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A Resonance in Agriculture

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E-COMMERCE IN Agriculture

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Agriculture Updates

India and Fiji sign MoU for cooperation in the field of agriculture and allied sectors

Union Minister for Agriculture & Farmers Welfare, Shri **Narendra Singh Tomar** and Fiji's Minister of Agriculture, Waterways & Environment**, Dr. Mahendra Reddy** signed a **Memorandum of Understanding (MoU)** for cooperation in the field of Agriculture and allied sectors between India and Fiji in a **virtual meeting**. The MoU provides for cooperation in the fields of Dairy Industry Development, Rice Industry Development, Root crop diversification, Water Resources Management, Coconut Industry Development, Food Processing Industry Development, Agriculture Mechanization, Horticulture Industry Development, Agricultural Research, Animal Husbandry, Pest and Disease, Cultivation, Value Addition and Marketing, Post-Harvest and Milling, Breeding and Agronomy.

COEs established in Karnataka under Indo-Israel Agriculture project

For taking the **Israeli technologies** in the field of Horticulture, **Sh. B. S. Yediyurapp**, Chief Minister of Karnataka and **Sh. Narendra Singh Tomar**, Minister for Agriculture & Farmers Welfare jointly inaugurated the **3 Centers of Excellence (COEs)** established in Karnataka under **Indo-Israel Agricultural Project (IIAP).**

MIDH Division of Ministry of Agriculture & Farmer's Welfare, Government of India and MASHAV - Israel's Agency for International Development Cooperation - are leading **Israel's largest G2G cooperation**, with **29 operational Centres of Excellence (COEs)** across India in **12 States.**

Union Agriculture Minister inaugurates NHB Centre at Gwalior

Union Agriculture Minister inaugurated the new **Centre of National Horticulture Board (NHB)** at **Gwalior**. NHB, which is mandated for integrated development of **hi-tech commercial horticulture** and **post-harvest management/cold chain infrastructure** in the country, is having centers/offices at various locations of the country and atleast one centre is there almost in each state for implementation, monitoring and coordination of its various Schemes and activities

India's tea export in fiscal 2020-2021 drops.

India's tea exports in fell in respect of both volume and value although **fiscal 2020-21** there was an increase in the unit price compared to the previous fiscal.

An analysis of the latest data available with the **Tea Board** shows that the average price of India's tea in the export market rose to **₹258.99 kg in 2020-21** from **₹226.12** in the previous fiscal, marking a **gain of 14.54 per cent**. However, the higher price brought down the export orders. Besides, the lockdown in many countries in the world's fight against Covid-19, disturbances in the exchange market as also the banking transactions adversely affected the purchase of tea in many countries.

Govt. launches mobile app 'Matsya Setu' for aqua farmers

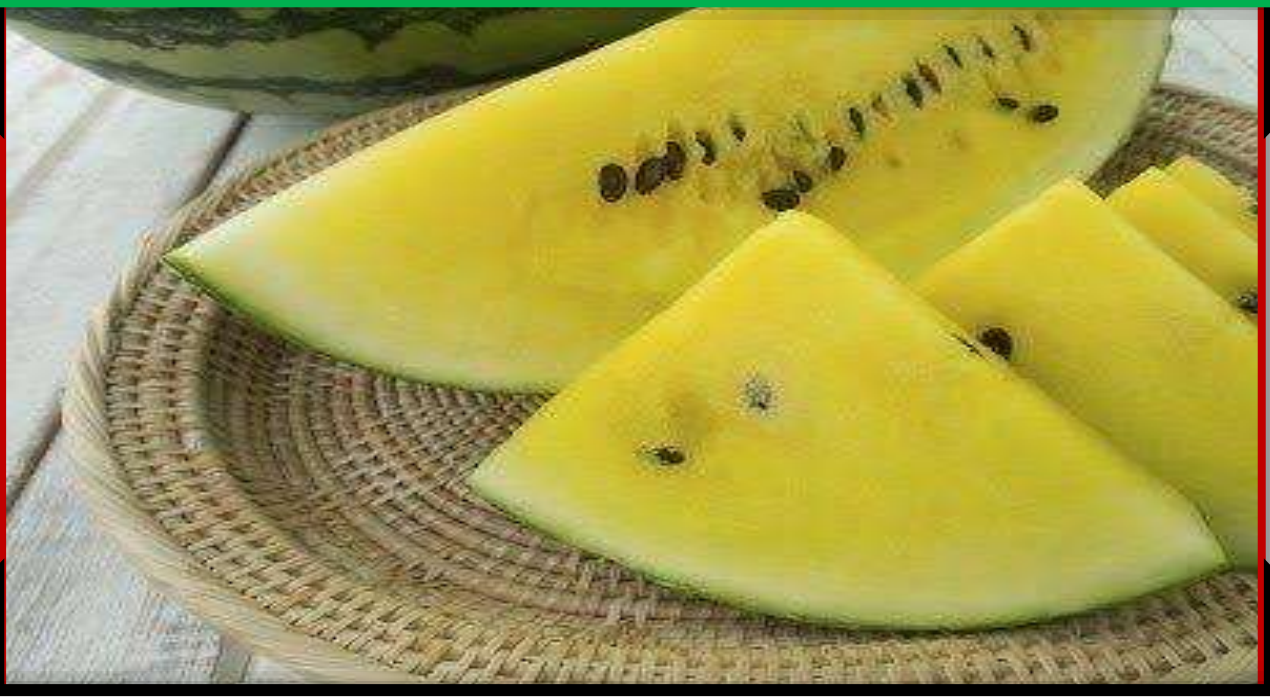
Union Fisheries, Animal Husbandry and Dairying Minister **Giriraj Singh** launched a mobile app **'Matsya Setu'** to disseminate the latest freshwater aquaculture technologies to the country's aqua farmers. The app has been developed by the **ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA),** Bhubaneswar, with the funding support of the **National Fisheries Development Board (NFDB),** Hyderabad.

Matsya Setu app has **species-wise/ subject-wise** self-learning online course modules, where renowned aquaculture experts explain the basic concepts and practical demonstrations on breeding, seed production and grow-out culture of commercially important fishes like carp, catfish, scampi, murrel, ornamental fish, and pearl farming.

Assam gets first agri business growth lab

Assam has got its **first Assam Agribusiness Growth Lab** which will support 100 Agri-Enterprises in four years. The programme was formally launched in **Guwahati by Vinod Seshan**, **State Project Director, ARIAS Society.** This is the first of its kind programme to support enterprises in the agri and allied sectors launched in Assam. **Assam Agribusiness Growth Lab (AAGL**) is being initiated by CIIE.CO an incubator of IIM Ahmedabad in partnership with **Assam Agribusiness and Rural Transformation Project (APART)** under the aegis of Assam Rural Infrastructure and Agricultural Services Society (ARIAS). "The time is ripe for various ecosystem players, government and private stakeholders, academic institutes and promising entrepreneurs to join hands and give a fillip to the growth of agri businesses of the state. "

Yellow watermelon variety introduced by Bayer in India



German agrochemicals major **Bayer** has launched the **first-ever yellow watermelon** variety **Yellow Gold 48** under Seminis brand in India. This yellow watermelon has been developed from superior germplasm as part of Bayer's global research and development efforts, the company said in a statement.

The **yellow watermelon variety** has been commercially introduced in India following **two years of local trials.** With **Yellow Gold 48**, watermelon growers can benefit from enhanced yield potential, better disease and pest tolerance, and higher returns. Yellow Gold 48 variety is best suited for cultivation from **October to February** and for harvest from **April** onwards and will be available in the market until **mid-July.**

Farm exports grew over 17% in FY21: Anup Wadhawan

India's farm sector exports give reason to cheer in spite of an overall contraction in merchandise exports in FY21. Vegetables from Varanasi, bananas from Ananthpur in Andhra Pradesh and ranges from Nagpur aided in that growth.

Agriculture exports in FY21 grew **17.3% to $41.25 billion** from a year ago after remaining stagnant in preceding three years, an official statement said quoting commerce secretary **Anup Wadhawan**. This indicates the farm sector's robust performance while the overall merchandise exports contracted by **7.26% to $290.63** billion in the pandemic ravaged year.

The assured prices behind India's agricultural boom

This **rabi marketing season** has seen the highest **procurement of wheat** by government agencies in history. At **43 million tonnes**, this is 33% higher than the average for the past five Rabi seasons. It underscores the prime role played by the government in procurement of farm produce. This becomes important in the context of the three farm laws that were introduced last year but whose implementation was put on hold amid ongoing farmer unrest.

E-COMMERCE In Agriculture

Cover Story

E-commerce! E-commerce! E-commerce! have heard it routinely since 2012, but wait a minute its even today far untouched in some sector like Agriculture. In a world totally heading towards globalization for each and every product, far after, Green revolution, far after 1991 globalization in India and today its 2021, still Agriculture sector isn't totally globalized, seems strange? Yes, you should.

We see Malnutrition ahead of us, We see Wastage of food ahead of us when the supply of produce is higher than the demand but we see increment of GDP from 17.8% in 2019-20 to 19.9% in 2020-21 even in this pandemic, there is huge scope for agribusinesses but yet Farmers aren't profited to the remark, if we

see the Curve of Total income of Average farmers in India, the slope is negative. Now somehow we see a ray of positive slope since E-commerce has arrived with potential in India. Since 2016 we see huge efforts and upto mark results in E-commerce and farmer relationship.

E-Commerce refers to the buying and selling between parties involved, in case of both services and goods. It also involves payment accomplishment of the goods and services via an online platform (electronic means). It can be differentiated with popular e-commerce as it only involves B2B trade where general e-commerce involves mainly B2C trade.

In a world full of profit oriented business, farmers must get globalized too with the 21st century Era. No one can escape the magic of technology and with e-commerce farmers are welcomed like in a cradle with 100% profit. Yet the reach and network effectiveness is at adolescent stage in villages which needs to be worked out and we see some of the upcoming Agri startups coming up with this issue to solve all problems of farmers and nurture their goal to give and get profit, Overall creating a Culture of farm produce aliveness where there is no middle men and farmer is treated like king.

Scope of Agricultural e-commerce in present scenario

Farmers get more or equal money for their produce. That is total Cost of Cultivation till harvesting of a crop, always equals the output income earned by farmers from selling at e-commerce platforms.

Retailers at shop/chiefs in hotels get fresh in time graded quality produce to cook food for customers.

There is a great scope for e-agribusiness in agriculture, especially in horticulture and processed products. Mango, grapes, spices etc. has large demand in national and international market.

Products like sugar, tea, processed agri. products, dairy products beverages,agri equipments, fertilizers, biofertilzers , etc can also sold online to gain more profit.

Farmers get up-to-date information about the market and can sell their produce through the electronic medium.

Can e-commerce be applied to Agriculture?

The most important hurdle for the farmers is not producing the products. It is selling the product at right place. There are so many levels of middlemen even now who are exploiting the farmers. To solve this hurdle the only one model is to bring buyers and sellers to one platform to match them based on the commodity, quantity, quality, vicinity and expected profit giving prices to farmers without price risk. And this is achieved by incorporating e-commerce in Agriculture as a platform.

The following step will useful to start e-commerce in Agriculture

Select the area of operation both supply & demand

Selection of the product- Product can be chosen on the basis of customer demand & logistic support because we can't select all agricultural products due to their nature

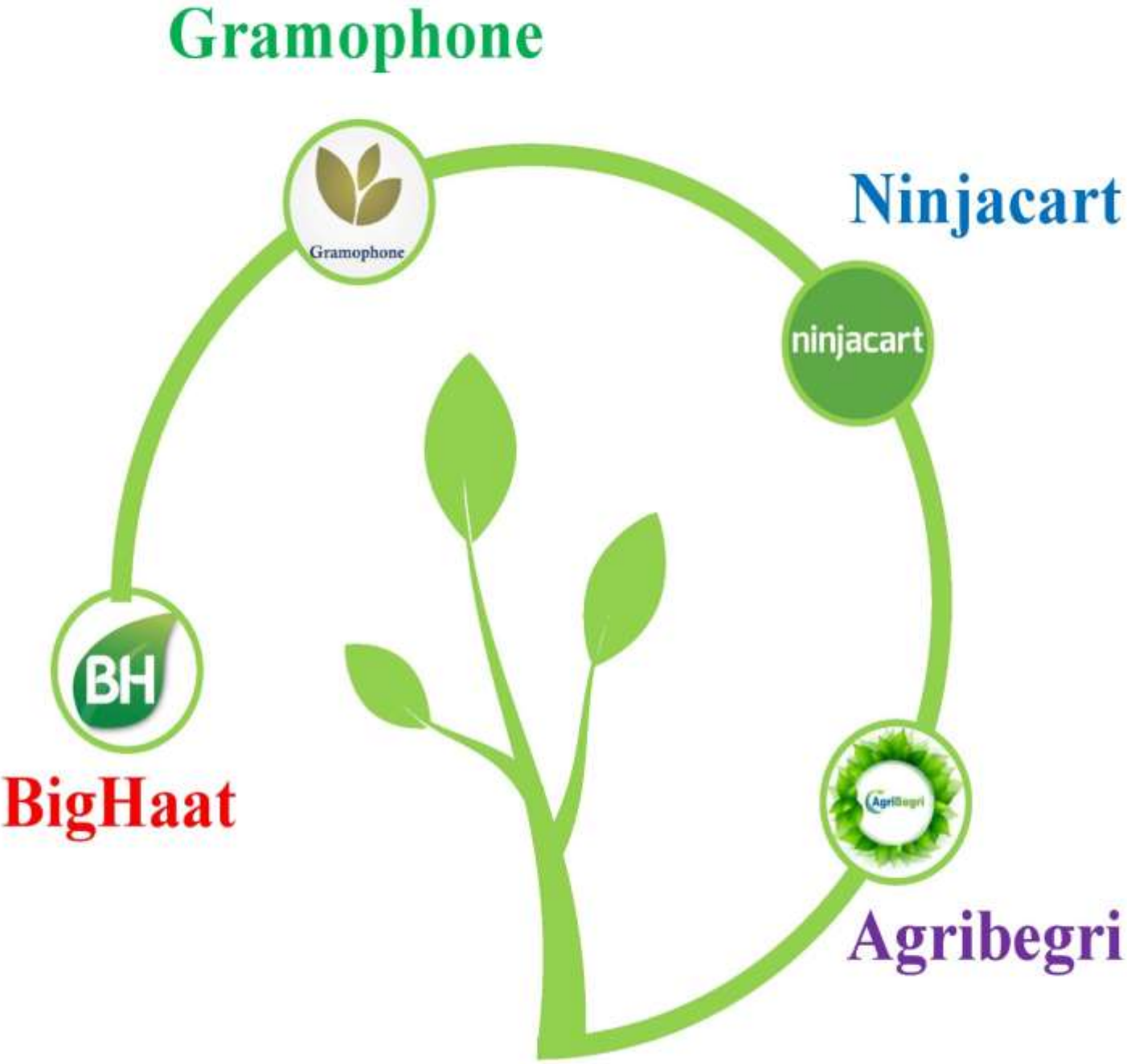
Customer Need- Customer need (weekly/monthly) should understand first then decide to supply chain

Product Quality- Product quality should define clearly because there is no clear cut quality definition/specification of Agri products.

Customer Behaviour- Before taking decision area specific survey on customer behaviour because in this section Indian customer still wants feel & touch.

Increase product basket gradually on the basis of customer demand. If you have an option to invest more money in the business then you can choose all demanded

Here is few innovative startups pertaining to the agriculture sector who prove to be innovative solving customers problem.



BigHaat

Bengaluru based agritech startup **[B2C Market place business model]** founded in 2015 by **Sachin Nandwana and Sateesh N.** Its vision is "Transforming the future of farmers by harnessing the power of data science and technology" to build largest and dominant Agri digital platform with a target to impact over 10 million farmers in Next 3 years.

