeric and ghee to relieve cough and aid during asthma. During an asthmatic attack, turmeric with jaggery and butter may be taken to relieve symptoms.
- Jaggery mixed with onion juice is said to have an expectorant effect, useful during both wet and dry cough.
- *Haritaki* along with jaggery, taken before bedtime and in the morning is good for relieving phlegm.
- Ayurveda also prescribes a diet rich in bitter and astringent foods, as opposed to sweet or sour foods, during asthma. Wheat and cow's milk are believed to be beneficial for asthma patients. Ginger, black pepper, *tulsi*, liquorice, nutmeg, mint and galangal are also useful for curing respiratory ailments.

Haritaki along with jaggery, taken before bedtime and in the morning is good for relieving phlegm.

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6. Olive oil

Alpha-tocopherol, the vitamin E contained in olive oil, improves lung function. The fatty acids contained in olive oil are also helpful for reducing inflammation. The best way to ingest olive oil and get maximum benefits is through your salads as exposure to heat during cooking could change its chemical composition and lose some of it health properties.

7. Broccoli

A 12-week clinical study performed in Jiangsu province by the Bloomberg School of Public Health at Johns Hopkins University found that people who ate broccoli excreted toxins associated with ozone and particulate matter pollution. This excretion is due to the presence of sulforaphane, an anti-carcinogenic compound contained in broccoli.

8. Flaxseed

Flaxseed has high levels of phytoestrogens and omega 3 fatty acids. Phytoestrogens have anti-oxidant properties that help to reduce the symptoms of asthma and other allergic reactions. You can take flaxseed daily in smoothies, salads or add it to your baked foods.

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Agricultural bio-warfare and bio-terrorism

Article id: 22518

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INTRODUCTION

Considerations of biological warfare and bioterrorism nearly always focus on the direct threat of the use of human diseases as weapons. However, the possibility of biological attack on the plant or animal resources of a country is increasingly recognized as a serious threat. What follows is the outline of a systematic analysis of the threat of biological attack on the agricultural sector of a country, meant to succinctly cover the issues, without case studies or examples. Since it was first presented at the Association for Politics and the Life Sciences annual meeting in 1999, several publications have addressed many of these issues in more detail; they are listed at the end. Nevertheless, there is merit in having a concise summary of the many complex issues in accessible form. What goals might an attack on the agricultural sector serve?

Attack the food supply of an enemy belligerent

This is the classical rationale for the inclusion of anti-plant programs in national biological weapons programs. Every major state biological warfare (BW) program we know of has included an anti-agricultural component, from the World War I German use of anthrax and glanders against animals to the Iraqi program on wheat cover smut. For most agents, effective use would require large stockpiles and extensive delivery efforts; however, there is potential for delivery by secret agent to initiate point-source epidemics of highly contagious agents.

Destabilize a government by initiating food shortages or unemployment

Disruption of the agricultural sector can cause profound dislocation of societies. Direct losses of plants or animals could cause food shortages, increases in food prices, and unemployment. All of these could, if severe, have serious destabilizing effects on social and political structures. Many developed countries are quite vulnerable to disruption of the agricultural sector.

Alter supply and demand patterns for a commodity

A widespread-epidemic, or any outbreak that triggered the imposition or relaxation of trade restrictions, could result in significant changes of supply of the affected plant or animal materials on domestic and international markets. This in turn would open up or close markets for others (a possible motivating factor). Biological attack could also be used to manipulate futures, and for other manipulations of the financial markets.

Control an undesirable plant or animal (biocontrol)

The use of legitimate, peaceful biocontrol is expanding steadily, and provides an unfortunate body of knowledge and range of ready-made delivery technologies for the interested agricultural bioterrorist or biowarfare program. There have been two recent programs to develop pathogens of drug crops as biocontrol agents. These have been conducted under the United Nations Drug Control Program (UNDCP) auspices, funded and performed by the US (fungal pathogens of coca), and funded by the United States (US) and the United Kingdom (UK) and performed by Uzbekistan (fungal pathogens of poppy). Both of these programs involve the

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development of biological agents and delivery devices, and both are presumably intended for use principally or entirely in other countries.

Who might be tempted to initiate an attack on the agricultural sector?

Countries

Countries might consider agricultural attack for military, political, ideological, or economic reasons. Since there could be quite severe consequences of being recognized as responsible for a biological attack, such efforts would likely be covert. This would entail an effort to make the outbreak appear natural--most probably a point-source outbreak, or multiple outbreaks with an apparently natural common source (see below).

Corporations

Agricultural corporations, including producers, processors, and shippers, could benefit immensely from the economic impacts, market share changes, and financial market effects of a successful biological attack. Many also employ expert plant pathologists or veterinarians and have large collections of pathogens. The combination of motivation, expertise, and materials within a single, closed organization is worrisome.

Terrorist groups

Terrorist groups might be interested in agricultural bioweapons for a variety of reasons: international terrorist organizations for the harm they could do to enemy states or peoples, millennial groups for their potential contribution to societal collapse, local extremists for their potential value in deterring farmers from raising particular crops or using particular technologies. In many cases of ideologically-motivated terrorist attack, there would be willing assumption of responsibility by the perpetrator; in other cases there could be an attempt to disguise the outbreak as natural or as the work of others.

Individuals

Individual perpetrators (bio-criminals) could include disgruntled employees or ex-employees in the agricultural sector, ideologically motivated individuals, speculators on the commodities market, or individuals with a profit motive (such as the New Zealand farmer[s] assumed to have covertly imported RHDV).

What would be the consequences of attack on the agricultural sector?

Direct losses due to disease

Direct financial loss due to mortality or morbidity of domestic animals or crop plants can vary from insignificant to catastrophic. In many cases the direct losses would be modest and would fall on a small number of farms. One of the major determinants of the magnitude of the direct losses will be the rapidity with which the disease is noticed and diagnosed. In developed countries most of the foreign diseases of greatest concern would likely be identified fairly early, allowing the direct disease losses to be kept modest.

Losses due to efforts to contain outbreaks

The control of an outbreak of an imported, highly contagious animal or plant disease is routinely done by destruction of all potentially exposed healthy host organisms. With animal diseases, this normally means the slaughter of all host animals in the immediate vicinity. With plants, thousands of acres of crop plants may have to be destroyed to contain an outbreak. Thus the losses attendant on outbreak control can exceed, often by several orders of magnitude, the direct losses due to the disease itself.

Losses due to sanitary or phytosanitary restrictions on international trade

Under the World Trade Organization (WTO), member states are allowed to impose import restrictions on agricultural products to prevent the importation of pests or disease agents. Thus, importing countries free of a particular disease are usually quick to block imports from countries in which that disease breaks out. This

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happens frequently, as these diseases periodically resurface in areas from which they have been absent; trade restrictions typically last a month or two when control of the outbreak is rapid, or they may endure much longer if disease control is slow and difficult.

Losses due to indirect effects (market destabilization, etc.)

The substantial market effects of a widespread outbreak, or one that has major impacts on international trade, could have secondary effects, such as share-holder losses, revenue losses to processors and shippers, etc. In the extreme, if losses are very large and if future losses appear likely, significant levels of investor panic could lead to market destabilization.