1. It provides Agricultural equipments, Agricultural Machineries, Agricultural products, poultry equipments.
2. Their product catalog includes seeds, pesticides, fertilizers, pumps, tractors, growth promoters, etc.
3. The company claims that its clients include farmers, NGOs, nurseries, institutional growers, etc

Features

- Wide Range of Products
- Guaranteed Market's Best Price
- Secured Payments
- Easy Return / Refund policy

Connected Farmers

4 Million

Agribegri

AgriBegri Trade Link Pvt Ltd. incorporated in the year 2016. It is one of largest Online Agri Shop for each and every products required for agriculture - Seeds, Fertilizers, Pesticides, PGR, Irrigation and Farming Tools and equipments with Guaranteed Market's Best Price, and Free Home Delivery throughout India.

AgriBegri™

Agro Info Mart

1. Agri Equipments, Gardening, Seeds, Fertilizers, Irrigation,Cattle & Bird Care Farm Products.
2. AgriBegri also deal in wholesale and Retail
3. AgriBegri provide guaranteed market's best price and customer support

Gramophone

Gramophone

It is one stop solution for all kinds of inputs for farmers. Its founded by IIT-Kharagpur alumni Tauseef Khan (CEO) and Nishant Vats Mahatre (Co-Founder) in 2016, headquarter in Indore, Madhya Pradesh.

1. farmers can buy genuine crop protection, crop nutrition, seeds ,implements and Agri hardware at their doorstep.

2. Its like a brother to every farmer as its helps every farmers when get a single miss call and assist with produce immediately.

3. Gramophone also allows farmers to send a picture of their crop on WhatsApp to request inputs from agri experts.

Gramophone used tech to increase crop yields by over 30pc for 8 lakh+ farmers.

Connected Farmers 8 Lakh+

Ninjacart

ninjacart

Ninjacart is Revolutionizing India's largest B2B fresh produce Supply chain. the agri-tech startup has successfully built a tech-enabled supply chain for fresh farm produce, delivering 1,400 tonnes of fruits and vegetables daily.

1. **Focus on small vendors, mom-and-pop stores and unorganized provision stores**

2. **1,400 tonnes of fresh produce per day from farmers across 20+ states and delivers to 17K+ local kirana stores and restaurants**

3. **Currently the supply chain is equipped to more vegetables and fruits from farmers to retailers and businesses across 7 cities everyday in less than 12 hours.**

collection centres **200+**

Warehouses In India **1200**

Conclusion

Today digitalization has evolved throughout the world on every platforms so due it has on Agriculture sector. If we are eating food today without any shortage or risk factor in this pandemic situation its possible only because of e-commerce in Agriculture. We saw era of green revolution and globalization, the production level is increased with increase in population growth but still we see Malnutrition, starvation and food Wastage at hike. Farmers can cultivate, produce easily but the marketing part becomes a hurdle for every small and marginal farmer. Thus E-commerce became a lending hand to many farmers throughout world. Since a decade e-commerce is trending and has captured huge people under it to beleive in the quality,price factor and time management for supplying agriculture related products and services with trust factor. But with these opportunities there are Challenges too which e-commerce companies in Agriculture field needs to address. Now e-commerce in India is still in infant stage with least or partial penetration in urban areas and zero penetration in rural areas. There are certain challenges like illiteracy of farmers to operate digital agri tools/app,Lack of awareness towards e-commerce and fear of providing personal information, poor connectivity and communication between farmer and company people,unfavorable conditions letting failure of crops and

disappointment of producing targeted goods and services.Computer illiteracy and unawareness about e-commerce,Problems in internet connectivity, Language problems,load shedding of electricity, Persistence of middlemen in supply chain of agriculture.Production is really optimistic but still the condition of marketing is not satisfactory, to overcome this one of best solution is e-commerce.

Lastly Conclusion is concluded that how internet based e-commerce will transform agribusiness is still indeterminate. Supply chains may become more efficient. Stronger connection between producers and consumers may result in more differentiated products that meet consumer needs. E-commerce offers an alternative venue of promoting and marketing agricultural products that has a benefit of reaching extensive geographical populations and providing detailed product information at a relatively low cost.

About the Author

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An Overview

ABOUT MEDICINAL VALUES OF CAPSICUM

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Capsicum, also known as red pepper or chili pepper, is an herb. The fruit of the capsicum plant is used to make medicine. It is a herbal supplement used for treatment of post-herpetic pain (shingles), circulatory problems (peripheral), clotting disorders, diarrhea, digestion problems, fibromyalgia (topical), heart disease (prevention), neuralgias (topical), neuropathies (topical), pain syndromes (topical), prurigo nodularis, migraine (intranasal). Capsicum comes in dried form, as a spice as chili pepper and paprika. The dried spice can be used in many sauces or can be added to beverages, such as tea. The dried variety is available as whole dried peppers, as a single spice, or in dried spice blends. With chili's ready availability in many markets, it should be considered that though the dried spice is convenient and might be effective in its health benefits, eating it fresh may provide more benefits.

Additionally, it might have been used in traditional medicine for the treatment of cough, toothache, sore throat, parasitic infections, and wound healing.

How does it work ?

The fruit of the capsicum plant contains a chemical called capsaicin. Capsaicin seems to reduce pain sensations when applied to the skin.

Uses & Effectiveness

Lutein and zeaxanthin are carotenoids which are found in relatively high amounts in capsicums. They may improve eye health when consumed in adequate amounts. Regular consumption of capsicums may cut the risk of visual impairments like cataract and macular degeneration.

Red capsicums help in activating thermogenesis and increase the metabolic rate. Thus, they have a mild thermogenic action that increases the metabolism without increasing the heart rate and blood pressure unlike hot peppers. Hence, capsicums can support weight loss.

Being rich in antioxidant and anti-inflammatory nutrients, bell pepper provides several anti-cancer benefits. The risk of cancer increases due to chronic excessive inflammation and chronic unwanted oxidative stress. These factors can be offset with regular intake of phytonutrients having antioxidant and anti-inflammatory properties. Moreover, bell peppers also contain health supportive sulphur compounds. The enzymes in bell pepper help to prevent gastric cancer and esophageal cancer. The carotenoid lycopene is found to be effective in the prevention of prostate, bladder, cervix and pancreas cancer.

Other Benefits

- Back pain. Some research shows that applying a plaster that contains capsicum to the back can reduce low back pain.
- Capsaicin is found in the white membranes of peppers which is responsible for imparting heat to the seeds as well. It lowers the cholesterol levels and triglycerides. It kills the ulcer causing bacteria in the stomach and boosts immunity.
- Bell peppers are good sources of potassium. This mineral helps in keeping the fluids and minerals balanced in the body. It enhances muscle function and regulates blood pressure.
- Getting healthy, long and thick hair is everyone's dream. But unfortunately an unhealthy lifestyle and lack of proper supply of nutrients in the diet often lead to several hair problems like hair thinning, dandruff, split ends and hair loss. Now this might appear strange, but bell pepper can support hair growth by improving the circulation of blood to the scalp.

- Dietary antioxidants has protective role against many diseases such as cancer, diabetics, cardiovascular and anemia. Vitamins E, C and β-carotene are important as protective antioxidant and peppers arerich in vitamins C and E as well as carotenoids and xanthophylls. 29, 30 Antioxidant levels and responses in paper varies according to variety, growing stage and environmental conditions.
- Hot peppers were higher in vitamin E and β-carotene, however, extracts from sweet varieties were higher in antioxidant content and phenolic compounds.
- Bell peppers help in clearing out the congested mucus membranes in the nose and lungs and eliminate toxins through sweating.

Coclusion

Medicinal uses and health benefits of pepper are globally well documented. However issues related to safety, efficacy, quality, and development and potential risks, especially those linked to aflatoxin contamination need to be researched. On the other hand farmers can contribute reducing in aflatoxin contamination at farm level by removing discolored fruits and improving drying method.

*****

INFLUENCE OF PROHEXADIONE -CALCIUM ON TEMPERATE FRUIT CROPS

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Prohexadione-calcium is a plant bio regulator, primarily used to inhibit excessive vegetative growth in fruits and other crop plants. It is a gibberellin biosynthesis inhibitor currently marketed by BASF as Apogee. It is currently registered for apple to reduce the apical dominance. The net effect is a reduction in immobile, biologically active GA_1 and an increase in the levels of mobile, but inactive GA_{20}. Moreover, prohexadione-calcium has various advantages as compared to other plant growth retardants; it has negligible toxicological effects, short persistence period in plants and soil and provides resistance to various diseases and insects by inhibiting the biosynthesis of phenol. It is emerged as a new approach that produces shortest shoot length and did not have any negative effect on yield, fruit quality as well as return bloom. Although many plant growth retardants are used such as adenile benzyl amine, GA_{12} aldehyde (is used to reduce the acidity in fruits), chloroqemutat (causes reduction in shoot length) and ethephon (requires high dose for shoot reduction but sometimes it leads to substantial thinning) are used to overcome the problems like excessive vegetative growth and alternate bearing in fruit plants but it has been found that application of prohexadione-calcium significantly reduces such problems when applied at appropriate time and in proper quantity. A number of reports have confirmed that it is an effective growth retardant that retards shoot growth and favours quality fruit yield. So, prohexadione-calcium is only a solution for reducing the vegetative growth in fruit plants without affecting fruit yield and quaity.

Chemistry and manufacture

Active constituent

The active constituent prohexadione-calcium is manufactured in Japan by Ihara Chemical Industry Co., Ltd, 1800 Nakanoko, Fujikawa-cho, Ihara-gun, Shizuoka (Approval Number: 59700).

CHEMICAL CHARACTERISTICS OF THE ACTIVE CONSTITUENT

Common Name	Prohexadione-calcium
Synonyms and Code Number	BX-112, KUH-883, KUM-883, LAB 285 342, BAS 9054 W, BAS 122 W, BAS 125 W
Chemical Name (IUPAC) (CA)	Calcium 3-oxido-5-oxo-4-propionylcyclohex-3enecarboxylate Calcium 3-oxido-5-oxo-4-propionylcyclohex-3enecarboxylate
Chemical Abstracts Service (CAS)	
Registry Number	127277-53-6
Molecular Formula	$C_{10}H_{10}CaO_5$
Molecular Weight	250.26

Chemical structure

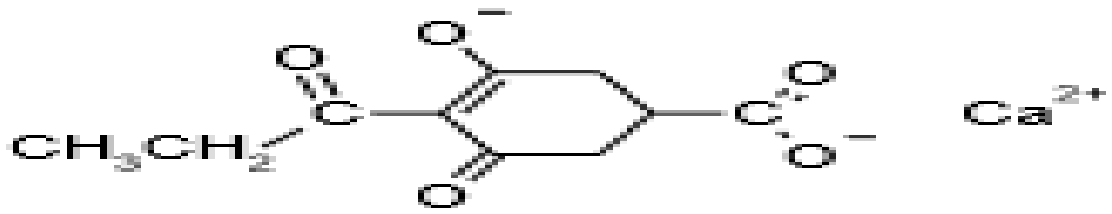

Table 1: PHYSICAL AND CHEMICAL PROPERTIES OF THE PRODUCT

Distinguishing Name	Regalis Plant Growth Regulator
Formulation Name	Water dispersible granule
Active Constituent Concentration	Prohexadione-calcium (100 g/kg)
Mode of Action	Foliar applied and absorbed *via* green tissue; translocated basipetally, as well as acropetally, within plants
Physical State	Solid
Colour	Grey
Odour	Moderate spicy
Relative Density	1.665
Bulk Density	755 g/L (loose), 784 g/L (tapped)
Acidity, Alkalinity or pH value	Not applicable
Viscosity	Not applicable
Surface Tension (at 20°C)	46.5 mN/m at 0.1% , 43.1 mN/m at 1.0%
Flash Point	Not applicable
Storage Stability	Storage life 2 year (under polythene container)

Mode of action

The mode of action of prohexadione-calcium differs from other gibberellin biosynthesis inhibitors currently in use in commercial horticulture. Many of these growth regulators, including the quaternary ammonium compounds, substituted pyrimidines, norbornenodiazetine derivatives, and triazole derivatives function by interrupting the synthesis of gibberellin early in the biosynthetic pathway, specifically at the synthesis of ent-kaurene. Prohexadione-calcium is known to interfere with the 3-ß hydroxylation of GA_{20} to GA_1. The net effect is a reduction in immobile, biologically active GA_1 and an increase in the levels of mobile, but inactive GA_{20}.

Table 2: Effect of prohexadione calcium and paclobutrazol on vegetative characters of 'Clapp's Favourite' pear

Treatment			Shoot extension growth (cm)	Internodal length (cm)	Leaf area (cm^2)
	Chemical	**No. of spray**			
T_1	Control	No spray	21.44	4.39	24.63
T_2	Prohexadione Ca 100 ppm	Single spray (S_1)	18.43	2.42	23.44
T_3	Prohexadione Ca 200 ppm	S_1	17.54	2.20	23.04
T_4	Prohexadione Ca 300 ppm	S_1	17.63	2.25	23.10
T_5	Paclobutrazol 100 ppm	S_1	18.47	2.42	23.44
T_6	Paclobutrazol 200 ppm	S_1	17.64	2.21	23.08
T_7	Paclobutrazol 300 ppm	S_1	17.88	2.28	23.10
T_8	Prohexadione Ca 100 ppm	Double spray (S_2)	17.89	2.10	23.00
T_9	Prohexadione Ca 200 ppm	S_2	16.92	1.82	22.20
T_{10}	Prohexadione Ca 300 ppm	S_2	17.01	1.85	22.40
T_{11}	Paclobutrazol 100 ppm	S_2	17.89	2.16	23.03
T_{12}	Paclobutrazol 200 ppm	S_2	17.09	1.84	22.75
T_{13}	Paclobutrazol 300 ppm	S_2	17.17	1.88	22.88
CD ($p \leq 0.05$)			**0.17**	**0.26**	**0.80**

Table 3: Effect of prohexadione calcium and paclobutrazol on bio-chemical caharacteristics of 'Clapp's Favourite' pear

Treatment			Total soluble solids (%)	Total sugars (%)	Acidity (%)
Chemical		**No. of spray**			
T_1	Control	No spray	9.72	8.35	0.52
T_2	Prohexadione Ca 100 ppm	Single spray (S_1)	11.12	8.62	0.48
T_3	Prohexadione Ca 200 ppm	S_1	12.14	8.98	0.47
T_4	Prohexadione Ca 300 ppm	S_1	11.80	8.89	0.47
T_5	Paclobutrazol 100 ppm	S_1	11.01	8.52	0.51
T_6	Paclobutrazol 200 ppm	S_1	12.00	8.99	0.45
T_7	Paclobutrazol 300 ppm	S_1	11.71	8.99	0.47
T_8	Prohexadione Ca 100 ppm	Double spray (S_2)	11.91	9.13	0.47
T_9	Prohexadione Ca 200 ppm	S_2	13.21	10.23	0.43
T_{10}	Prohexadione Ca 300 ppm	S_2	13.06	10.11	0.44
T_{11}	Paclobutrazol 100 ppm	S_2	11.73	9.01	0.49
T_{12}	Paclobutrazol 200 ppm	S_2	12.92	9.89	0.44
T_{13}	Paclobutrazol 300 ppm	S_2	12.74	9.67	0.46
CD ($p \leq 0.05$)			**0.34**	**0.35**	**NS**

Table 4: Effect of prohexadione-calcium and paclobutrazol on calcium and potassium content in leaves and fruits of 'Clapp's Favourite' pear

Treatments	**No. of spray**	**Calcium in leaves (mg)**	**Calcium in fruit (mg)**	**Potassium in leaves (mg)**	**Potassium in Fruit (mg)**
Control	Water spray	342.33	40.63	24.45	10.12
Prohexadione Ca 100 ppm	Single spray (S_1)	404.67	48.09	56.63	11.50
Prohexadione Ca 200 ppm	S_1	500.24	60.12	76.86	12.57
Prohexadione Ca 300 ppm	S_1	502.00	62.56	69.95	12.00
Paclobutrazol 100 ppm	S_1	398.67	44.61	45.66	11.00
Paclobutrazol 200 ppm	S_1	472.33	54.62	70.84	11.68
Paclobutrazol 300 ppm	S_1	474.33	56.62	65.07	11.21
Prohexadione Ca 100 ppm	Double spray (S_2)	464.67	54.33	89.96	15.86
Prohexadione Ca 200 ppm	S_2	572.28	69.92	98.40	22.78
Prohexadione Ca 300 ppm	S_2	574.00	71.24	92.44	18.36
Paclobutrazol 100 ppm	S_2	458.73	53.31	67.77	12.78
Paclobutrazol 200 ppm	S_2	524.33	63.08	73.83	18.36
Paclobutrazol 300 ppm	S_2	523.67	63.22	69.36	16.53
CD ($P \leq 0.05$)		**63.49**	**7.63**	**11.37**	**4.35**

CONCLUSION

Prohexadione calcium is the novel plant growth regulator that inhibits the late stages of gibberellins (GAs) biosynthesis in plants, thus reducing the vegetative growth in plant. It has emerged as one of the most important management tools that an orchardist has available to control vegetative growth and to reduce the disease incidence in fruit plants.

BIOTECH TOOLS

FOR GENETIC ENHANCEMENT IN SOYBEAN

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Soybean is one of the most important pulse crop used worldwide and having the abundant protein and oil sources useful for human food and so animal feeds. Since the majority of traditional breeding methods are useful to crop improvement, those are insufficient to fulfil the growing demands for trait specific needs. In plant breeding programme biotechnological tools are having wide role to meet out the production constraints and useful to enhance the biotic and abiotic resistance development and also for quality enhancement. The different biotechnological tools used for crop improvement is plant tissue culture techniques, transgenic approaches, molecular breeding methods and genome editing techniques.

Transgenic approach by Agrobacterium mediated gene transfer

Ti plasmid found in *A. tumefaciens* which produce grown gall diseases in plants. It is used for foreign gene transfer into the plants. This bacterium having a plasmid vector that contains tumor-inducing genes called T-DNA, along with some genes helps to the T-DNA integration into the host plant genome. This process is carried out by removing most of the T-DNA without removing the left and right border sequences (24 bp), which integrate a foreign gene into the genome of cultured plant cells (Figure-1)

The *cry* is one of the crystal proteins which is derived from *Bacillus thurinjiensis* soil bacterium. The *cry* protein is pro toxin and not active in original state when enter into insects midgut its get activated at pH of 8 to 10. The activated protein is attached with specific midgut receptors and forms spore ultimately leads insect deaths.

Holotrichia parallela is coleopteron pest called as dark black chafer it causes merely more than 50 per cent yield loss in favourable conditions for infestation. Qin *et al*., (2019) transferred *cry8*-like gene from the *Bt* strain HBF-18 into Jinong 28 by constructed with pCAMBIA3300 plasmid under the CaMV 35S promoter and *NoS* terminator. The transgenic plants obtained by agrobacterium (Strain LBA4404) mediated gene transfer confers resistance against the pest. Among 8 transgenic plants, the line Jinong28-cry4 accumulates 16 ±2 and 17±2 ng/mg *Bt* toxin in roots and leaves respectively in T_0 generation.

CRISPR/Cas gene editing

CRISPR (Clustered Regularly Interspaced Short Palindromic repeats) is a class of short palindromic repeat sequences widely presented in prokaryotic genome. These short repeat sequences are complimentary to some foreign DNA sequences, commonly virus DNA sequences which are invade into bacteria or Archaea. So, the viruses infect the bacteria, these repeat DNA sequences produced and bind with foreign DNA sequence and using the endonuclease called Cas (CRISPR associated), will cut the foreign DNA into pieces.

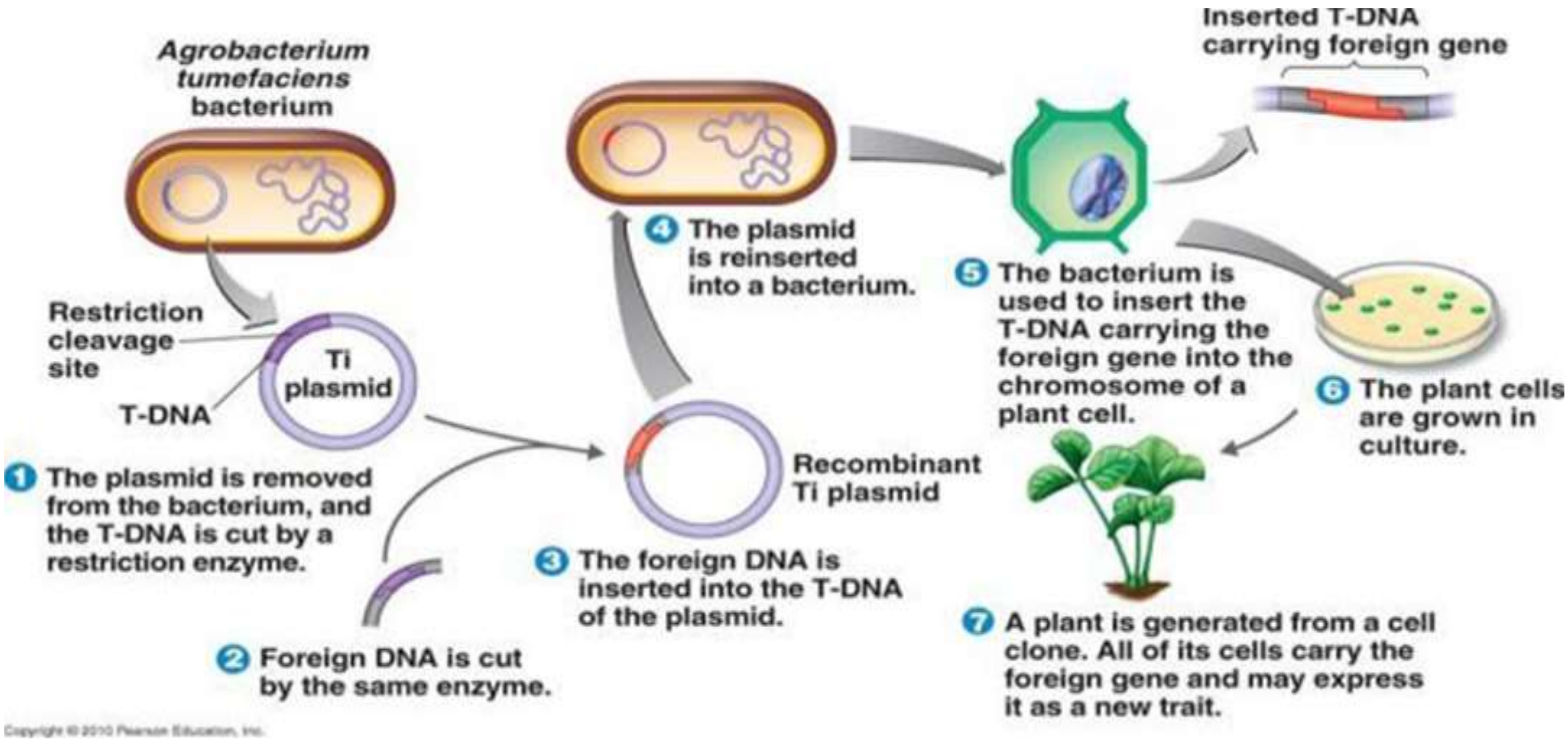

Figure- 1 Agrobacterium mediated gene transfer

So, this is called as acquired immune defence mechanism in prokaryotes against virus. Thus now it was used as genome editing tool for crop improvement in several aspects. Here the single guide RNA (sgRNA) containing tracRNA and crRNA along with the Cas9 endonuclease used for gene editing by creating double strand break in the DNA. In the engineered CRISPR/cas9 system having the tracRNA and spacer sequence with 20 nucleotides which are complementary to targets and by using the Ruv and HNH domine of Cas enzyme creates the double strand break.

Soybean is a typically short day plant which requires 8 to 10 hours for flowering and more sensitive to the photoperiod. In the long day condition the flowering is affected by the long photoperiod and delay the flowering. In soybean there is a gene called *E1* controls the flowering time. In addition to this gene the two major *Flowering locus T* (FT) namely *GmFT2a* and *GmFT5a* involved in flowering. In the long day condition the gene E1 down regulate these two locus and ultimately leads delayed flowering and maturation period of the crop.

In order to obtaining the early flowering under long day condition Han *et al*., (2019) using the CRISPR/ Cas9 system to knockout the E1 gene. The Cas9 gene and gRNA was constructed under the CaMV 35S and *At*U6 promoter respectively and transferred into Soybean cultivar Jack by agrobacterium infection. The two transgenic plants with 40bp deletion and one with 11 bp deletion showed homozygous mutant phenotypes. Under long day condition these plants flowering is commenced within 37 DAE as compare with control.

Marker assisted backcrossing (MABC)

The utilization of molecular markers is now widely used for specific trait selection and gene introgression. MABC is nothing but the introgression of specific gene from donor parent into recipient parent by repeated backcrossing with recipient parent and selection based on the markers linked with that traits.

Kunitz trypsin inhibitor (KTI) is a anti nutritional protein present in soybean and inactivation of these protein requires heating process and leads additional cost in soya industry. Kumar *et al.*, (2015) introgressed

the null allele of KTI called *ti* from the PI542044 soybean accession to recipient parent JS97-52 is a Indian soybean cultivar. After 6 backcrossing 9 KTI free lines were identified by linked SSR marker Satt228 with 98.6% of recurrent parent genome recovery.

Some other important biotechnological works in soybean

Biotech approach	Trait focused	Remarks	
CRISPR /Cas9	GmLox1, GmLox2, and GmLox3	Lox genes produce beany flavour, which not suitable for consumption. Generated lipoxygenase-free mutant lines (GmLox-28 and GmLox-60) by knockout of these genes	Wang *et.al*.,(2020)
TALENs	FAD2-1A and FAD2-1B	Partial hydrogenation of polyunsaturated fats leads increased cholesterol level. TALENs induced mutants showed increased oleic acid content	Haun *et.al*.,(2014)
ZFNs	DCL) and RNA silencing gene	Independent gene mutations in DCL4a and DCL4b gene. dcl4b mutant showed ZFN induced heritable mutation	Curtin *et al.*, (2011)
MABC	Lox2	Off flavour producing allele Lox2 is eliminated by introgression of null allele of Lox2 from PI596540 into S97-52 cultivar with help of SSR linked marker Satt656	Rawal *et.al*.,(2020)

Note: Lox- lipoxygenases TALENs-Transcription activator-like effector nucleases, ZFNs- Zinc finger nuclease, FAD-Fatty acid desaturase.

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PREDISPOSING FACTORS FOR ECTOPARAsITES INFESTATION IN BOVINE/EQUINE

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Ectoparasites are the group of organisms that infest and derive their sustenance from exterior surface of a host eg. ticks, lice, mites etc. They are to blame for a variety of direct and indirect losses to the animal's overall health and production. Numerous factors, including herd size, animal age and breed, general body condition, hygienic conditions of animal and its surrounding, and several environmental conditions, predispose animals to ectoparasitic infection. Eradication of ectoparasites from animals once infested is quite challenging due to their very prolific nature and multiple stages capable of surviving off the host in the environment. Thus prevention is the only key to protect animals from ectoparasites as well as diseases associated with them and thereby enhancing the animal productivity.

Risk of ectoparasites in animalsare due to following factors-

1. RELATED TO ANIMALS:

1. **Number of animals-**More the number animals kept together, more will be the chances of ectoparasite infestation due to transmission from one animal to another eg. Mites cannot survive away from an animal body for more than several days therefore are transmitted by direct body contact between animals.
2. **Species of animals reared-**Same species reared together poses more threat for infestation as the amplification rate will be enhanced due to high availability of the specific host. If different species will be reared with good managemental approach then diseases will be better controlled eg.Amblyoma larvae and nymphs will prefer small animals (rodent, birds, reptiles) whereas adult ticks will prefer larger mammals like buffalo,cattle etc.
3. **Age of animals**-Younger animals are more frequently infested with ectoparasite than adults which can be attributed to poorly developed immune system of young animals eg. Young animals are more frequently infected with lice than adult.
4. **Sex of animals -** Sex of animal has influence on prevalence of different types of ectoparasites eg. In a study prevelence of *Hyalomma habraeum*(26.6%) and *Hyalomma rufipes* (17.4%) was higher in male than female horses which may be associated with hormonal influence. Lloyd (1983) reported that higher level of prolactin and progesterone hormones make the individual more susceptible to infection and found female horses to be more commonly infected with *Boophilus decoloratus* and *Boophilus equii* (4.4%) than males.

5. **Breed-**Indegenous breeds show better immune response against ectoparasite infestation and are less prone to ectoparasite infestation as compared to exotic breeds. Also dark coloured breeds(brown/black) are found to be more affected.
6. **Weight-**Small sized animals are seen to be more frequently affected than larger body weight groups. This can be associated with poor body condition of animals having less body weight as compared to higher body weight groups.
7. **Haircoat -** Breeds with darker hair coat (black/brown) are more prone to ectoparasite infestation. This can be associated with the reason that dark coat color helpsectoparasites to camouflage well. Frequently groomed and smooth hair coat is less prone to ectoparasite infestation as compared to rough hair coat.
8. **Body condition score- A**nimals with higher body condition score (BCS) are seen to be less affected as compared to those with low BCS.This can be linked to well developed immunity in animals with optimum BCS.
9. **General behaviour-** Animals having normal behaviour, temperament, gait, posture are less prone to ectoparasite infestation as any abnormality indicates diseased condition. Active animals are generally able to shoo the mosquitoes, flies and fleas away from their body, vice-versa for dull and debilitating animals.
10. **Diseased condition-**Any chronic or debilitating disease (eg.tuberculosis in cattle) predisposes animal to ectoparasite infestation due to weak immune response of animal.
11. **Presence of any wound/abrasion -**Larvae of some ectoparasites feed uponwound or exudate produced due tobacterial infection, thus providing conducive conditions for development of the parasite eg.larvae of flesh fly are deposited near fresh wound and feed there.
12. **Previous history of ectoparasite infestation-**Past infection can strongly shape immunity by triggering adaptive response that increase the strength and specificity of immune response.Host with prior exposure to an ectoparasite is often more resistant than naive hosts.
13. **Type and site of lesion present-**It will help in identification of parasite which in turn aid in accurate treatment.