What are the special features of attack on the agricultural sector?

Agents are not hazardous to perpetrators

With the exception of a few agents of zoonotic disease, most of the diseases that are likely to be considered for an attack on the agricultural sector are completely harmless to humans. They are thus much less challenging to produce, stockpile, and disseminate than lethal human pathogens.

Few technical obstacles to weaponization

A military style attack by airplane on large acreage of crops would require crop dusters and large stockpiles of agent. Nevertheless, nothing would be difficult to obtain on the open market. Less ambitious attacks would require much less in the way of equipment or agent stockpiles. If the goal is to cause only a few cases in order to disrupt trade, then no special equipment and only a few microliters of agent are needed. And, as discussed below, it is possible to introduce biological agents without even entering the target country.

Low security of vulnerable targets

Many potential sites for release of an animal agent, such as auction houses, have very low security. Access to large numbers of animals with destinations all over a country or region is simple and easy. Seeds, fertilizers, and pesticides provide routes for infection of crop plants, although of somewhat higher (but still not robust) security. And of course pastures and fields themselves have essentially no security at all.

Lower moral barrier to cross

It is often argued that there is an innate human revulsion to the use of disease as a weapon; if so, this could constitute an important disincentive to bioterrorism and biowarfare. However, it is unlikely that this sentiment extends to biological attack on plants or animals. Furthermore, the response after a biological attack on plants or animals would be less substantial than if the attack involved human victims; finally, the penalties of being identified as the perpetrator would be lighter.

Maximum effect may not require many cases

If the goal is to disrupt trade by introducing a highly contagious disease into territory from which it is absent, then the attack does not have to be constructed to cause a large number of cases--a handful of cases may be sufficient. Obviously, it is much easier to cause a small outbreak than a large one.

Point source to mimic natural introduction can be effective

Because of the high background of naturally-occurring disease, it is possible that a deliberately instigated outbreak could be mistaken for a natural one. If avoiding detection is important, an attack would be constructed to take advantage of this confusion. Especially if the goal is disruption of international trade, where few cases are necessary, it is feasible to construct an attack to appear to be a natural point-source outbreak.

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How might attack on the agricultural sector be deterred?

Enact appropriate legislation

Enactment of legislation implementing the Bioterrosim warfare council is required of all States Parties; however, many have not yet done so. Such legislation can be a significant deterrent to biological attack on the agricultural sector. The legislation should, among other provisions, provide for substantial criminal penalties for the hostile use anywhere of biological agents against plants or animals as well as people, and it should provide for extradition for anyone charged with using such agents against the agricultural sector of another state. States that already have enacted such legislation should review its provisions to ensure that they adequately cover biological attack on plants and animals.

Insure effective epidemiological investigation to determine origin of outbreaks

Biological attack on the agricultural sector is likely to be covert. Such attacks will be options for perpetrators only to the extent that they are able to maintain the plausibility that such events are natural events. Increased epidemiological capacity, especially in strain identification from molecular sequence data, makes it increasingly difficult to escape detection, and thus would act as a substantial deterrent.

Reduce reliance on monoculture and expand the diversity of genotypes cultured

States that engage in high intensity agriculture of a limited range of varieties could reduce their vulnerability to both deliberate and natural disease outbreaks by increasing the use of intercropping, expanding the diversity of genotypes utilized, reducing the size of plots, and a variety of other agricultural changes designed to reduce susceptibility to disease outbreaks. However, these constitute substantial changes in established practice, and are probably not likely to be instituted without sustained and forceful political leadership.

CONCLUSIONS

This analysis shows that anti-agricultural biowarfare and bioterrorism differ significantly from the same activities directed against humans: there exist a variety of possibilities for economic gain for perpetrators, and the list of possible perpetrators includes corporations. Furthermore, attacks are substantially easier to do: the agents aren't hazardous to humans, delivery systems are readily available and unsophisticated, maximum effect may only require a few cases, delivery from outside the target country is possible, and an effective attack can be constructed to look natural. This constellation of characteristics makes biological attack on the agricultural sector of at least some countries a very real threat, perhaps more so than attack on the civilian population. The Conference of States Parties to the Biological and Toxic Weapons Convention should thus take this threat seriously and consider if any actions by it or by individual States Parties are advised. The following suggestions constitute a starting point for this consideration.

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Plastic mulching - Types and importance in Agriculture

Article id: 22519

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INTRODUCTION:

Covering the area of roots around plants with any material is known as mulching. Earlier this mulching used to be done with rice husk, sugarcane waste, dry leaves and small stones. But now a days with increase in importance of mulching plastic sheet is being used to cover around the plants, known as plastic mulching.

Advantages of plastic mulching:

- **Increased water use efficiency**: Saves water by reducing evaporation losses from soil around plants. Depending upon the water needs 30-40% of the water can be saved. By using mulching with drip irrigation, additional 20% of water can be saved.
- **Weed control:** 85% of the weeds can be controlled by using mulching sheet as the sheet obstructs the sunlight which is required for photosynthesis
- **Reduce soil erosion:** Mulching sheet obstructs the direct contact of rains with soil through which soil erosion can be reduced
- **Improved microbial activity:** Controls soil temperature and forms favourable microclimate for microorganisms around plants through which microbial activity will be improved. Microorganisms improves soil structure, fertility and also improves nutrient uptake by plants.
- **Controls pests and diseases**: By spreading plastic film on soil during summer, thermal radiations enters into soil and controls pests and diseases causing organisms
- **Reduces cost of cultivation:** Using this mulching reduces leakage of manures to deeper layers and also controls weeds, pests and diseases which reduce the usage of plant protection chemicals in turn reduce cost
- **Improves yield and quality:** Plastic mulching provides favourbale environment to plants throughout the life cycle which leads to increase in yield (20-50%) and quality of produce.

Types of mulching sheets:

Mulching sheets lasts for about 3 years. Mulching sheets are available in different colours like black, white, red, blue, green, yellow, silver and double coloured. Different coloured sheets are used for different crops and different seasons. For ex: Using red, black and green mulches in tomato gives more yield with good quality than using white and silver mulches. White coloured mulches should be used during summer and black coloured mulches should be used during winter.

How to apply mulch sheet:

Mulching can be applied in two ways:

1. **Mulching before sowing:** Holes should be made to mulch sheet depending on the spacing between plants and rows. Spread mulch sheet on every row and cover with soil. Sow the seed in each hole and cover with soil and then irrigate the field. 20-25% of the seed can be saved by this method.

2. **Mulching after transplanting:** Cut the mulching sheet in required size and then make holes based on spacing between plants and spread on each row.

Fig. White coloured mulching

Precautions to be taken while mulching:

- Mulch sheet should not be dragged forcely
- Mulch sheet should be applied only during low temperature conditions *i.e.,* either morning or evening as it will expand if applied during sunny hours.
- Mulch sheet should not be applied if wind flow is high.