2. MANAGEMENTAL FACTORS

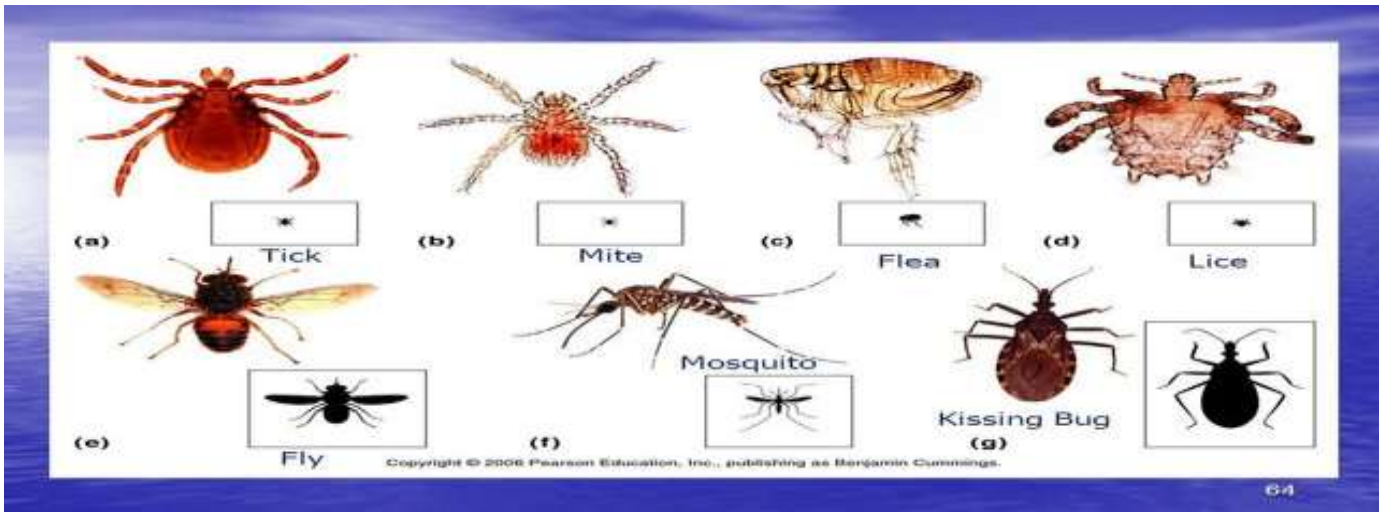
1. **Vaccination –**Vaccines available against few ectoparasites eg Bm86 based vaccine against *Rhipicephalus microplus* can assistin effective control of the respective parasite population and diseases associated with them. Immunization of animals with anti tick vaccine causes reduction in number of engorging females, their weight and reproductive capacity which further reduces the number of ticks at population level.
2. **Pasture grazing -**Grazing of animals onpastures having higher ectoparasitic densities increases the risk of ectoparasite infestation. Stocking density on pasture and type of species grazing on the same pasture also affect the risk of ectoparasites infestation on the animals.
3. **Pasture management-**Poorly managed pasture increases the risk of ectoparasite infestation on animals. Management of pasture against the ectoparasites with strategies like good drainage, pasture spelling, removal of native fauna, pasture rotation combined with acaricide application to pasture greatly reduce the chances of ectoparasite infestation on pastured animals eg**.**If the animals are placed on spelled pastures early in winter when the ticks are producing few or no progeny and then alternated at 4-month intervals,the ectoparasite population can be controlled with a markedly lower number of treatments.
4. **Farm Hygiene:** Transmission of ectoparasites can also occur through contact with a contaminated environment (bedding, housing, harness/grooming, tools etc.), therefore unhygienic environmental

conditions predispose the animals to ectoparasitic infestation. Improved farm hygiene will also help to reduce breeding places of various ectoparasites eg manure heaps serve as primary breeding site for many species of fly such as *Stomoxys calcitrans.* Some ectoparasites live and lay their eggs in cracks and crevices and thus the presence of cracks and crevices in the animal houses increases the risk of ectoparasitic infestation.

5. **Animal Hygiene -**Animals with poor hygienic condition are more predisposed to ectoparasitic infestation as compared to animals with good hygienic condition. Regular grooming and bathing of animals helps in early identification as well as removal of ectoparasites from the animal body eg. Animals with higher grooming rates are found to have less number of ticks, presumably ticks are groomed off before they have a chance to engorge more frequently groomed animals**.**
6. **Feeding of animal-**Proper feeding can reduce risk of ectoparasite infestation as it will contribute to overall health of the animal and therefore better immunity against ectoparasites.
7. **Clipping -**Regular **c**lipping of haircoat reduces the risk of ectoparasitic infestation as certain ectoparasites lay their egg and feed on animal's hair. eg. animals with denser hair coat tend to have higher infestation of lice as compared to those with thin hair coat.
8. **Chemical control -**Various chemicals are available to control different kind of ectoparasites eg. Cypermethrin, deltamethrin etc. The choice of ectoparasiticide used for treatment depends on the persistence of compounds on skin and hair coat and susceptibility of ectoparasitic population to a particular ectoparasiticide. Ectoparasiticides can be applied to animals by various methods like dipping, hand spraying, pour on acaricides, injection, impregnated ear tags etc.
9. **Introduction of new animal-**Any new animal introduced into the herd should be inspected properly for presence of ectoparasites and must be treated immediately in order to prevent spread of new parasites on to the farm eg. effective management of lice requires quarantine of new animals for a period of time sufficient for all lice to be eliminated by treatment.
10. **Mixing of treated and non-infected animals-**Animals treated should be separated from non-infected ones for some time eg. cattle treated with ivermectin must be separated from non-infested cattle for between 9-14 days; otherwise spread and reinfection may occur.
11. **Housing conditions- A**nimals in houses with proper ventilation, sunlight, floor space etc. are less prone to ectoparasite infestation. Type of house i.e.bamboo,stone/compound also affect prevalence of ectoparasites eg. higher flea density is seen on animals residing in bamboo houses than those residing in stone houses. Overcrowding of animals in the farm predisposes them for ectoparasite infeststion.

3. ENVIRONMENTAL FACTORS

Most ectoparasite populations on animals vary seasonally, depending on the temperature and rainfall pattern of the area eg. low minimum temperatures in winter may lead to environmental conditions that are unsuitable for tick population survival whereas higher temperature increase tick development and hatching rates, but reduce tick survival and egg-laying success. Ticks are more likely to reside in moister areas because increased humidity can increase tick survival.



Picture showing different types of ectoparasites

4. MISCELLANEOUS FACTORS:

a. **Veterinary services available -** Availability of proper veterinary services in the area can help preventing ectoparasites infestation as it can be treated early which further prevent its spread. Absence of veterinary regulations for ectoparasite control in the movement of livestock across borders also contribute to the spread of ectoparasite

b. **General morphology of ectoparasites-** Small sized ectoparasites can be overlooked and hence more chances of their occurrence due to lack of treatment.

c. **Pattern of infection-** It includes number and species of animal affected and help in identification of parasite and its control and treatment.

Prevention

- Farmers should maintain a strict preventive regimen for controlling the ectoparasites by taking the predisposing factors into consideration rather than waiting until the infestation becomes severe and difficult to control.
- Animals should be fed properly to develop good body condition and better immunity to combat ectoparasitic infestations.
- A thorough physical evaluation of animals should be done at least once weekly for presence of ectoparasites or any lesions indicating possible infestation of ectoparasites.
- Animals showing signs of parasite infestation should be isolated immediately to prevent its spread to rest of the animals.
- Newly introduced animals should be quarantined and should not be mixed with the main flock until complete eradication of the external parasites.
- Animal houses should be cleaned regularly, cracks or cervices in the floor and walls of animal housing should be sealed with cement. Dense vegetation around the animal house should be cleaned.
- All litter, dung etc should be deposited out of animal contact.
- Animal hygiene is equally important and shearing and washing of animals regularly helps in controlling ectoparasitic infestation.
- Any wound or abrasion on the animal body should be cleaned and covered properly to protect it from ectoparasitic infestation.

- Good pasture management including rotational grazing, pasture spelling, proper drainange, acaricide application etc. helps in prevention of acquiring ectoparasitic infection due to pasture grazing.
- Vaccination against certain ectoparasites effectively help in prevention of infestation with the particular ectoparasite.

CONCLUSION

Ectoparasites are responsible for causing considerable economic losses to farmers through decreased production, disease transmission, down grading quality of hide/skin, and expenditure incurring for their control. Infestation caused by ticks, lice, fleas, biting flies, midges, mites etc could impose a heavy burden to livestock affecting productivity through blood loss, decrease immune response, discomfort, mechanical tissue damage, hypersensitivity, skin damage, lameness, weight loss, retarted growth rates and in severe cases death of the animal. In addition, ectoparasites represent a constant threat to livestock due to their competence for the transmission of large number of pathogens with high morbidity and mortality implications. This culprit can be very difficult to eliminate, and current control is usually based on a range of chemical treatments. However many species have evolved multiple drug resistance, making their chemical control quite complex. Hence, there is a need to create awareness about predisposing factors and appropriate control/preventive measures against ectoparasitic infestation. A better understanding of current distribution, risk factors coupled with prevention and control of ectoparasites would contribute substantially to reduce losses caused by ectoparasites to the livestock industry.

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Discovery or Origin

of R – genes and its evolution

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Resistance genes (R-Genes) are genes in plant genomes that convey plant disease resistance against pathogens by producing R proteins. The main class of R-genes consists of a nucleotide binding domain (NB) and a leucine rich repeat (LRR) domain(s) and are often referred to as (NB-LRR) R-genes or NLRs. Generally, the NB domain binds either ATP/ADP or GTP/GDP. The LRR domain is often involved in protein-protein interactions as well as ligand binding. NBLRR R-genes can be further subdivided into toll interleukin 1 receptor (TIR-NB-LRR) and coiled-coil (CC-NB-LRR).

Resistance can be conveyed through a number of mechanisms including:

- The R protein interacts directly with an Avr gene (Avirulence gene) product of a pathogen (see Gene-for-Gene relationship).
- The R protein guards another protein that detects degradation by an Avr gene (see Guard Hypothesis). The R protein may detect a Pathogen-Associated Molecular Pattern or PAMP (alternatively called MAMP for microbe-associated molecular pattern).
- The R protein encodes enzyme that degrades a toxin produced by a pathogen.

Once the R protein has detected the presence of a pathogen, the plant can mount a defence against the pathogen. Because R genes confer resistance against specific pathogens, it is possible to transfer an R gene from one plant to another and make a plant resistant to a particular pathogen. Many plant resistance proteins

are single-pass transmembrane proteins that belong to receptor kinases and Toll-like receptors. R genes are of large interest in crop breeding, providing a large part of the immunity required by agricultural pathosystems.

Background

Humans have been associated with plants since ancient times, and plants in general are an important part for the whole ecosystem on earth, the understanding of plant survival up until now is something that have been an important topic for scientists. Plants in general are in constant symbiotic relationships with fungus, and even bacteria, but there are cases these symbionts can take advantage of this symbiotic relationship in which case will result in a disadvantageous situation for both organisms. R genes protein syntheses are a way of identifying the pathogen
effectors and stop their infection throughout the plant system. Molecules essential for pathogen defense are *pattern recognition receptors* (PRRs), *wall associated kinase* (WAKs), receptors with nucleotide-binding domain (NLRs) and leucine-rich repeats (LRRs). All these R proteins play roles in detecting and recognizing pathogen effectors, initiating multiple signal transductions inside the plant cell, these signals transductions will lead to different responses that will aid in pathogen destruction and prevention of further infection. These responses are:

- Production of Reactive Oxygen (ROS)
- Hypersensitive Response
- Closure of the stomata
- Production of different chemical compounds (terpenes, phenolic, tannins, alkaloids, phytoalexins).

Note that plants have various mechanisms to prevent and detect pathogenic infections, but factors such as geography, environment, genetic, and timing can affect the recognition pattern of a pathogen or can have an effect on the recognition of avirulent (avr) pathogens in plants.

Pathogen recognition

R-genes synthesize proteins that will aid with the recognition of pathogenic effectors:

Pattern recognition receptors (PRRs)

This receptor is often composed of leucine-rich repeats (LRRs). LRRs have a wide range of bacterial (proteins), fungal (carbohydrates) and virulent (nucleic acids) recognition, this means that LRRs recognizes many different molecules but each LRRs usually has a very specific molecule it detects. The ability of PRRs to recognize various pathogenic components relies on a regulatory protein called brassinosteroid insensitive 1 – associated receptor kinase (BAK1). Once the pathogen has been recognized by PRRs the release of a kinase into the nucleus has been transduced triggering a transcriptional reprogramming.

Wall associated kinase (WAKs)

The plant cell wall is conformed of pectin and other molecules. Pectin has abundant galacturonic acids which is the compound that WAKs recognizes after a foreign invasion in the plant. Every WAKs (WAK1 & WAK2) has an N-terminal which interacts with pectin in the cell wall when pectin is being degraded to galacturonic acids by fungal enzymes. Pathogen-associated molecular pattern (PAMPs) and damage-associated molecular pattern (DAMPs) are often identified by lectins which is a protein that binds specific carbohydrates.

Nucleotide-binding domain and leucine-rich repeats (NLRs)

Most R genes code for these immune receptor proteins.[1] NLRs shifts its conformation from ADP state to and ATP state which allows it to send as signal transduction. The activation of NLRs is yet to be completely understood, according to current studies suggest that it is subject to multiple regulators (dimerization or oligomerization, epigenetic and transcriptional regulation, alternative splicing, and proteasome-mediated regulation) Despite all these differences NLRs, PRRs, WAKs, effector trigger immunity (ETI) and PAMP-triggered immunity (PTI) there are certain similarities such as in the mechanism of signal transduction which includes mitogen-protein kinase (MAPK) cascades through phosphorylation which will be, calcium ion signaling.

An overall overview about the mechanical interaction about a plant defense and the ability of a pathogen to infect a plant would be for instance such a common interaction between bacterial flagellin and receptor-like kinase which triggers a basal immunity sending signals through MAP kinase cascades and transcriptional reprogramming mediated by plant WRKY transcription factors (Stephen T). Also plant resistance protein recognize bacterial effectors and programs resistance through ETI responses.

Signal transduction

A plant defense has two different types of immune system, the one that recognizes pathogen/microbes associated molecular patterns (PAMPs), and this is also known as PAMP-triggered immunity (PTI). Plant defense mechanism depends on immune receptors found on the plasma membrane and then the mechanism can sense the pathogen associated molecular patterns (PAMPs) and microbial associated molecular patterns (MAMPs). Detection of PAMPs triggers a physiological change in the cell activated by the pattern recognition receptors (PRRs) initiating a cascade response which through the recognition of PAMPs and MAMPs lead to the plant resistance. The other type of defense is also known as effector-triggered immunity (ETI) which is the second type of defense mediated by R-proteins by detecting photogenic effectors. ETI detects pathogenic factors and initiates a defense response. ETI is a much faster and amplified system than PTI and it develops onto the hypersensitive response (HR) leading the infected host cell to apoptosis. This does not terminate the pathogen cycle, it just slows the cycle down.

Plants have many ways of identifying symbiotic or foreign pathogens; one of these receptors causes fluctuations in the calcium ions and this fluctuation in the calcium ions. A transcription factor plays an important role in defenses against pathogenic invasion.

Genetic engineering

R-genes are common subjects of gene cloning. Every advance in techniques of sequencing and transfer has eased this process, progressively requiring less linkage drag, expense, and laboratory work over time. In the future even better results are expected from ever larger data sets, across ever larger numbers of individuals and populations, with ever greater resolution due to both more accurate sequencing and post-sequencing computational comparison between individuals.

Overview of discovery or origin of plant resistance genes (R- Genes)

Plants rely on two branches of the innate immunity system to prevent or eliminate microbial infections: one involves cell surface receptors to respond to pathogen- or microbe- associated molecular patterns, and the other acts inside plant cells by using proteins with nucleotide-binding site (NBS) and Leu-rich repeat (LRR) domains. NBS-LRR proteins confer recognition of pathogen effectors either directly or indirectly and trigger disease resistance. Most of the plant disease-resistance genes (*R*-genes) cloned so far

encode NBS-LRR proteins. NBS-LRR proteins are typically classified into two major subfamilies based on the presence or absence of an N-terminal signaling domain. Those possessing the Toll/IL receptor (TIR) domain are referred to as TIR-NBS-LRR proteins (TNLs); those without this domain are referred to as non-TIR-NBS-LRR proteins (nTNLs). Comparative genomic analyses show that *R*-genes are widely distributed in land plants. However, no *R*-genes have been reported in algae to date. Thus, plant *R*-genes are generally thought to have originated in land plants but this idea appears mistaken. **(**Gao *et al* (10.1104/pp.18.00185) have performed comparative genomic and phylogenetic analyses of *R*-genes in a wide variety of plants, with an emphasis on basal-branching plants. They report on the presence of of *R*-genes in the genomes of basal- branching streptophytes, including charophytes, liverworts, and mosses. Phylogenetic analyses suggest that plant *R*-genes originated in charophytes and R-proteins diversified into TIR-NBS-LRR proteins and non-TIR-NBS-LRR proteins in charophytes. Moreover, R-proteins evolved in a modular fashion through frequent gain or loss of protein domains. Most of the *R*-genes in basal-branching streptophytes underwent adaptive evolution, indicating an ancient involvement of *R*-genes in plant-pathogen interactions. These findings provide novel insights into the origin and evolution of R-genes and the mechanisms underlying colonization of terrestrial environments by plants.