Selection of mulch sheet depending on situation:

1. Rainy season-Mulch sheet with holes
2. Salt water conditions-Black mulch sheet
3. Summer crops-White mulch sheet
4. Sandy soils-Black mulch sheet
5. Weed management-Black mulch sheet
6. Soil solarization-Transparent mulch sheet

CONCLUSION: Using of plastic mulching along with drip irrigation reduce cultivation cost, improves soil structure and fertility and also controls weeds, pests and diseases effectively and also saves environment.

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Livestock Insurance with special reference to farmer's vulnerability in disaster prone areas

Article id: 22520

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The need of insurance arises due to the fact that it leads to protecting the economic value of the assets. Each and every asset has value and an untimely unfortunate loss leads to a lot of suffering for the owner of the asset. An instrument to smoothen the irreversible loss is insurance which is a way and not a mean that helps to reduce such adverse consequences. Crop and livestock insurance can act as important risk mitigation strategies during disaster conditions. Several studies have highlighted clear gaps in terms of risks covered by crop and livestock insurance. In reality crop insurance schemes have received a lot of attention; the risk coverage of livestock continues to receive step motherly treatment.

INTRODUCTION

The pioneering country in initiation of livestock insurance schemes is credited to Germany in the year 1909 and subsequently other countries followed the suit. Government of India introduced the livestock insurance scheme on a pilot basis during the years 2005-06 and 2006-07 of the 10th Five Year Plan (2002-07) in 100 selected districts through Department of Animal Husbandry, Dairying and Fisheries (Chand et al., 2016). Since May 2014, the Centre has been implementing risk management and insurance scheme in all the districts of India for all animals including non-milch ones. Under this scheme, 50% subsidy is provided on insurance premium – but it is restricted to five animals per beneficiary per household for all animals except sheep, goat, pig and rabbit. In the case of these four, a subsidy is available for 50 animals. The sum insured under the policy is the market value of the animal. The basic premium rate per annum is up to 4% of the sum insured. The proposal for insurance is to be accompanied by a health certificate from a veterinarian giving age, identification marks, health status and market value of the animal. At the time of claim, most companies require a death certificate from a qualified veterinarian, post-mortem examination report and radio-frequency identification chip, which is inserted in the front left leg at the time of insuring the animal (Singh, 2015).

The insurance policy provides coverage for death due to:

1. Accident (Inclusive of fire, lightning, flood, inundation, storm, hurricane, earthquake, cyclone, tornado, tempest and famine)
2. Diseases contracted or occurring during the period of this policy
3. Surgeries
4. Riot and strike

Livestock is an important sector of national economy in the rural areas comprising mostly poor and landless farmers who rear livestock as a source of supplementary income. But the livestock farmers suffer considerably in calamities like a flood or drought or other disastrous situation as agricultural farmers. In Kerala alone, 75,857 cattle are reported to have died due to floods and landslides in August 2018. But, in spite of concerted efforts by the Central and State governments, livestock insurance has not picked up at the desired pace. A serious debate has been raging on to strengthen the livestock insurance in the country; the insurance scheme for animals has to take off. In case of crop insurance under Pradhan Mantri Fasal Bima Yojana, the scheme is compulsory for loanee farmers (for crops notified by a state government) and banks deduct the premium from the farmers' Kisan Credit Card account. On the other hand, the animal insurance scheme is optional and that is the foremost reason for its failure. Banks are not involved in livestock insurance and due to a lack of awareness and the procedure required to purchase insurance, few farmers bother to insure their animals (Jose et al.,2018). So, in order to provide risk coverage to farmers rearing animals, especially in flood-prone states like Andhra Pradesh, Tamil Nadu, Odisha, Bihar and east Uttar Pradesh, and drought prone regions of Maharashtra, Bihar, Rajasthan, Tamil Nadu, Odisha, Telengana etc., the coverage of livestock needs to be substantially expanded.

CONCLUSION

Animal husbandry provides supplementary income to small and marginal farmers and it employs women in large numbers, providing insurance coverage can protect them from losses in calamities. In particular, livestock Insurance has faced negligence from a policy perspective, and this is a key barrier to the success of longer term risk management and resilience building strategies in sustainable livestock production. The future of the livestock insurance depends on the ability of insurers to package their products in a manner that is far more appealing, impactful, and relevant to the struggles of the disaster hit livestock farmers. The relevant concrete steps taken by the Central and State Government, insurance companies can provide a necessary impetus to the vulnerable farmers grappled with economic and collateral damages with frequent incidences of disaster.

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Herbicide Resistance in Agriculture

Article id: 22521

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INTRODUCTION

Chemical weed control by herbicide is the easiest and effective weed management practice. Weeds cause nearly 34% crop loss but share of herbicide is only 16% among total pesticide use. The consumption of herbicide in Japan is as high as 5000g/ha, while in India it is hardly 40g/ha. The world's use of herbicide is growing rapidly, including India. In contrast to the benefits, there are some inadvertent drawbacks such as herbicide resistance, shift in weed flora and environmental concerns. The most prominent among them is the development of herbicide resistance in targeted organisms. Farmers shifted to sulfosulfuron and mesosulfuron + iodosulfuron from tailor made herbicide i.e. isoproturon to control weeds in wheat crop due to development of isoproturon resistant biotype after its continuous use in North and North Eastern India.

Herbicide resistance

Herbicide resistance may be defined as the inherent ability of weed species or biotype or weed population to survive and reproduce following a herbicide application at a dose that is earlier found lethal to the vast majority of weed population. Herbicide resistance is simply an altered response of a weed species to a herbicide which was earlier susceptible.

Resistance is always dependent on the rate of application of pesticide. Resistance development is an evolutionary process where rare resistant individual becomes the major one. Resistance is also induced by genetic engineering, mutation and gene flow.

Types of herbicide resistance

1. Cross resistance (CR):

Cross resistance refers to a condition or situation when weed biotype is resistance to two or more herbicides due to presence of single resistance mechanism (single genetic mutation). e.g., Isoproturon resistant weed, *Phalaris minor* found resistance to Pendimethalin 30% EC.

a. Target site CR: It refers to the situation when all the herbicide to which target has shown or evolve resistance affect the same site or enzyme like Cochia species is resistance to ALS inhibitor (sulfonyl urea and imidazolinone herbicide).
b. Metabolic CR: It refers to the situation when all the herbicide to which a weed species has shown resistance, their toxic product is degraded by the same mechanism or same pathway.
c. Negative CR: NCR is the situation when a weed or biotype is resistant to one herbicide or a family of herbicides but more susceptible to some other than its natural wild type susceptible population. Negative CR is very effective tool to prevent resistance in weeds.

2. Multiple resistance:

Multiple resistance refers to the condition where resistance plant possess two or more distinct resistance mechanism and due to this, that weed or biotype show resistance to two or more classes of herbicide. e.g., *Lolium rigidum* is a species of annual grass showing resistance to almost ten to fifteen herbicides**.**

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Factors affecting development of resistance

There are different factors that determine the development of herbicide resistance in weeds;

- ✓ ***Weed characteristics***: Initial frequency of the herbicide resistant individual, selection pressure by resistant population, ecological/biological fitness of weeds, weed biology, seed bank in the soil and nature of inheritance of resistant genes.
- ✓ ***Herbicide characteristics***: Herbicides with highly specific mode of action, herbicide metabolism, long residual activity of herbicide, over dependence on single herbicide, type of herbicide use and its time and dose of application.
- ✓ ***Cropping practice***: Tillage and cropping system.