Evolution of Resistance Genes in Plants

Potential pathogens deliver effector proteins into plant cells to suppress microbe-associated molecular pattern (MAMP)-triggered immunity in plants, resulting in host—pathogen co evolution. To counter pathogen suppression, plants evolved disease resistance (R) proteins to detect the presence of the pathogen effectors and trigger R-dependent defenses. Most isolated *R* genes encode proteins possessing a leucine-rich-repeat (LRR) domain, of which the majority also contains a nucleotide binding site (NBS) domain. There is structural similarity and/or domain homology between plant R proteins and animal immunity proteins, suggesting a common origin or convergent evolution of the defense proteins. Two basic strategies have evolved for an R protein to recognize a pathogen effector (then called avirulence factor; Avr): direct physical interaction and indirect interaction via association with other host proteins targeted by the Avr factor. Direct R-Avr recognition leads to high genetic diversity at paired *R* and *Avr* loci due to diversifying selection, whereas indirect recognition leads to simple and stable polymorphism at the *R* and *Avr* loci due to balancing selection. Based on these two patterns of *R-Avr* coevolution, investigation of the sequence features at paired *R* and *Avr* may help infer the R-Avr interaction mechanisms, assess the role and strength of natural selection at the molecular level in host—pathogen interactions and predict the durability of *R* gene-triggered resistance. Plants are under strong evolutionary pressure to maintain surveillance against pathogens. Resistance (R) gene-dependent recognition of pathogen avirulence (Avr) determinants plays a major role in plant defence. Here we highlight recent insights into the molecular mechanisms and selective forces that drive the evolution of NB-LRR (nucleotide binding-leucine-rich repeat) resistance genes. New implications for models of R gene evolution have been raised by demonstrations that R proteins can detect cognate Avr proteins indirectly by 'guarding' virulence targets, and by evidence that R protein signalling is regulated by intramolecular interactions between different R functional domains. Comparative genomic surveys of NB-LRR diversity in different species have revealed ancient NB-LRR lineages that are unequally represented among plant taxa, consistent with a Birth and Death Model of evolution. The physical distribution of NB-LRRs in plant genomes indicates that tandem and segmental duplication are important factors in R gene proliferation. The majority of R genes reside in clusters, and the frequency of recombination between clustered genes can vary strikingly, even within a single cluster. Biotic and abiotic factors have been shown to increase the frequency of recombination in

reporter transgene-based assays, suggesting that external stressors can affect genome stability. Fitness penalties have been associated with some R genes, and population studies have provided evidence for maintenance of ancient R allelic diversity by balancing selection.

Conclusion

In plants, resistance (*R*) genes play a key role in their remarkable immune responses. *R* genes are usually dominant (but sometimes recessive) genes that provide full or partial resistance to one or more pathogens. We include receptors of pathogen-associated molecular patterns (PAMPs) as *R* genes because they provide partial and sometimes even full resistance *R* genes exist in natural plant populations and have been used by humankind since early crop domestication. With the isolation of the first few plant *R* genes, immense opportunities now unfold for protein biochemists, biologists, physiologists, and geneticists alike to elucidate how these gene products function and the gene families evolve. Most of the *R*-genes in basal-branching streptophytes underwent adaptive evolution, indicating an ancient involvement of *R*-genes in plant-pathogen interactions. These findings provide novel insights into the origin and evolution of R-genes and the mechanisms underlying colonization of terrestrial environments by plants. The available source suggest that different R genes can follow strikingly distinct evolutionary trajectories, indicating that it will be difficult to formulate universally applicable models of R-gene evolution.

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IMPORTANT PEST AND DISEASE MANAGEMENT IN MANGO

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Mango (Mangifera indica Linn) is the most important fruit of India and is known as "King of fruits". The fruit is very popular with the masses due to its wide range of adaptability, high nutritive value, richness in variety, delicious taste and excellent flavour. The fruit is consumed in both forms raw and ripe. Raw fruits of local varieties of Mango trees are used for preparing various traditional products like raw slices in brine, amchur, pickle, murabba, chutney, panhea (sharabat) etc. Raw fruit of local varieties of Mango are used for preparing pickle and raw slices in brine on commercial scale while fruits of Alphonso variety are used for squash. The wood is used as timber, and dried twigs are used for religious purposes. The fruit is cultivated in the largest area i.e. 2312 thousand ha and the production is around 15.03 million tons, contributing 40.48% of the total world production of mango. The main mango producing states in India are Uttar Pradesh, Andhra Pradesh, Karnataka, Bihar, Gujarat and Tamil Nadu. Total export of mangoes from India is 59.22 thousand tons.

Pest

Mango leaf hopper: This is the most serious and wide spread pest in India. The nymphs and adult insect make puncture and suck the sap of tender leaves, inflorescence and fruits. The female hopper lay 100-200 eggs on the mid-rib of tender leaves, buds and inflorescence. The total life cycle lasts for 2-3 weeks.
The management of this pest include the following operation:

- Pruning of overcrowded branches in December
- Immediately after harvest orchard keep clean.
- Spraying of Carbaryl (0.2%) or Chlorpyriphos (0.04%) or Dimethoate (0.06%) thrice at an early stage of panicle formation, full panicle length before flowering and fruit set.
- Spraying of Nimbicidine (0.2%) at initial stage of hopper population.

Mealy bug: Spraying of Chlorpyriphos 20 EC 2.5ml/lit or Monocrotophos 36 WSC 1.5ml/lit will give control over the pest. Band the trees with 20 cm wide 400 gauge polythene sheets will prevent the spread of the pest. Similarly, release of Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10/tree will be a very effective bio-control measure.

Mango leaf hopper & Mealy bug infestation

(B) Diseases:

Powdery mildew: It is one of the most serious diseases prevalent throughout the country and all the commercial varieties are susceptible to this disease. The diseases is characterized as grayish mealy growth on inflorescence and leaves leading to flower drop and defoliation. The pea size fruits also get sometimes infected with this disease, which become mummified and black. The disease survives in the form of dormant mycelia on the older leaves and in the malformed panicles.

Management:

Mango Powdery mildew & Red rust infestation

- The disease can effectively be controlled with the sprays of wettable sulphur (0.2%), Thridemorph or calixin (0.1%) and Karathane (0.1%). Carbendazim (0.1%) is also effective against this disease. Application of Sulphur dust (350 mesh) in the early morning will protect.
- New flush or spray Wettable sulphur 0.2% or Tridemorph 0.05% will control powdery mildew.

Red rust: The presence of the rusty red fructification of the alga on the surfaces of leaves, veins petiole and young twigs is the symptom of this disease. In the initial stage, the spots are greenish grey and velvety, which trun reddish brown later. Spots are circular to irregular in shape, erumpent, measuring 2 mm in diameter.

The control measures of this disease include the following treatments:

- Proper and balanced nutrition to the tree, as this disease is directly related to the poor growth and vigour of the tree.
- Avoid crowding of trees by planting at proper distance and resorting to pruning of crowded branches.
- Application of Bordeaux mixture (5:5:50) and copper oxychloride (0.3%).

Management of Physiological Disorders

Mango suffers from the following major physiological disorders, which need corrective measures for saving the crop from loss. Some of these disorders and their possible causes and suggested corrective measures are given below.

Mango malformation:

- Malformed tissue have lower levels of reducing, non-reducing and total sugars, starch and carbohydrate than the healthy ones.
- The malformed seeding have higher protein, total amino acid, basic, neutral aromatic and sulphur containing amino acids than healthy seedlings.
- Bombay green variety of mango is highly susceptible to malformation.
- Bhadauran, Illaichi and Alib are resistant to malformation.
- The accumulation of mangiferin in differentiating buds induces their transformation into malformed inflorescence.
- Ascorbic acid, Glutathione, $K_2S_2O_3$ are the recommended anti- malformation to reduce the incidence of malformation.
- Spray of NAA @200 ppm in October-November followed by deblossoming (Feb. – March) control the malformation considerably. .

Mango malformation and Black tip

Black tip:

- Black tip in mango is caused due to deleterious effect of brick kiln fumes which contain SO_2, acetylene and CO_2.
- Borax (0.8%), caustic soda (0.6%) and washing soda are applied to control this malady, caustic soda is most effective

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Genetic Transformation Methods in Maize

About the Author

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Maize is the principal grain crop of the world. It is also the crop where genetic engineering has been employed to a great extent to improve its various traits.Some of the marketed transgenic maize are Herbicide tolerance Insect resistance Drought tolerance Maize with increased nutritional value (To increase the essential amino acid – methionine, iron, zinc, etc.).The first transgenic maize cultivars were launched in 1996 in the USA. Causes conformational change in the pigment or associated protein – causes photochemical oxidation reduction.

Steps in Transformation

1. Choice of genotypes and explants for *in vitro* regeneration and transformation
2. Media for *in vitro* regeneration and transformation
3. Transformation techniques
4. Selection system

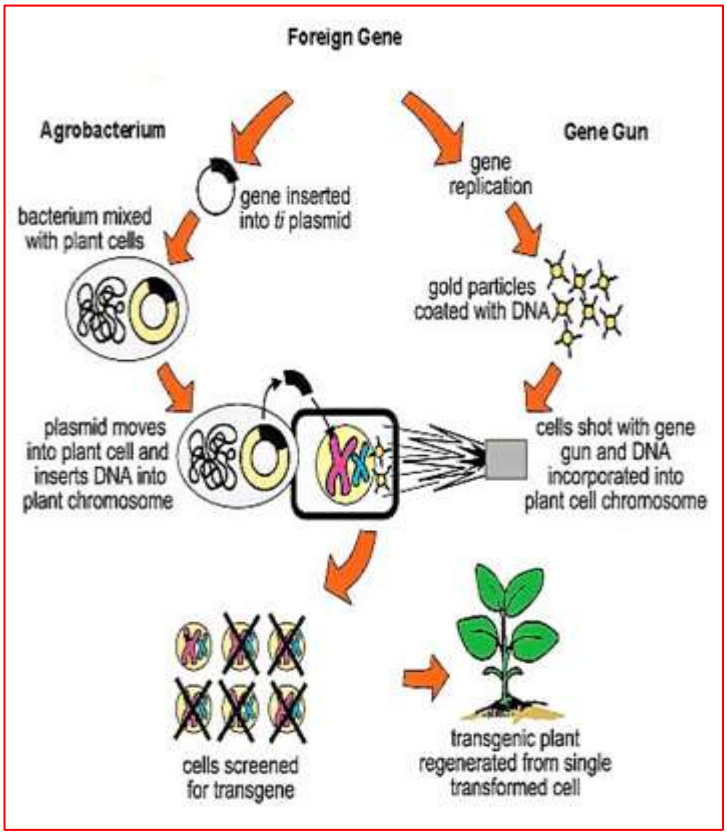
Choice of genotype

- ✓ Identification of right genotype is the key to develop transgenic maize.
- ✓ Selection not based on agronomic superiority but on its amenability to tissue culture and transformation.
- ✓ Regeneration capacity of maize genotypes in tissue culture was genetically determined by nuclear genes.
- ✓ Hi-II (High type II callus production) is one of the most widely used genotype for commercial maize transformation.
- ✓ Hi-II genotype showed maximum transformation efficiency.
- ✓ Type I callus -less compact and less regenerable type of callus.
- ✓ Type II callus-friable, embryogenic, and transformable.

- ✓ Identification of right genotype is the key to develop transgenic maize.
- ✓ Selection not based on agronomic superiority but on its amenability to tissue culture and transformation.
- ✓ Regeneration capacity of maize genotypes in tissue culture was genetically determined by nuclear genes.
- ✓ Hi-II (High type II callus production) is one of the most widely used genotype for commercial maize transformation.

Media preparation

- ✓ Green and Phillips (1975) produced the first somatic embryos in maize.
- ✓ MS, N6 (Chu) or Linsmaier and Skoog (LS)-based culture media mostly used for maize transformation.
- ✓ Optimization of different components, such as carbon source, amino acids, vitamins and concentration of plant growth regulators in culture medium is often required.
- ✓ When using MS and N6 salts,
  - lower nitrate and high NH_4^+ levels induce compact Type I callus
  - high nitrate and low NH_4^+ level induce friable Type II callus



Transformation Techniques

1. DNA transfer to protoplast by electroporation
2. Particle bombardment
3. Silicon Carbide Whiskers
4. *Agrobacterium*-Mediated Transformation
5. In planta Transformation

(i) DNA transfer to protoplast by electroporation

- ✓ DNA of interest is transferred to protoplasts by applying electric pulse to the mixture of DNA and protoplasts.
- ✓ The first successful integration of transgene - Black Mexican Sweet maize.
- ✓ Instead of electric pulse polyethylene glycol (PEG) can also be used.

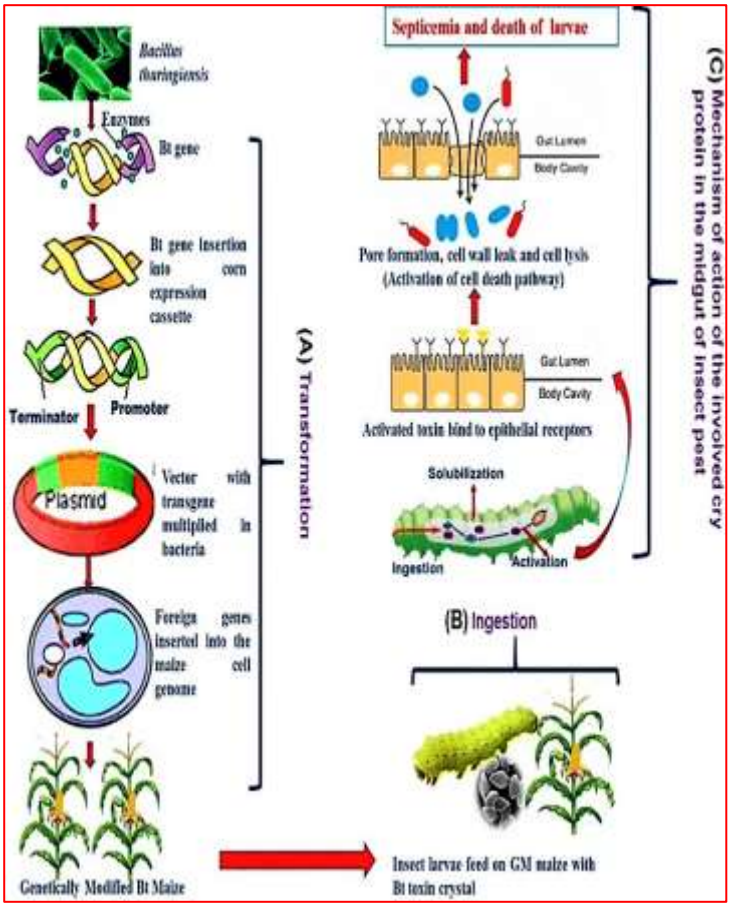
(ii) Particle bombardment

- ✓ In this technique, target DNA is transferred through cell wall penetration by tungsten or gold particles coated with plasmid DNA.
- ✓ In comparison to protoplast transformation, particle bombardment method generated more fertile transgenic events from embryogenic callus.
- ✓ Immature embryos were used as target tissue for particle bombardment mediated transformation of *cry1Ab gene pl*asmid DNA.

(iii) Silicon carbide whiskers

- ✓ Silicon carbide whiskers are needle like structure having size of 20 mm in length.

- ✓ They penetrate cell wall and plasma membrane of target cell to transfer desired DNA.
- ✓ But this method has certain limitations, such as low transformation frequency and delivery of DNA only to fine cell aggregates.
- ✓ Like silicon carbide whisker, another physical method of gene delivery using an air gun apparatus has also been used for transient gene expression studies in maize.
- ✓ This apparatus utilizes compressed air from a commercial air gun to force macro projectiles and DNA-coated tungsten particles.



(iv) Agrobacterium-Mediated Transformation

- ✓ *Agrobacterium tumefaciens* soil pathogen is a natural genetic engineer which has ability to transform plants.
- ✓ Advantage - low copy of relatively large DNA fragments can be integrated into host plant genome with minimum rearrangement. This results in high quality transgenic plants.
- ✓ Improved *Agrobacterium*-mediated transformation method to overcomes above mentioned barriers known as **Sonication-Assisted *Agrobacterium*-mediated transformation** (SAAT) -involves periodic exposure of target plant tissue to sonication waves in the presence of *Agrobacterium.*

In planta Transformation

- ✓ In planta transformation of Arabidopsis by vacuum infiltration of whole plants and the floral dip are now routinely used.
- ✓ However, similar protocols for maize are not feasible.
- ✓ Maximum numbers of commercial transgenic events have been developed using particle bombardment, followed by *Agrobacterium*-mediated transformation.