Mechanisms of herbicide resistance

Mechanisms of herbicide resistance can be broadly grouped into two categories:

1. Target site resistance
2. Non-target site resistance

Target-site resistance (TSR):

It is generally due to a single or several mutations in the gene encoding the herbicide target enzyme, which, in turn, decreases the affinity for herbicide binding to that enzyme. In many cases resistance to herbicide like ALS inhibitors, dinitroaniline, triazine etc. are due to alteration of the target action site. In addition, gene amplification is the most recently described mechanism, for example, for example, in Amaranthus palmeri and Kochia scoparia, EPSPS gene amplification correlates with glyphosate resistance and induces resistance by increasing target enzyme production, effectively diluting the herbicide relative to the target site.

Non-target-site resistance (NTSR):

It is caused by mechanisms that reduce the amount of herbicidal active compound before it can attack the plant. Reduced penetration and/or altered translocation, enhanced herbicide sequestration and/or metabolism (detoxification) are the major causes of resistance. Active vacuolar or cell walls sequestration can prevent the herbicide to reach the site of action resulting the herbicide resistance. For example, glyphosate resistance in *Conyza canadensis*, *Lolium sp*. etc. is due to vacuolar herbicide sequestration. Finally, the biochemical reactions that detoxify herbicides can be grouped into four major categories: oxidation, reduction, hydrolysis and conjugation.

Mechanism of resistance

1. **Differential herbicide uptake:** In resistant biotypes uptake of herbicides seems to be difficult due to morphological barriers like over production of waxes, hairy epidermis, reduced leaf area etc.
2. **Differential translocation:** In resistant biotypes the apoplastic (cell wall, xylem) and symplastic (plasma lemma, phloem) transport of herbicide is reduced due to different modifications.
3. **Enhanced metabolism:** Rapid degradation and conjugation of herbicide into nontoxic or less toxic form are major mechanism of resistance in several weed species. In few cases triazene resistance in weeds has shown resistance through detoxification.
4. **Sequestration and compartmentation:** Some plants are capable of restricting the movement of foreign compounds (herbicides) within their cells or tissues to prevent the compounds from causing harmful effects. In this case, an herbicide may be inactivated either through binding (such as to a plant sugar

molecule) or removed from metabolically active regions of the cell to inactive regions, the cell wall, for example, where it exerts no effect.

5. **Altered site of action:** It is the modification in the binding site of action of a herbicide due to some genetic changes in biotype or weed species showing resistance to a particular herbicide or group of herbicides compared to susceptible one, and result of this the resistant biotype remain unaffected by that same applied herbicide. In fact, resistance in different weed species is due to different mechanisms. Development of resistance in many weed species to most of triazine herbicides is due to the altered site of action.

Management of herbicide resistance

Herbicide resistance management is as complex as its mechanism of development. There are some alternatives to control and prevent the development of herbicide resistance such as:

1. Quarantine Measures
2. Cultural Techniques
3. Herbicide rotation and herbicide mixtures
4. Use of alternative herbicide with short residual life
5. Rotation of Crops
6. The use of bio herbicide to manage resistance
7. Integrated Weed Management

Some other cultural practices followed to block the emergence of resistance are selection of weed competitive crop cultivars, use of clean seeds, stale seed bed technique, closer row spacing, timely sowing and rate of seeding, good crop husbandry and soil solarization.

CONCLUSION:

Herbicide resistance is a global phenomenon and an unprecedented level is growing in thenumber of resistant weed biotypes. Herbicide over-reliance should be reduced and herbicide combined with other methods should be used. Herbicide should be used in rotation or as mixture. The best way to manage herbicide resistance problem is to include the cultural, quarantine and other practices in an integrated manner.

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AGROFORESTRY: Tree seed production and management

Article id: 22522

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1.0 INTRODUCTION

Agroforestry tree seeds, technical information and other reforestation support to small scale efforts in the developing world. Because of the increasing use of agroforestry as a tool to improve food production, restore land, and alleviate some of the negative environmental effects of unsustainable agriculture, the demand for seeds is continually growing. Community-based forestry and agroforestry programs around the world reforest denuded lands, protect valuable watersheds and produce indispensable tree products for soil improvement and fodder. These programs begin planting operations with a commodity of small size but great importance-seed! Adequate supplies of high quality seed are necessary to grow high quality seedlings. Unfortunately, shortages of seeds are common and limit the success of many community-based tree planting programs. Any discussion about tree seed production must consider the saying “garbage in garbage out”. If you plant junk seeds you will inevitably harvest junk trees.

1.1 Local Seed Production

Organizations and individual farmers can overcome the “seed problem” by “growing their own seed. Seed production serves organization and individuals in several ways;

- Less time is spent searching for seed sources and less money is spent on seed purchases. The time and money saved can be allocated to other activities.
- Locally produced seed has a proven genetic quality for local environmental conditions.
- Organisations and farmers also realize a financial benefit when seed is sold. Seed sales increase income and decrease economic risk by diversifying farm production and targeting new markets.

1.2 Some of the benefits of growing seeds locally include:

- Seeds are adapted to local environmental conditions.
- Seeds are available locally when the right growing conditions occur (i.e. before the rainy season).
- Seeds no longer get lost or damaged during transportation from distant places.
- Creates the potential of generating income by selling extra seeds or by implementing bee keeping activities around flowering trees.
- Seed stand trees can provide services such as shade, soil and water conservation.

2.0 Meeting long-term seed needs

2.1 Seed Orchards

Relatively few organizations are willing or able to make the long-term commitment necessary to establish orchards for the tree seed production. If the decision is made to establish seed orchards a long term plan is very important. Several years of planning are required before the first tree is planted. A number of issues must be considered before establishment. Some relevant issues include

- Are there sufficient financial resources and have land tenure issues been resolved?
- What type of orchard is appropriate for the tree species of interest?
- Are there locations where tree species will flower early and heavily?

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- Does the organization have the expertise to manage the seed orchard successfully?

A seed orchard is an area where seeds of particularly valuable genotypes are produced to obtain seed as quickly and economically as possible. This is a specialized plantation of selected species, which are isolated to avoid contamination, and managed to produce frequent, abundant, and easily harvested seed crops. Orchards can be used for genetic improvement and production of large quantities of seed for operational planting. Generally, the benefits of orchards are the production of seed with improved disease and insect resistance growth wood qualities, adaptability and tree from.

2.2 Seedling seed Orchards

Seedling seed orchards are plantations with known family identity that are managed for maximum seed production. They consist of a population of open (naturally) pollinated families of selected trees. Often they are "first-generation" orchards that are the result of species and provenance trials. Typically they result from rouging, a process of removing the trees with less desirable genetic potential. Most multi-purpose tree seed orchards are of this type.

2.2.1 Site Selection Criteria

An ideal site will have;

- Good soil structure, drainage and fertility, with protection from high winds.
- Seed orchards also require level or gently sloping terrain with easy access and good security.
- They should be located near the nursery or farm offices so that equipment and personnel are readily available. This will aid in overall orchard efficiency by reducing travel time to the site.