Selection system

- ✓ Selection system is very important for identification of transgenic events.
- ✓ It imparts a selective pressure which allows transformed cells to proliferate, while suppressing the growth or killing of the non-transformants.
- ✓ Widely used selection systems in maize transformation are
  - Antibiotic resistance
  - Herbicide tolerance
  - Sugar metabolism

Development of *Bt* corn

- ✓ *Bt* corn is genetically modified to contain the *Cry* proteins.

- ✓ Although insecticides are often used, their action has proved to be inconsistent or ineffective within the agricultural industry.
- ✓ *Bt* insecticides have shown to be sensitive to UV radiation and heat, as well as applied with incomplete coverage, and reduced toxicity to older larvae.
- ✓ By genetically modifying corn to produce its own *Bt* proteins, these short falls can be resolved.
- ✓ Since the *Bt* protein is present consistently within the plant tissue, it is there when and where larvae feed.

Commercial Success of Maize Transgenics

- ✓ So far, 143 different events of transgenic maize have been approved for commercial cultivation or food/feed use across 30 countries.
- ✓ The released events belong to six major trait groups- herbicide tolerance (121 events), insect resistance (115 events), modified product quality (12 events), pollination control system (6 events), and abiotic stress tolerance (4 events), with stacking of events being a common phenomenon.
- ✓ In 2015, out of 185 million ha of global maize area, 29%, i.e., 53.6 million ha was planted with maize cultivars with transgenic traits (James, 2015).
- ✓ Since its introduction into agriculture, Bt corn has yielded $537 million, which is an increase of about $1.31 per acre planted.

Advantages of Transgenic plants in Maize

- ✓ Improvement in nutritional value of food
- ✓ Increase in farmers income
- ✓ Increase in food supply
- ✓ More convenient and flexible to use
- ✓ Safer environment through decreased use of pesticides
- ✓ Improved the quality of ground and surface water with less pesticide residues
- ✓ Safe to non-target organisms and human beings

Disadvantages of transgenic plants

- ✓ Secondary pest incidence
- ✓ Disruption of pollinators and plant communities would occur if the toxin is expressed in plant nectar and pollen
- ✓ CCD- Is affecting bee hives and it is supposed to be the use of Bt transgenic crops
- ✓ GM ingredients cause cancer- Histopathologist (Dr. Stanley Ewan) **"Food and Water contaminated with GE material could increase the growth of Malignant tumor".**

Conclusion

Transgenic plants have the potential to solve many of the world's hunger and malnutrition problems. Some of these, like, Gene editing, Cis-genesis, Intra-genesis, RNA-dependent DNA methylation, etc., would necessitate further fine tuning of the maize transformation work- flows. Help to protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides hazards.

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BROODING AND REARING

About the Author

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Chicks should be kept warm and comfortable and fed on a well-balanced diet. The care and management of chicks during early part of their life constitutes brooding. Successful brooding results in the production of healthy pullets in terms of egg and meat production.

The success of brooding depends mainly on the following things.

1. **Disease free chicks and healthy stock:** to start with, healthy high quality chicks are of prime importance. Parent stock should be free from diseases. The chicks must be vaccinated with mereck's and F1 vaccine.
2. **Maintenance of proper temperature:** the temperature under the brooder is to reduce at the rate of 5^0F every week of age after the first week (from 95^0F) until approximately 70^0F is achieved.

Brooding temperature necessary for various ages of chicks

Age of the chicks (week)	Brooding temperature
0 – 1	95^0F
1 – 2	90^0F
2 – 3	85^0F
3 – 4	80^0F
4 – 5	75^0F
5 – 6	70^0F

3. **Fresh air and ventilation control:** Fresh and pure air is essential for proper growth of young chicks. The chicks feel discomfort in humid, hot house. So they need dry, fresh air and pure water in the brooder.
4. **Keeping the chicks busy:** chick guard of 18'' (45 cm) high all around the brooder about 2 ft away from the edge of brooder must be placed. Feeder and waterer should be placed in between the chick guard and wall of the brooder. Feeder and waterer should be big enough. Otherwise, they will overcrowd to take food and drink water, leading to cannibalism.

5. **Safety from fire:** Electric, gas, kerosene, hot water etc. are used to keep the brooder and brooder house warm. Care should be take3n to avoid the fire hazard.
6. **Dryness:** The brooder house should be clean and dry. The chick may be affected in paralysis if they are kept in damp brooder house.
7. **Sanitary condition:** The poultry farm and its surroundings must keep clean. Disinfectant solution should be kept just inside all entry doors and used to clean the attendants boots each time be enters the building. Visitors should not allow on the farm. The entire building including litter and all equipment should be fumigated, if the previous flock had a serious disease problem.
8. **Proper feeding and management:** The growth of young chicks depends mainly on the properly balanced diet.
9. **Litter:** Litter is spread on the floor to prevent the direct contact with the floor. Straw, wood dust, paddy husk etc. are generally used for making the litter. The litter should be dry and free from moulds. Depth of litter should be approximately 5cm (2 inches). Lime is used @ 500 gm/100 sq. ft to keep the litter dry and free from disease organism. The dusty or excessive wet litter should be removed.
10. **Protection enemies: Cat**, rat, owls and other predatory animals etc. are the common enemies of the poultry birds. Plies and rodents are also major source of infection. They must be controlled.
11. **Skill full management:** The success of farming depends on skillful management.
    a. **Vaccination**
        1. at day old stage mareck's vaccine should be given.
        2. On 5th day F_1 vaccine should be given.
        3. At 3rd week gumboro (IBD) vaccine should be given.
        4. At the 6th week, fowl pox vaccine is to be given
        5. At 7th week IBD vaccine once again is to be given.
        6. At the end of 9th week, vaccination against Ranikhet (R_2B stain)
        7. At the end of 17th weeks once again against Ranikhet (R_2B stain) is to be given.
    b. **Debeaking:** It is done to prevent feed wastage and reduce picking. About one half of the both the lower and upper beak is removed keeping the lower beak slightly longer than the upper. Debeaking at the 6th to 10th day of age is ideal with less stress on birds and better labor efficiency.

System of brooding

There are two general system of brooding

1. **Natural brooding or hen rearing**
2. **Artificial brooding.**

Natural brooding or hen rearing: The natural brooding method is used on farmers where only few chickens are raised each year. Local hens as a class are ideal mothers as they possess a strongly developed maternal instinct and as they and as they are comparatively small they seldom injuring the young chicks by trampling on them. Depending upon her size, a hen will brood 15 - 20 chickens. The broody hen will provide all the warmth required by the chicks.

Brooding coop/rearing coop: A rearing coop is made up of packing box material at a dimension of 2x2x2 feet keeping slight slope from front (i.e. 2ft height) to back (i.e. 1.5 ft height). The essential requirements of such a coop are dryness, durability, ventilation, cheapness, roominess and safety. The broody hen supplies her young with necessary heat by means of her own body and feathers.

Feeding chickens and hen: the chick should given small quantities of feed frequently for the first week. The feed should consist of chick mash, mixed with water or milk to a crumbly consistency. The hen must get balanced grower mash, clean water must be available for hen and chicken.

Artificial brooding: Artificial brooding is the handling of newly born chicks without the aid of hen. Successful brooding depends to a considerable extent upon proceeding the chickens with inadequate and steady source of heat. The heating unit is known as a brooder or foster mothers. Artificial brooding has several advantages over the natural brooding

1. Large number of chicks may be brooded at a time
2. Chicks may be reared at any time of the year
3. No need of broody hen
4. Sanitary condition may be controlled
5. Temperature may be regulated as required.
6. Feeding may be under taken according to plan.
7. There is a no possibility of the spreading insect from the mother hen to the chickens

Kinds of brooder: Brooders may be different in accordance with the nature of source from which the heat is supplied such as

1. **Hover brooder**
2. **Coal brooder**
3. **Oil brooder**
4. **Electric brooder**
5. **Battery brooder**

The essential of a good brooder are: a dependable mechanism for controlling temperature and regular supply of fresh air, economic in construction, durable, adequate light and space, dryness, safety from fire, easy to disaffection and protection against chick enemies.

Floor space, temperature and water space for chick in artificial brooding

Age	Floor space	Brooder temperature	Water space
1st week	100-120 sq. cm/chicks	95^0F	Start on shallow pans to avoid crowding, use 4 waterer per brooder.
2nd week - 4th week	250 to 300 sq. cm/chicks	90^0F 85^0F 80^0F	Provide 4 to 6 waterer of three litre capacity/brooder, fill waterer at least twice daily
5th - 8th week	700 to 800sq. cm/chicks	75^0F 70^0F	Use waterer trough with adjustable stands keep waterer at chicks shoulder level 2 cm space per birds

Management of chicks in the brooder

1. The chickens should be provided with plenty of room. Because of over crowding invariably result in poor and uneven growth amongst the chicken and high mortality.
2. The floor of the house should be covered with litter which protect the chicks from cold surface of the floor and also absorb moisture from dropping and helps in maintaining sanitary condition in the brooder house.
3. The brooder house should be dry and free from molds. The litter of high quality keeps the room dry. The litter should be renewed as soon as it becomes damp and or very dirty with dropping.
4. The young chicks should be removed from the incubator and transferred as quickly as possible to the brooder which should have been running for at least 24 hour previously.
5. The temperature should be adjusted as per requirement of the chicks.
6. Provide clean fresh water infront of the birds at least twice daily
7. As the chicks grow, increased space area should be given
8. The young birds should be given chopped green grass every day from one weeks onwards.
9. Some form of calcium such as lime stone, grit and oyster shell should also be fed ad libitum from day old onward.
10. The brooder including feed hoppers and water should be cleaned daily. The waterer should be filled with clean and fresh water at least twice daily
11. The brooder should in such place where cold winds and rain water does not get in .
12. Chicks may be taught to roost which they are four weeks of old. Every roosting is help to reduce overcrowding and prevent litter born infection.
13. Brooder may be removed 4 to 5 weeks depending up on the weather.

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SUSTAINABLE AGRO-PRACTICES

FOR AUGMENTING FOOD SECURITY PRIOR AFFECTED BY CLIMATE CHANGE - INDIAN SCENARIO

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The magnitude of India's food-security issues has been exacerbated by climate change. The connecting link between the climate change attributes and food security criteria is complicated and most of the research concentrates on the attributes of food availability. The influence of change in climate on food security of India is examined in this article, which mainly considers three dimensions i.e. availability of food, access of food, and absorption of food. It concludes that ensuring food security prior affected by of climate change will be a formidable challenge, and suggests a range of approaches, including the adoption of sustainable farming techniques, a greater focus on urban food security and public health, the provision of livelihood security, and long-term relief interventions in the event of emergencies like natural calamities.

Introduction

Food is a constant theme that runs through all 17 United Nations Sustainable Development goals (SDGs) and it is crucial for accomplishing overall targets in time. With one-sixth of the global population, it is essential for India to meet the objectives. The SDG India Index 2020-21 was just announced by NITI Aayog, showcasing national and state progress on the SDGs. 34.7 percent of children under the age of five are stunted in India; 40.5 percent of children aged 6-59 months are anaemic; 50.3 percent of pregnant women aged 15-49 years are anaemic; and kids aged 0-4 years are underweight. India is responsible for a quarter of the world's hunger (Figure 1). In India, chronic undernutrition or stunting hinders four out of ten children from reaching their full developmental capabilities. In addition to malnutrition issues, India's food chain is struggling from the negative impacts of green revolution technology. Equity considerations are also important in a country dominated by smallholders. Agriculture's positive contribution to nutrition has now been scientifically verified. Crop diversification to climate-resilient and yet commercial crops is frequently suggested as an alternative, particularly in areas where existing practices are ecologically unsustainable. Diversification may be assisted by encouraging farmers during the transformation and maintain a great value chain.

While the fluctuations of global warming are progressively impacting Indian agriculture, it is also a substantial source to Greenhouse gases. Conservation agriculture, organic agriculture, and agro-ecological approaches are instances of climate-smart interventions that may address current environmental concerns while maintaining food and nutrition security. The most popular example is natural farming techniques, which have been explored in areas of Andhra Pradesh, India and successfully offer harmony towards ecological systems and nature conservation. In some parts of the country, crop residue burning has become a major concern. Monoculture and other package of incentives that maintain environmentally unsustainable agriculture methods are mostly responsible.

With proper agriculture and soil management, crop production offers solutions to such pernicious problems such as zero-tillage, rotation of crop, management of in-situ crop harvest residue or mulching, and industrial uses like generation of bio-fuel. The ecosystem is polluted by the overuse of chemical pesticides and fertilisers. Organic farming, which uses natural methods to cultivate crops, avoids this issue. Botanical pesticides, green manuring, biological pest

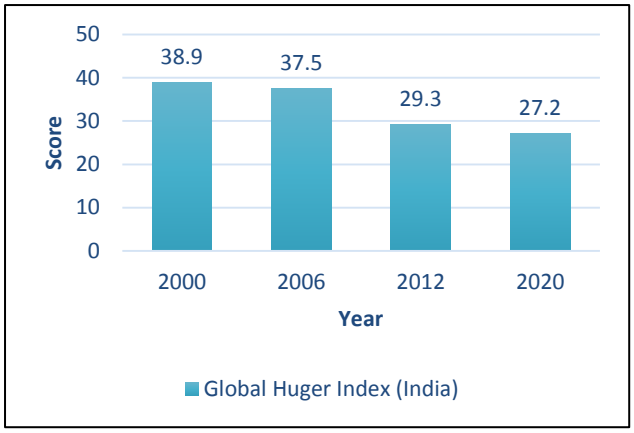


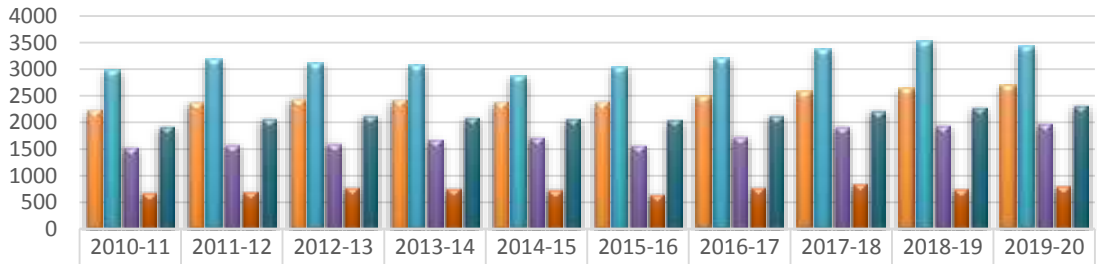
Figure 1. Global hunger index scores of India (Global Hunger Index Database)

management, as well as other environmentally friendly techniques are used. Meanwhile, the green movement is gaining momentum in states like Sikkim and Himachal Pradesh. Changing consumer preferences is a major aspect in reforming Indian food systems, and it has a positive correlation with crop and diet diversification. The agricultural research system should emphasize the establishment of desirable agricultural commodities that are abundant in essential micronutrients such as iron, zinc, and other minerals. To accomplish all of this, the government must boost its expenditures in agricultural research and development.

Climate change affecting food production in India

"Food security exists when all people, at all times, have physical, social, and economic access to sufficient, secure, and nutritious food that satisfies their dietary needs and food preferences for an active and healthy life," according to the 1996 World Food Summit. Food security has three primary elements, according to this definition: food availability, food access, and food absorption. As a result, adequate food production isn't enough to safeguard the food security in India. Food security is impacted on crops, cattle, forests, fisheries, and aquaculture, and it can have serious economic and social repercussions such as lower earnings, degraded security of livelihoods, disruption of trade, and negative human health effects. It is crucial to remember, however, that the overall impact of climate change is determined not just by the magnitude of the climatic shock, but also by the underlying vulnerabilities.