Generally, abandoned agricultural lands make good sites. It is important that site environment characteristics encourage early and heavy flower production. Site requirements differ depending on the tree species of interest.

Seed orchards size depends on seed production objectives. Generally, if average rate of seed production per tree is known, then calculating the number of trees needed to reach the production per tree is known, then calculating the number of trees needed to reach the production objective is straightforward. An orchard where insects are controlled and soil fertility is well managed will yield seed of higher quality and quantity than an unmanaged orchard.

3.0 Orchard Establishment and Management

3.1 Land Preparation

- Ripping to eliminate soil compaction should be considered on abandoned agricultural land.
- Soil pH should always be tested and nutrient levels amended as required to promote growth and flowering.
- Generally the elements of importance are nitrogen for growth and phosphorous for flowering. However, a deficiency of any macro or micronutrient can effect seed production.

3.2 Planting

- Orchards should be established with planting material of high quality.
- Containerized seedlings have worked well in most tropical conditions.
- Weed control is very important and can be achieved through chemical, mechanical or manual means.
- Planting seedlings of high quality and reducing weed competition are the first steps to developing a successful orchard.

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- Tree spacing in a seed orchard is wider than timber plantations. Actual spacing will be determined by the canopy shape and size of each specific species. Often seedling s a re planted at closer spacing. After a few years inferior tree are removed to achieve the desired spacing.

3.3 Cultural practices

3.3.1 Irrigation

Irrigation will improve establishment success and help maintain growth and vigor of the seed orchard. On arid sites it may be possible to induce flowering by timing of irrigation. There is some indication that flower induction is promoted by moisture stress in some tree species.

3.3.2 Ground covers

Ground covers should be considered between rows to suppress weeds and conserve moisture. The orchard floor will be protected from wind and water erosion while soil nutrients and soil moisture will be retained for longer periods.

3.3.3 Pruning

The size of the canopy of the tree will influence flowering and seed production. Generally, the larger the canopy the greater the seed production. Pruning and coppicing can be used to modify tree form to increase sunlight penetration and canopy size. Both modifications enhance flowering, seed production and ease of seed harvest.

Each tree species responds to pruning differently, so prune with care until the tree responses as desired. Pruning and coppicing must be timed to disrupt seed production as little as possible

3.3.4 Pests and Diseases

A major factor to determine whether a seed orchard is economically viable will depend upon success of controlling orchard pests. There a re 2 categories of consequential orchard pests, those that attack the flowers and seeds and those that attack the tree. Monitoring and control measures are important strategies for improving seed yields.

3.3.5 Record keeping

Record keeping will provide a reference of orchard performance and give insight into productivity and corrective actions that should be taken if problems develop.

Records of importance include:

- Age at first flowering
- Months of flower production and level of flowering
- Complete weather records and historical data will aid in seed orchard management and help in planning future orchards.
- Recording fertilizer rates and formulations as well as dates of application are important
- Irrigation quantity, frequency, and dates will help to establish relationships between flowering and seed production
- Insect and disease management records of material used, dates and rats applied method of application and results are also very important.
- Silvicultural treatments such as pruning and thinning should be recorded.
- Site maps should be updated when trees are removed.
- Records of adverse environmental conditions such as droughts, high winds, floods and heavy rains and hurricanes should be noted and the effect these events had on flowering and seed production

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4.0 Techniques of Seed Harvesting and Handling

When the seed of most tree legumes is mature and ready to harvest, pods will become dry and change colour. This indicates that the seed embryo is mature ands can be harvested without loss of germination ability. Harvest windows are fairly narrow about 2 to 4 weeks in duration. It is important to stay on top of harvesting. Late harvesting can result in yield loss due to pod shatter and pest predation, so correct harvest timing is essential.

Dry seed pods are usually collected by hand picking Extraction of seeds can be accomplished by beating the pods with a flail, walking over them, or rubbing them through a screen. For larger operations, commercial threshers are more practical.

Cleaning infested or bad seed using floatation will work with seed having hard seed coats i.e. *Leucaena*. Fill a container to about 25% with seed and pour in clean water until the container is 75% full. Good seeds will sink. The poor seeds, trash, and insects will float to the top where they are removed. Stir the water and continue to skim off the trash. Slowly pour off the water by tilting the container at a slight angle. The water treatment may need to be repeated several times to remove the bulk of poor seeds. Seeds are removed from the container and spread out on a drying rack until dry then stored. Air sorting is another method that can be used to blow off chaff and empty seeds.

Proper storage is necessary to maintain seed viability. Most seeds with hard seed coats store for 1-2 years with little loss of viability. The factors that will affect seed viability are;

- moisture content of the seed
- humidity
- temperature

For long term storage a moisture content of 4 to 6% is ideal. Storage should be about 4.5-10degree C with relative humidity no higher than 70 but preferably below 50. Seed sorted for extended periods should be sealed in airtight moisture resistant containers. This will protect seed against insects' disease and mould.

5.0 Nursery Management

Introduction

Seeds of some plants may not germinate immediately after being planted. All seeds have an outer layer that protects the delicate embryo inside. With species that do not germinate immediately, this covering or seed coat may be waxy or hard preventing the water that is necessary for germination to enter the seed. Under natural conditions, the seed coats break down over time (sometimes years). Once the breakdown is complete and if the seed embryo has not been damaged, germination takes place under favorable conditions.

Seed treatment has a number of advantages:

- Because of the breaking of the physical barrier that inhibits the uptake of water, seed treatment allows quicker emergence of the seedling
- Under natural conditions, the seed coats break down slowly over time resulting in the uneven germination of a seed crop from the same year. Seed treatment allows seeds to germinate within a few days of each other giving rise to a uniform crop of seedlings.

There are several types of seed treatment. These include soaking in cool water, immersing in hot water, treating seed with acid and physical weakening of the seed coat e.g. scrapping off portions of the seed coat.

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Species: Appropriate seed treatment

Acacia angustissima: A, C
Cajaus Cajan: A,
Calliandra calothrysus: A, B, C
Leucaena spp: B
Sesbania sesban: A, B, C

A. Cool Water Treatment

Soak seeds in cool, water at room temperature until the seeds swell. The volume of water should be about five times the volume of seeds. Soaking time may vary from 6 to 48 hours depending on species, age and quality of seed. This treatment is appropriate for seeds with a thin or soft seed coat, recently harvested seed, seed of small size and large quantities of seed

B. Hot Water Treatment

Pour boiling water over the seeds at a volume five times the volume of seeds. The seeds must be stirred gently during the 2 to 5 minute soak. Pour off the hot water, replace with cool water and soak for 12 hours. This treatment is appropriate for seeds with hard or thick seed coats, old seed and large quantities of seed

C. Physical Weakening of Seed Coat

Cut or scrape a small opening in the seed coat. A knife, nail clipper, metal file, sand paper or sanding block can be used for this operation. To avoid damaging the seed embryo, cut or scrape the seed coat only opposite the point where the seed was attached to the fruit of the mother plant. Seed treated in this way is soaked for 12 hours in cool water. This treatment is appropriate for all types of seed with the exception of those that are very small or having a soft seed coat. However, being time consuming, this treatment is feasible only for small quantities of seed.