Climate change contributes to India's lengthy food security challenges by influencing agricultural production in a number of ways. For one aspect, it might lead to significant increase in annual rainfall unpredictability, either inter-annually and intra-seasonally. Low productivity is one of the most serious issues confronting Indian agriculture. Figure 2 demonstrates that India's food grain yield per hectare has remained constant. Climate change will have an especially devastating impact on water availability in India, because large parts of the country already confront water scarcity and depend heavily on groundwater for agriculture. According to the World Resource Institute, 54% of India has been under severe to extreme water stress (Figure 3). Agriculture in India, and thus India's food supply, is extremely sensitive to climate change, owing to the sector's continued vulnerability to monsoon variability. After all, rain-fed agriculture accounts for about 65 percent of India's cropped land. Figure 4 demonstrates that Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, and Uttar Pradesh have the most districts with extremely high and high climate change risk.



	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Rice (Kg/Ha)	2239	2393	2461	2424	2390	2400	2494	2576	2638	2705
Wheat (Kg/Ha)	2988	3177	3117	3075	2872	3034	3200	3368	3533	3421
Coarse Cereals (Kg/Ha)	1531	1590	1617	1677	1729	1579	1750	1934	1944	1976
Pulses (Kg/Ha)	691	699	789	764	744	656	786	853	757	817
Total Foodgrains (Kg/Ha)	1930	2078	2129	2101	2070	2056	2129	2235	2286	2325

Figure 2. Yield per hectare - food grains (Reserve Bank of India database)

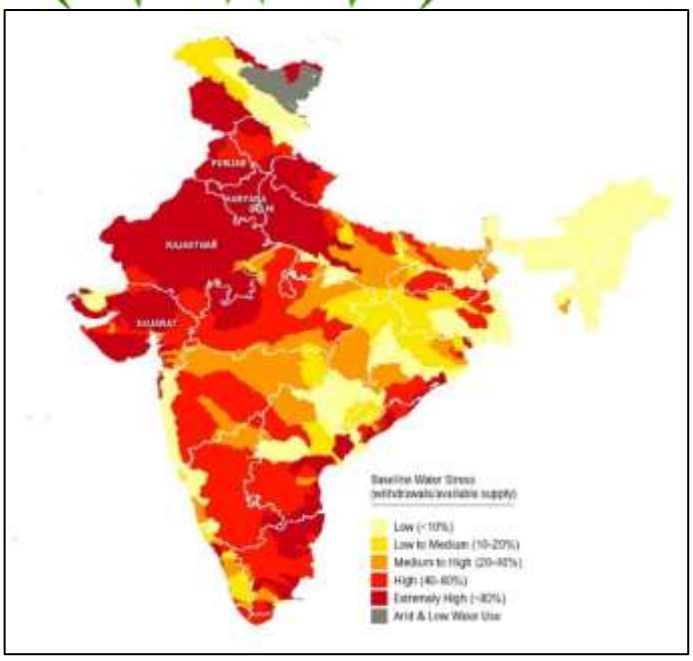


Figure 3. Map showing India in high to extremely high water stress crisis (World Resource Institute)

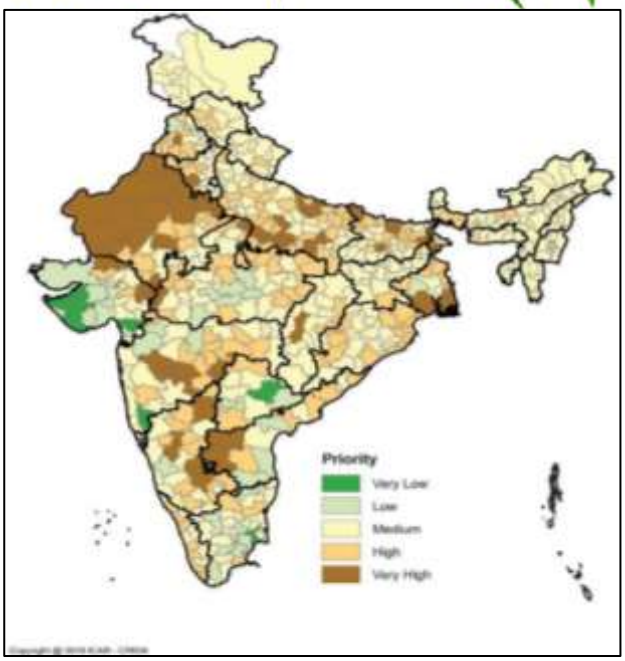


Figure 4. Map showing risk of Indian agriculture to changing climate (2020-2049) (ICAR-CRIDA)

Climate change affecting food access in India

Although much progress has been made in the knowledge of crop producing sensitivity to produce, very few models evaluate the impact on access to food caused by climate change. According to the IPCC's Fourth Assessing Report, 200 to 600 million additional people worldwide could be starving by 2080 depending on the change in climatic scenario (Yohe *et al.*, 2007). India is especially vulnerable since small and marginal farmers rely on rain-food monoculture in its rural areas, which offers just a few months of food security in the ordinary year. Climate change risks will likely be highest among the low income groups resident in informal settlements, who are frequently located in regions exposed to waterfalls and landslides and where homes are particularly sensitive to extreme weather events, such as water and wind hazards.

Since food is the major spending for urban poor families, displacement, livelihood loss or damage to productive assets as a consequence of such extreme weather events would directly affect household food security. Net cereal access per capita was recorded in 2017 as 451,700 g/day (Figure 5). This is a growth of 443,700 g/day for 2016 compared to 2016. Pulses were also observed in 2017 at 54,400 g/day (Figure 5). This indicates an increase of 43.600 g/day in 2016 compared with the prior level. Zinc deficiency leads to decreased immunity and the risk of infections may be increased. The prevalence of zinc was found to be 42.6% for children under 5 years of age, but it was 43.8% for children less than 5 years of age in five states (Kapil et al., 2011). The anaemic of children 69.4% and 58.4% respectively, were determined by NFHS-3 (2005–06) and NFHS-4 (2015–16) by children aged six- to five months (NFHS III - 2005-2006). This problem was not reduced to the intended amount by nutrition and health policies and initiatives (Figure-6). The problem of underspending and over-nutrition in both urban and rural areas in adults is highlighted by various research findings. Figure-7 shows the nutritional profile of adult women since 1975. The overall nutritional condition of NFHS-3 and NFHS-4 adults shows decreasing in male (34.2% –20.2%) and male (35.5%–22.9%) chronic energy failure.

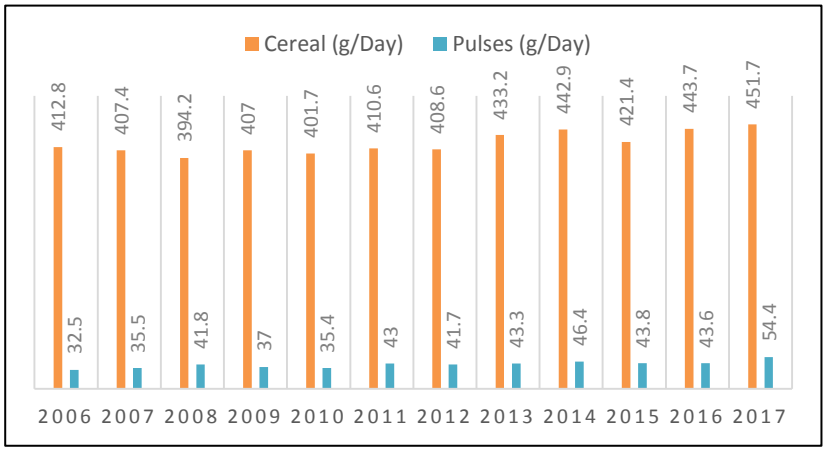


Figure 5. Per Capita Net Availability of food grains in India (Cereals and Pulses) (India Premium Database's Agriculture Sector)

Doubling farmers' income for augmenting food security in India

To accomplish doubling farmer's earnings could involve new approaches and some modification in the policy position. One could be identifying and targeting of the poor or low-income farmers. It could be difficult to reach the aim of doubling farmers' earnings in this short period of time unless it is understood who has low incomes in agricultural sector and/or is marginalized in respect of access to technology, commodities, funding, knowledge and facilities (Kumar and Chahal, 2018). A four-point action framework was designed by the NITI Aayog socioeconomic research group to double Indian farmers' earnings. The four-point implementation plan initiatives involve compensation pricing for farmers via change of the current business system, productivity enhancement, agricultural policy reforms and relief measures. The Indian MSP policy encourages farmers to intensify their cultivations. Instead of cost of production and other production concerns, domestic agricultural prices are more impacted by global future prices of agricultural commodities. The global trend of future global agri-product prices is lower than national or MSP prices. This hinders the corresponding increase in domestic MSP or market prices in comparison to production costs. Because small and marginal farmers with small holdings dominate India's agriculture, increasing productivity is probably the main factor in doubling the income of farmers. Modern communications technology may be a suitable and effective way of disseminating information (Kumar and Chahal, 2018) in the farming community to strengthen food security.

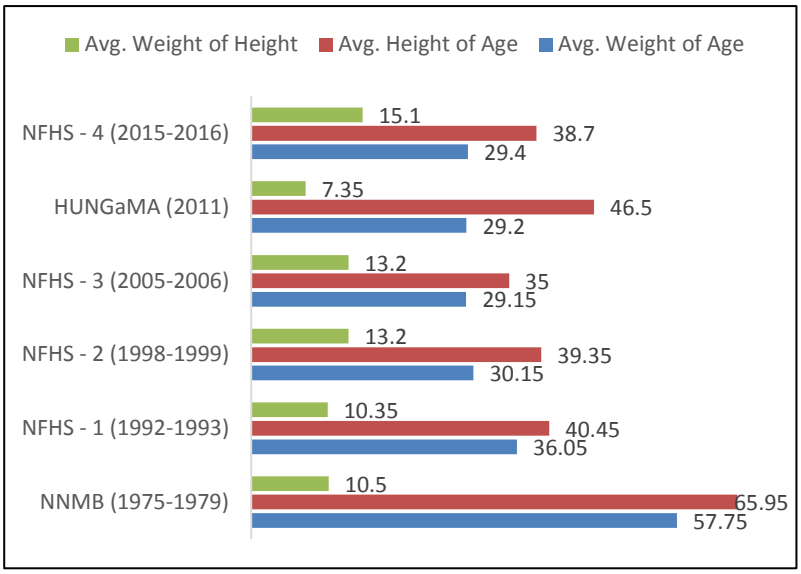


Figure 6. Child under nutrition in 0-5 years in India (Mishra, C. P., 2017) (NFHS – National Family Health Survey, NNMB - National Nutrition Monitoring Bureau, HUNGaMA - Hunger and Malnutrition Survey)

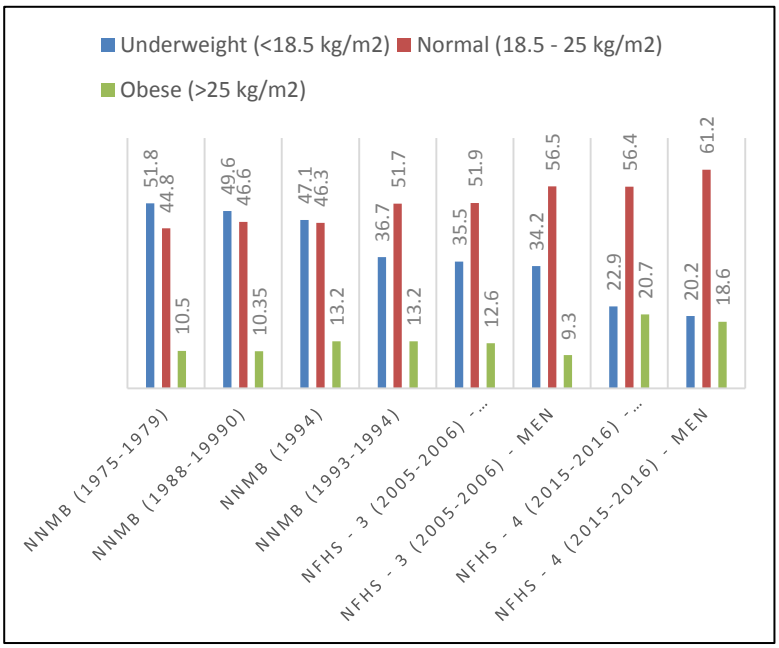


Figure 7. Adult malnutrition in India (Mishra, C. P., 2017) (NFHS – National Family Health Survey, NNMB - National Nutrition Monitoring Bureau

Conclusion

According to FAO, in all stages of the food supply chain since harvesting, food processing, food packing and transportation to the final stage of consumption, 40% of food produced in India either is lost or wasted. According to another estimate, winning the fight against food loss and waste can save India US$61 billion by 2050 through higher profitability of the business, decreased food poverty, lower emissions of GHG, water use, and environmental damage. Moving to a circular economy might help India get toward SDGs with a reduction in food waste to half by 2030. Apart from its benefits in the reduction of food waste and the move to zero hunger, companies and governments must recognise the potential of the circular economy to boost corporate competitiveness, sustainable economic growth and

employment through waste-to-value programmes. India can alter the usage of resources by reusing, recycling and redistributing food by means of the circular economic concepts. The fact that India's achievement is crucial to achieving the global objective of Zero Hunger is not to be denied. Transformation to sustainable, healthy and resilient food systems is necessary to accomplish the objective of zero hunger. Some recommendations for sustainable food security in the context of changing climate in India can be outlined as:

- **a.** Adoption of sustainable agricultural practices through new innovative conservation technology.
- **b.** Construction of proper water storage structures for rain water harvesting to ensure availability of water round the year.
- **c.** Ensuring proper and healthy nutrition on per day basis in urban and rural areas irrespective of ages.
- **d.** Strengthening livelihood security by providing opportunity for storage of food products for sustainable uses.
- **e.** Long-run relief measures to mitigate natural disasters to ensure availability of food.
- **f.** Proper cold storage facilities for ensuring conservation of various horticultural crops.

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CONTRACT FARMING IN INDIA

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India's agriculture sector makes a significant contribution to its Gross Domestic Product and provides livelihood for many millions of people. Agriculture is not only a means of trade and a source of livelihood, but is fundamentally associated with our culture. Introduction of reforms in agricultural marketing is the need of the hour to bring the requisite changes in its structure and to push the sector to take off from its low growth rate of 2-3% to at least a respectable 4-5%. During recent decades, agricultural commodity chains in developing countries have experienced substantial restructuring due to changes in both demand- and supply-side factors. On the demand side, factors such as population growth, greater urbanization, increase in income levels and changes in preferences have reshaped demand for agricultural commodities. On the supply side, factors such as market liberalization (both national and international); improvements in transportation and logistics; and improvements in technologies have affected the supply chains.

Historical Background

Contract farming is nothing new. During the British period there was indigo plantation through contract farming. But that was exploitative. Modern contract farming is mutually advantageous. For the first time it was introduced in Taiwan in 1895 by Japanese government. In India it was introduced by Pepsi company for the cultivation of vegetables particularly tomato and potato in Hosiarpur taluk of Rajasthan in 1927. In Karnataka contract farming was started with the cultivation of gherkin in 20th century.

Contract farming

Contract farming is introduced in the case of peasant farming. There are two parties in the contract farming. One party is the landowner or peasant. The other party is a contracting company. A system for the production and supply of agricultural/horticultural produce under forward contracts between producers/suppliers and buyers. The essence of such an arrangement is the commitment of the producer/ seller to provide an agricultural commodity of a certain type, at a time and a price, and in the quantity required by a known and committed buyer.

Contract farming is generally defined as farming under an agreement between farmers and a sponsor (processing and/or marketing firm) for the production and supply of agricultural products under forward agreements, frequently at predetermined prices. Contract farming can be defined as agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm product or products.