Calendar calothyrsus

Altitude	250 - 1800 m
Mean annual temperature	22 - 28 ^{0}C
Main uses	Fodder, bee forage, aesthetics
Mean annual rainfall	600 - 2800 mm
Soil type	Light textured, slightly acidic soils. Does not tolerate water logging

Cajanus cajan

Altitude	Sea level - 2000 m
Mean annual temperature	18-38 ^{0}C
Main uses	Fodder, soil improvement, food
Mean annual rainfall	400-2500 mm
Soil type	Prefers alluvial, verticals and alfisols. pH 5 to 7. Sensitive to saline soils and susceptible to water logging.

Sesbania sesban

Altitude	100 - 2300 m
Mean annual temperature	18-23 ^{0}C
Main uses	Soil improvement
Mean annual rainfall	500-2000 mm
Soil type	Tolerates seasonal or permanently waterlogged soils as well as saline and acidic and alkaline soils

Leucaena spp.

Altitude	30-1500 m
Mean annual temperature	18-30 ^{0}C
Main uses	Fodder, soil improvement
Mean annual rainfall	600-3500 mm
Soil type	Prefers slightly acid, fertile soils but is tolerant of leached soils

Acacia angustissima

Altitude	30 - 2600 m
Mean annual temperature	5 – 30 ^{0}C
Main uses	Fodder, soil improvement
Mean annual rainfall	600 - 2800 mm
Soil type	Prefers free-draining soils and tolerates acid soils.

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Use of traditional folk media for the behavioural changes among the rural community

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INTRODUCTION

Folk Media refers to traditional media based on sound, image and sign language. It is expressed in the form of traditional music, drama, dance and puppetry. Messages on issues like agricultural development, primary health care and nutrition, environment, education, women and child rights are projected through the folkmedia.The term folk, derived from the GermanVolkslehre (People's customs) has been used differently in different countries and at different times. Anthropologists use the term synonymously for myths, legends, folktales, folk songs, proverbs, riddles and variety of forms of artistic expressions whose medium is the spoken word. The term folk was coined by William Thomas in 1846.The most popular form of traditional folk media is the folk dance. Colorful, vibrant, melancholic, elegant, graceful — all these attributes form the core of folk dances. Folk music is yet another popular form of folk media. Music is governed by the language, colloquial accent, and instruments used by the local people. Street theatre is one more form of folk media that is being used widely to propagate socio political messages and to create awareness for social issues. A group of people perform on streets, and gather crowds. Puppetry is another form of folk media that is equally entertaining and informative. Puppets come in four basic types- glove puppets, string puppets, rod puppets and shadow puppets. Each type is found in a particular state like glove puppets are found in Kerala, Odisha, and Tamilnadu.

Various areas for behavioral changes through traditional folk media of villagers:

A. Disaster Risk Reduction:

i. Disasters and natural calamities, which is a reality in our country, which takes place every now and then, building resilience and safety project can be done with focus on children by empowering them as decision makers under child centric Community based disaster risk reduction response programme and making it a localreality.

ii. Monthly and regular meetings of children groups and child protection committees can work for child right, child protection, quality education, prevention of child labour, strengthening of health and hygiene practices and problems of dropout students etc. Can be discussed. Group communication on village level is very effective tool to motivate everyone for the participation.

iii. With the help of street play people can be motivated to form SHGs to earn a livelihood in a significant way. Grain banks can be established with an objective of helping vulnerable families during disaster at the community level that can be exclusively managed by women, women SHGs andcommunity.

iv. Mock drill on first-aid in local language can be organized. Strong sense of responsibility among the community members can be developed about their roles as a member of the task forces and how to respond during search and rescue, first-aid and reliefoperations.

v. Wall writing on WASH issues like safe drinking water, purification of water, various concerns during the disaster can be depicted invillages.

vi. Awareness through various campaigns like puppet show, street play, celebration of Global Hand Washing Day etc. can be done with school children andcommunities.

B. Health, Nutrition, Water Hygiene and Sanitation:

i. Community Health Services awareness campaign can be organized through traditional media. It can improve the utilization of primary health care services among communities. The interventions can result in substantial improvement of child health after training Village Women activists as well as conducting community awareness programmes through drama, street play and camps. The women can be made empowered around their health needs.

ii. Puppet shows and street plays can be organized to make the community awareof Tuberculosis andHIV.With the help of traditional folk media (natak, puppet shows) efforts can be taken to create awareness among mothers for safe delivery, pregnancy care and infant feeding practices and treatment of diarrhoea. After motivating the community through various traditional media training, they can also be imparted knowledge on different components of maternal and child health. Community can receive valuable information about institutional delivery, importance of breast feeding, immunization, nutrition, child's mental and physical health, breastfeeding, sanitation and hygiene etc. They can also become aware about the different government schemes for the pregnant woman and the new born child and immunization etc.

C. Child Protection:

Awareness among communities about child protection issues like child right, child abuse, girl child abortion, child marriage, child labour and child trafficking issues can be done easily through various traditional media not only community people but Panchayat representatives can also be made aware about the child rights.

D. Education:

The government has implemented different schemes for the rural people but they are unable to access the benefits of government schemes because of lack of information. With the purpose of providing qualitative education among children, children SikshaJankariMelacan be conducted to sensitize community members on various government schemes in which the information related to educational schemes can be given to the community members. Nataks can be played in villages with the objective of generating awareness on Right to Education and learning without fear in community. This also included girl education in the community. Through the street plays, different government schemes for girl education can be demonstrated. This effort can touch the community and result will be very positive.

E. Women Empowerment:

i. Efforts through traditional media can be made at community levels to provide women awareness about debit and credit facilities for them through various banks and free them from any exploitation by the local money lender. On the other hand women can also become empowered in decision making process at family level. It can also enhance the leadership skills amongwomen.

ii. Traditional media, like street play can aware women community about violence against women. Protection of women from Domestic Violence Act 2005 and its provisions can be highlighted through this the folk media. The objective of the communication can create and raise awareness among key persons within the society as well as community on violence against women. This effort will make women vocal—they will be able to put their voices before panchayat representatives, government officials and social leaders for accessing the benefits of government schemes.

iii. It's a fight to change the attitude and bring community people on a platform where their involvement can be encouraged for the development. Here, traditional media can work miracle for them. Many works have been done by NGOs, governmental organizations and through various international organizations and positive results are sufficient to motivate to work more through this old media. It can make considerable difference in lives of rural people. And if it is used sensibly with other mediums, it is going to bring much change in the lives of the people who are residing in the rural areas of developing country likeIndia.

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CONCLUSION

One of the major issues in rural areas of India is that of dealing with people's attitude and responses to issues of development. Traditional folk media are playing meaningful role in the affairs of developing countries in Asia and Africa. As a much loved body of interpreters ofindigenous culture, they have proven to be highly influential with the rural masses. As the reality has not changed in rural areas of India much now so the traditional media is still making a difference in rural lives. This media is matchless as it's a persuasive means of communication.As against the urban-based mass media, the rural-based folk media are found to enjoy greater credibility with rural audience. When handled with care and consideration, the sensitive folk media have proved themselves to be meaningful and effective tools of communication for development.The traditional media are communication channels which reflect people's culture. These media were not introduced to the people like the modern mass media but are part of the people's culture and contributed greatly in shaping their existence. As Nwabueze (1995) rightly observed, these media have been described as a continuous process of information dissemination, entertainment and education used in societies which have not been seriously dislocated by western culture or any other external influences. The people still depend on these media in parts of Africa because of their effective interpersonal nature.

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Farm machinery testing and its importance

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INTRODUCTION

Testing of farm machinery is a very important aspect to be kept in mind when quality of farm machinery is concerned. The *Neolithic period* was the era of organic farming. In this era most of the farm operations were performed by using man and animal power and there were very few primitive tools. Use of hand tools and small agricultural machineries for farm operations was started in *Chaliolithic period*.

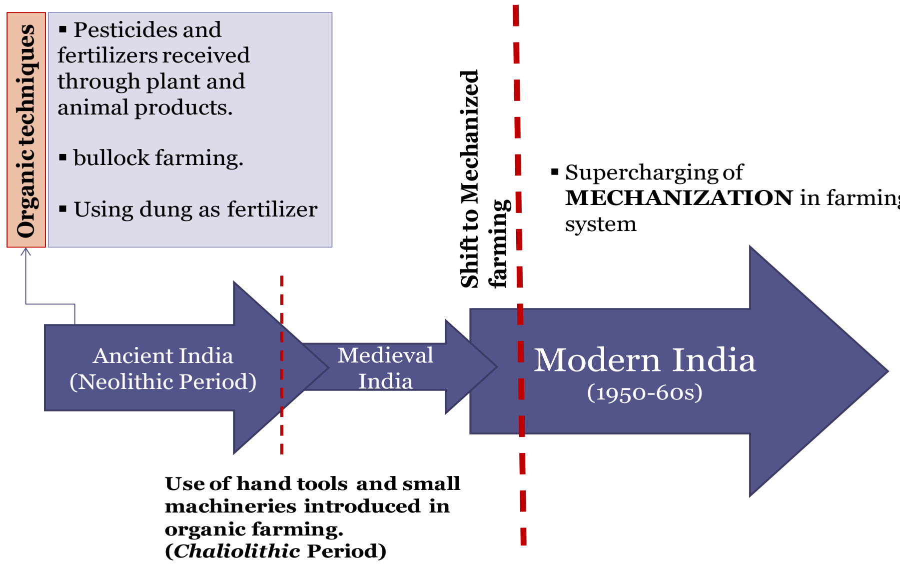

Fig. 1 Stages of Farm Mechanization

In the modern era, introduction of Green revolution supercharged the use of machines on the field operations in agricultural practices. Faster in faster, the growth of tractors and farm machineries started ruling the Indian Agricultural Farms. The industry of Farm implements and machineries grown to a greater extend. For the record, from only about 50,000 units in the early eighties, the size of tractor market in the country has grown by up to ~600,000 units per annum. The sector of farm implements spurts suddenly from 2000-01.

With the increase in use of farm machineries in agricultural the industry grew up and many small scale, medium scale and large scale industries related to farm machinery developed. Presently there are more than 5 lakhs small scale agricultural industries in India. As the volume of industries and machineries is increasing testing of these machineries has become essential to ensure good quality of machine and for consumers' protection.

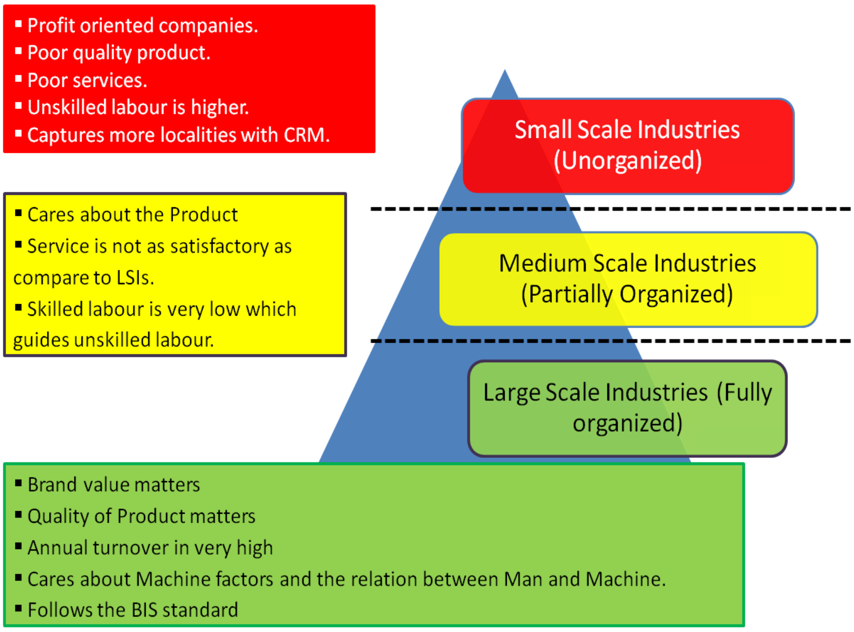

Fig. 2: characteristics of different industries related to Agricultural Machineries

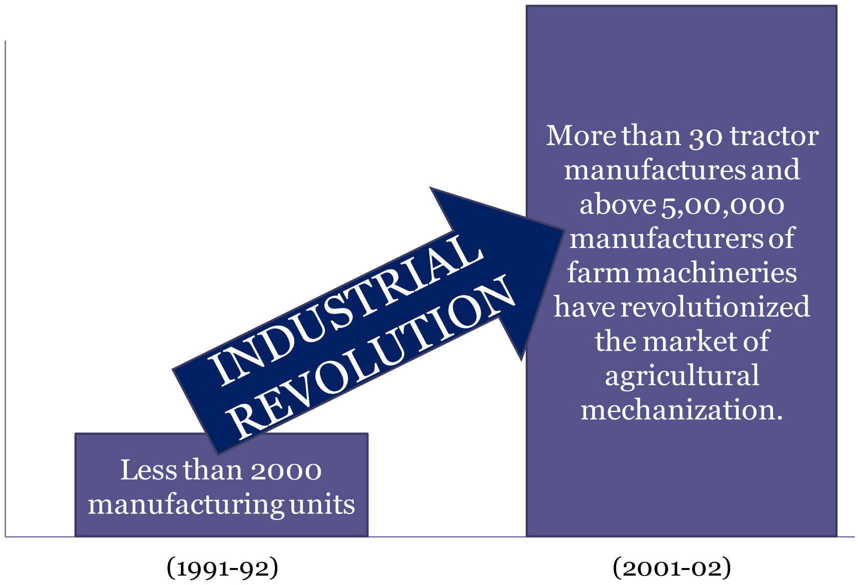

Fig. 3: Increase in the industries of tractors and farm machineries

Small Scale Industries (fully unorganized) are of more than 5 lakhs in numbers all across the country. In order of controlling the market of poor quality of machines into the field of agricultural produces, the testing of these farm machineries are essential.

Testing and Evaluation

Testing may be defined as analysis of behaviour of machines with standard codes/ norms under ideal and repeatable conditions while evaluation involves measurement of performance under actual field/ working conditions. In addition to functional performance of the machine, it also considers social and economical aspects.

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Testing objectives

1. To access the functional, suitability, durability and performance characteristics under different agro-climatic conditions.
2. Testing serves as a basis to decide the type of machine best suited to a particular condition which would be encouraged for import, export, production and popularization.
3. It helps the farmers and other prospective purchasers in determining the competitive performance of machines available in the market.
4. Provides materials to research workers and designers for further development, engineers and extension workers for guiding farmers and other purchasers in proper selection of equipment.
5. Forms basis of standard specifications to be used by the manufacturers and distributors.
6. Helps financial institutions in recommending financial assistance to both the manufacturers and the purchasers.
7. To carry out trials on machines and implements which have been proved successful in other regions of the world with a view to examine possibility of their introduction in the country.
8. To maintain check over the quality of agricultural machines tractors and other equipment through batch testing programme.
9. To assist the manufacturer in production improvement and upgrading the specifications of the machines.
10. To provide feedback to manufacturers through users' survey on nature of field complaints and standards of pre and after service facilities provided by them.
11. To assist the Bureau of Indian Standard on agricultural implements and machines.

Testing Network in India

There are four major farm machinery training and testing institutes in India which are as follows –

Table 1. Major Training and Testing Institutes in India

▪ **Central Farm Machinery Training and Testing Institute, Budni (MP)**	Specially for Tractor Testing with Farm Implements.
▪ **Southern Farm Region Machinery Training and Testing Institute, Anantapur (AP)**	For Testing Power Tillers and Farm machineries.
▪ **Northern Region Farm Machinery Training and Testing Institute, Hisar (Haryana)**	For testing Engines and Plant Protection Equipment
▪ **North Eastern Region Farm Machinery Training and Testing Institute, Biswanath Chariali (Assam)**	Farm machineries and general purpose agricultural hand tools.

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But it was hard to manage testing of tractors and farm implements and machineries just by four training and testing institutes. With this consideration, 25 SAUs were authorized to test Farm implements and generated certified report.

CONCLUSION

Hence, the ultimate objective of farm machinery testing is to identify the performance of the machine and report the weaknesses so that they can be corrected. The final machine manufactured should be in such a way that it can be used with minimum tolerance during in-field operations.


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Different Mechanisms of Insecticide Resistance

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The identification of mechanisms involved in insecticide resistance is one of the major challenges in insect toxicology and resistance management. The intoxication of an insect by an insecticide encompasses three levels of pharmacokinetic interactions- penetration of barrier tissues: distribution, storage and metabolism in internal tissues; and molecular interaction with the ultimate target site as the detoxification of insecticides by insects have three basic mechanisms- decreased cuticular penetration; increased metabolic detoxification and target site insensitivity. So, there are three types of insecticide resistance mechanism-
1.Cuticular penetration
2.Metabolic detoxification
3.Target site insensitivity

1. Cuticular penetration

Decreased cuticular penetration has been known to be a resistance mechanism since first described in the early 1960s.By itself this mechanism usually confers only low levels (>3 fold) of resistance, however, it does seem to provide protection to a wide variety of insecticides. Decreased penetration has been only at the level of the insect cuticle. However, any biological membrane has been potential to serve as a barrier and thus confer resistance. The decreased penetration mechanism also produces a similar delay in knockdown. However, the decreased cuticular penetration mechanism would not cause a delay in knockdown, if the insecticide were injected, whereas the kdr-type mechanism would still delay knockdown (Scott,1990).

2. Metabolic detoxification

This mechanism is a remarkably effective biochemical defense system that is as proficient against man-made chemicals as it is against the naturally occurring chemicals for which it was selected (Wilkinson,1980). View in this light, the development of insect resistance to insecticide through enhanced enzymatic detoxification should be considered as an accelerated version of the natural selection process. In such metabolic enzymatic detoxification, of the many types of chemicals to which insects are exposed, it lipophilic compound, these have the ability to penetrate the outer protective barriers (cuticle) of the insect and distribute themselves in the fatty tissues. Furthermore, such fat-soluble materials tend to accumulate in the fatty tissues, since their physco-chemical characteristic preclude their ready removal from the body in the aqueous or polar media in which excretion usually occurs. To counter this problem, insects have a process whereby lipophilic foreign compounds are converted or metabolized to more polar, hydrophilic materials that can be removed through the normal excretory mechanisms.

3. Target site insensitivity

The resistant insects tolerate, without showing any signs of symptoms of poisoning, a large internal amount of insecticide that would be more than enough to kill susceptible insects. It means, in certain resistant insects, the target site is less sensitive to the insecticide than susceptible insects. The nervous system of resistant strains has acquired resistance to the direct action of insecticides. The low sensitivity to an insecticide is at least in part responsible for the resistance of the insect to the insecticide. This has been shown to be the case for the resistance of the insect to the insecticide. This has been shown to be the case for several strains of house flies resistant to DDT, BHC, Deldrin and Organophosphates. The Possible mechanisms include reduced binding of the insecticide to the nerve membrane, a smaller degree of modification of the sodium channels by the insecticide, and modification of the membrane electrical properties to reduce repetitive response in the face of the increased depolarizing after potential.

Insecticides, Mode of action, and Mechanisms of resistance

Insecticides	Mode of action	Mechanisms of resistance
Cryolite	Disrupts midgut, inhibits cellular and digestive enzymes	No known resistance mechanism
Abamectin	Affects ligand-gated Cl-channels of the CNS and nerves innervating muscles	Site insensitivity and penetration, Esterase and PSMO (Polysubstrate monooxygenages) metabolism
Azadirachtin	Inhibits production of ecdysone, Antifeedant.	No known resistance mechanism
Delta-endotoxin	Destroys midgut epithelium	Altered binding site
Fatty acids	Disrupt semipermeability of membranes	No known resistance mechanism
Pyrethrum	Affects ion permeability of nerve membranes	Metabolized by PSMO Penetration, Kdr(Knockdown resistance)
Rotenone	Inactivates respiratory chain enzymes involved in the electron transport system	Metabolized by PSMO
Spinosyns	Affect nervous system	No known resistance mechanism
Synthetic chlorinated hydrocarbons	Affects ion permeability of nerve membranes for cyclodienes and DDT analogues	Kdr factor, Esterase metabolism, Penetration
Cabamates and Organophosphates	Bind of acetylenolinesterase	Altered acetylcholinesterease, PSMO,Penetration
Nitroguanidines	Block bind of nicotinergic acetylcholine to postsynaptic receptors	No known resistance mechanism
Phenylpyrazoles	Antagonists of GABA(Gamma aminobutyric acid) regulated chloride channel	No known resistance mechanism
Pyrethroids	After ion permeability of nerve membranes.	PSMO metabolism, penetration, Kdr, Esterases
Methoprene	Inhibits metamorphosis	Alteration of JH receptor binding characteristics

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