According to the contract, the farmer is required to plant the contractor's crop on his land, and to harvest and deliver to the contractor a quantum of produce, based upon anticipated yield and contracted acreage. This could be at a pre-agreed price. Towards these ends, the contractor supplies the farmer with selected inputs, including the required technical advice. Thus, the contractor supplies all the inputs required for cultivation, while the farmer supplies land and labour. However, the terms and nature of the contract differ according to variations in the nature of crops to be grown, agencies, farmers, and technologies and the context in which they are practiced.

The important features and highlights of this farming scheme are as follows: -

1. Contract farming Scheme is a key driver in doubling income of farmers
2. Subsequently, the state govt. will provide an assured market and better prices to farmers.
3. Through this scheme consumers will get goods at relatively low price.
4. This law will ensure better price of agricultural and horticulture products to the farmers.
5. Accordingly, farmers will get advance agreements and ensured supply for companies to increase investment.
6. Henceforth, Agricultural Produce Marketing Commodities (APMC) Act will allow privatization, opening and access to private mandis and beginning of e-trading to increase farmer's income.

Advantages

1. Contract farming is looking towards the benefits both for the farm-producers as well as to the agro-processing firms.
2. Makes small scale farming competitive - small farmers can access technology, credit, marketing channels and information while lowering transaction costs
3. Assured market for their produce at their doorsteps, reducing marketing and transaction costs
4. It reduces the risk of production, price and marketing costs.
5. Contract farming can open up new markets which would otherwise be unavailable to small farmers.
6. It also ensures higher production of better quality, financial support in cash and /or kind and technical guidance to the farmers.
7. In case of agro-processing level, it ensures consistent supply of agricultural produce with quality, at right time and lesser cost.

Crops suitable for contract farming

In general contracting is practiced by companies in case of crops that are:

- **Perishable**: cannot be stored for long periods and needs to find market immediately
- **Bulky:** costlier to transport
- **Plantation crops:** growers cannot wildness the plantations or the estates and are locked into relationship with processor
- **Processible:** need for processing-based inter-dependence between growers and processors which can be explored
- **Variations in quality:** where crops vary in quality and quality is important for processing
- **Unfamiliar:** medicinal plants like *safed musli*, *ashwagandha* etc. and new products for new markets like gherkins etc.

Model for Contract Farming

There are five models of contract farming namely, the centralized model, the nucleus estate model, the multipartite model, the informal model, and the intermediary model that are in vogue in the country. Contract farming usually follows one of five broad models, depending on the product, the resources of the sponsor and the intensity of the relationship between farmer and sponsor that is necessary.

Centralized Model

This type of model involves a centralized processor and/or packer buying from a large number of small farmers and is used for tree crops, annual crops, and poultry, dairy. The products often requiring high degree of processing, such as tea or vegetables for canning or freezing. It is vertically coordinated, with quota allocation and tight quality control. Sponsors' involvement in production varies from minimal input provision to the opposite extreme where the sponsor takes control of most production aspects.

Nucleus estate model

This type of model is a variation of the centralized model where the sponsor also manages a central estate or plantation. The central estate is usually used to guarantee throughput for the processing plant but is sometimes used only for research or breeding purposes. It is often used with resettlement or transmigration schemes and involves a significant provision of material and management inputs.

Multipartite Model

This type of model may involve a variety of organizations, frequently including statutory bodies which can develop from the centralized or nucleus estate models, e.g. through the organization of farmers into cooperatives or the involvement of a financial institution.

The informal model

This type of modelis characterized by individual entrepreneurs or small companies. It involves informal production contracts, usually on a seasonal basis. It often requires government support services such as research and extension.

Intermediary Model

This type of model involves sponsor in subcontracting linkages with farmers to intermediaries and there is a danger that the sponsor loses control of production and quality as well as prices received by farmers. Apart from this there are several reasons for the introduction of contract farming in India. Some of the reasons are follows:

- It is needed to bring about a market focus in terms of crop selection by Indian farmers.
- It will generate a steady source of income for the farmers.
- It will provide a linkage between agriculture and processing industries.
- It will generate gainful employment in rural areas, particularly for agricultural landless labour.
- It will reduce migration of labour from rural areas to urban areas.
- As a matter of fact contract farming will be mutually advantageous for both the farmers and the sponsoring companies.

NABARD's Initiatives in contact farming

NABARD developed a special refinance package for contract farming arrangements (within and outside AEZs) aimed at promoting increased production of commercial crops and creation of marketing avenues for the farmers. The various initiatives undertaken by NABARD in this direction are:

Financial Interventions

Uncommon Refinance package for financing farmers for contract farming in AEZs 100% refinance to disbursements made by CBs, SCBs, RRBs and select SCARDBs (having net NPA less than 5%).

Term facility for repayments (3 years)

Obsession of higher scale of finance for crops under contract farming. Extension of refinance scheme for financing farmers for contract farming in AEZs to contract farming outside AEZs besides coverage of medicinal and aromatic plants. Augmentation of Refinance scheme for contract farming under Automatic Refinance Facility.

Agricultural produce suitable for CF

The various agricultural produce is suitable for practices under contract farming like tomato pulp, organic dyes, poultry, pulpwood, mushrooms, dairy processing, edible oils, exotic vegetables, baby corn cultivation, basmati rice, medicinal plants, potato for making chips and wafers, onions, mandarin oranges, durum wheat, flowers and orchids, etc.

Challenges

- Contract farming arrangements are often criticized for being biased in favor of firms or large farmers, while exploiting the poor bargaining power of small farmers.
- Problems faced by growers like undue quality cut on produce by firms, delayed deliveries at the factory, delayed payments, low price and pest attack on the contract crop which raised the cost of production.
- Contracting agreements are often verbal or informal in nature, and even written contracts often do not provide the legal protection in India that may be observed in other countries.
- Lack of enforceability of contractual provisions can result in breach of contracts by either party.
- Single Buyer – Multiple Sellers (Monopsony).
- Adverse gender effects - Women have less access to contract farming than men.

Policy support

Agricultural marketing is regulated by the States' Agricultural Produce Marketing Regulation (APMR) Acts. To manage and create practice of agreement cultivating, Government has been effectively upholding to the States/Union Territories (UTs) to change their agriculture marketing laws to give an arrangement of enrolment of agreement cultivating supports, recording of their arrangements and legitimate debate settlement component for efficient advancement of agreement cultivating in the country. Up until this point, 21 States (Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Mizoram, Nagaland, Odisha, Punjab (separate Act), Rajasthan, Sikkim, Telangana, Tripura and Uttarakhand) have corrected their Agricultural Produce Marketing Regulation (APMR) Acts to accommodate contract cultivating and of them, just 13 States (Andhra Pradesh, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Odisha, Rajasthan and Telangana) have notified the principles to carry out the arrangement.

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NUTRITIONAL IMPORTANCE OF *"Okra" (Abelmoschus esculentus)*

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Okra (scientific name; *Abelmoschus esculentus*) is an attractive plant, which sprouts an upright, edible fruit. Perhaps the most well-known characteristic of okra is its sticky centre, which is often identified as a negative characteristic because when okra is cooked it can become gooey. Okra is popular in the Southern United States, where it is commonly fried and served whole, or used as a thickener in gumbo. (Gumbo is a flavourful dish, which usually contains meat, beef stock, vegetables, and strong flavourings like garlic cloves and hot sauce) Although these dishes are among the most popular ways to enjoy okra, it can be eaten in a variety of other ways, including raw, roasted, sautéed, and steamed. Okra is the residue left from ground soybean after obtaining the water-extractable fraction used to produce bean curd (tofu) or soymilk. It is a Japanese word meaning "honorable hull" or soy pulp. It is also called as soybean residue, bean curd residue, douzha or tofuzha in Chinese. It has a nut (almond and coconut) like taste and beige in color with light, crumbly, fine-grained texture, which makes it look like moist sawdust or grated coconut. Huge quantities of okra are produced worldwide. In Japan about 8 lakh tons, in Korea approximate 310,000 tons and in China about 2,800,000 tons are produced from tofu industry every year. It is a by-product with low commercial value generated during the manufacture of soymilk and is potentially a nutritious product high in fiber, protein, carbohydrates, vitamins, minerals and fat and has excellent functional properties.

Currently, it is used as stock feed and fertilizer or dumped in landfill. Particularly in Japan, most of the okra is burnt which creates carbon dioxide. Meanwhile, discarding of okra as waste is a potential environmental problem because it is highly susceptible to putrefaction. In fact, it contained high moisture content (70%–80%), which makes it difficult to handle and possesses high capacity for deterioration. However, it must be dried quickly to avoid spoilage to prolong its shelf life. The environmental problems arising from the massive generation of residues and its high moisture content have been attracting considerable attention towards drying of okra.

Furthermore, okra contains isoflavonoids which have a positive effect on health like lowering of certain hormone-dependent cancers, cardiovascular diseases and osteoporosis, possibly due to their antioxidative properties and their ability to bind the oestrogen receptor. Approximately one-third of the isoflavones present in the soybean remains in okra, suggesting that it is a good, low-cost source of nutrients. The three main isoflavones in soy are: daidzein, genistein, and glycitein. The isoflavones can act as antioxidants, but as phytoestrogens, they can act as estrogen agonists or antagonists, bind to the estrogen

receptor which is thought to lead to lower incidences of breast cancer. However, the exact mechanism by which soy isoflavones act remains to be fully elucidated.

Origin and geographic distribution

Okra plant or lady's finger was previously included in the genus Hibiscus. Later, it was designated to Abelmoschus, which is distinguished from the genus Hibiscus. Abelmoschus was subsequently proposed to be raised to the rank of distinct genus. Okra originated somewhere around the Ethiopia, and was cultivated by the ancient Egyptians by the 12th century BC. Its cultivation spread throughout Middle East and North Africa (Tindall 1983, Lamont 1999). Okra is grown in many parts of the world, especially in tropical and sub-tropical countries. This crop can be grown on a large commercial farm or as a garden crop. Okra plants are grown commercially in many countries such as India, Japan, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Myanmar, Malaysia, Thailand, India, Brazil, Ethiopia, Cyprus and in the Southern United States. Okra is found all around the world from equatorial areas to Mediterranean Sea as may be seen from the geographical distribution of cultivated and wild species. Cultivated and wild species of okra clearly showed overlapping in Southeast Asia, which is considered as the centre of diversity. The spread of the other species is the result of their introduction to Africa and America

Health benefits of okra

In vitro experiments have indicated that okra is a potential source of antioxidant components showing that protease hydrolysate from okra yielded antioxidant activity. Okra might be useful as a weight-loss dietary supplement and might protect the gut environment in terms of antioxidant status and prebiotic effect. Several nutritional intervention studies in animals and humans indicates that consumption of soy protein particularly containing conglycinin, soya-saponins, phospholipids and isoflavones, reduces body weight and fat mass in addition to lowering plasma cholesterol and triglycerides in obese humans, in addition to reducing plasma lipids and improves insulin resistance that favourably affect fatty acid metabolism and cholesterol homeostasis.

Nutrient quality of okra

Okra has high protein content (40% on a dry weight basis) with good essential amino acid profile and *in vitro* digestibility. The fat that remains in okra is approximately 10%, with a high polyunsaturated fatty acid content. Small amounts of starch, sugars and significant levels of B group vitamins and potassium are also recovered in okra. Despite the high nutritional and excellent functional properties like protein solubility, water holding capacity, emulsification, foaming, and binding properties of okra makes it suitable for potential application in food products, the most common use of this by-product is in the manufacture of animal feed. Okra also contains high amounts of dietary fiber and is considered as an excellent dietary fiber source and as such could be added to different foods. The composition of fibres, has been described as 12% hemicellolose, 5.6 % cellulose, 12% lignin. Okra contained 84.5% moisture, 4.8% protein, 3.6% fat, 3.3% fibre and 0.8% ash on wet basis.

Okra comprised 49% total dietary fibre, of which only 0.55% was soluble and observed that in okra-fed rats, *in vivo* colonic fermentation of okra resulted in a lower pH, but a higher faecal weight and higher

total short chain fatty acid production, compared to controls. There were no significant differences between the two groups in any of the analyses, with the exception of decreased body weight and increased faecal fermentation in the okra-fed group. Thus, stated that okra might be useful as a dietary weight-loss supplement with potential prebiotic effect.

In vitro experiments have indicated that okra is a potential source of antioxidant components, showing that protease hydrolysate from okra yielded antioxidant activity. Okra contains isoflavones that are also found in whole soybeans and other soybean products. The three main isoflavones in soy are: daidzein, genistein, and glycitein. These can occur in four different chemical forms: aglycons, glucosides, acetylglucosides and malonylglucosides. Total phenolic content of okra is almost half of the soybean seeds. It was observed that radical scavenging ability increased with the increase in temperature and solvent fraction up to 50°c and 33 % respectively, but with further increase in these parameters, the percentage of inhibition of DPPH radicals started declining.

Development of value-added products

Supplemented okra in cookies with the addition of up to 30% of the dried powder of okra without adverse effect on the sensory properties of the products. Tortillas supplemented with okra in an attempt to increase the protein content in tortillas and found the maximum acceptable supplementation of okra was of 10%. Soy/rice cakes were puffed from the mixture of okra pellets and parboiled rice using a rice cake machine. Main ratio was okra pellets and parboiled rice: 90/10, 70/30, 40/60, and 0/100 (w/w). The cakes were evaluated for specific volume (SPV), texture, colour, flavour, aroma and integrity. Consumers liked best the rice cakes containing 70% okra in which beany flavour and aroma was not a significant factor.

Harvesting

Normally, okra pods are harvested every second day from the time the first pod is formed. It takes 5 to 10 days from flowering to picking fruits ready for the markets. Harvesting is usually done early in the morning, after which it enters the market. Thailand market prefers small, tender fruits on every alternate day of okra. It is important to harvest this plant frequently to increase the yield and to spur the growth. Fresh okra can be transported quite easily in bulk and kept for a few days without much loss of quality.

Conclusion

The information presented here shows the potential nutritional importance of Okra and its role in improved nutrition and health. It is an affordable source of protein, carbohydrates, minerals and vitamins, dietary fibre and health promoting fatty acids. Scientific studies provide some evidence to support the potential beneficial effects of Okra components in lowering the risk for various chronic diseases, although information pertaining to the role of edible plant parts of Okra in disease prevention and the mechanisms of action are limited to date. This is due to the complex nature of disease etiology and various factors impacting their occurrence. It is imperative the scientific community continues to unravel the mechanisms involved in disease prevention and determine how food bio-actives from such foods as Okra can influence human health. Further research, needs to be performed to provide compelling evidence for the direct health benefits of Okra consumption. Therefore, promoting the consumption of traditional vegetables such as Okra could provide cheap sources of macro and micronutrients and mineral elements that can improve the nutritional status of resource-poor subsistence farmers in the area in particular and in Ethiopia in general. Furthermore, this vegetable can also be used as an indispensable tool when it comes to reducing the prevalence of malnutrition, especially among resource-constrained urban households in addition to rural household. Consumption of Okra by both low-income and high-income groups can also used as a means of dietary diversification.

BIOLOGICAL CONTROL OF INSECT PESTS WITH *TRICHOGRAMMA SPP.* FOR THE INCREASE OF AGRICULTURAL PRODUCTIVITY

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The genus Trichogramma is polyphagous and distributed in all terrestrial habitats and is one of 80 genera in the family Trichogrammatidae. Trichogramma are endoparasitoids, commonly known as 'stingless wasps' and are primary parasitoids of eggs of Lepidoptera, but parasitism also occurs in eggs of other orders such as Coleoptera, Diptera, Hemiptera, Hymenoptera and Neuroptera. It is very important for plant protection and it has the distinction of being the highest produced and most utilized biological control agent in the world, as it kills the pest in the egg stage itself before the pest could cause any loss to the crop and also that it is quite amenable to mass production in the laboratories and its success as biological control agent by mass releasing. Trichogrammatidae includes the smallest of insects, ranging in size from 0.2 to 1.5 mm. A female parasitizes 1-10 eggs per day or 10-190 during her life under laboratory conditions. Large females parasitize more eggs than smaller ones. The number of eggs laid per one host egg may vary from 1 to 20 or more depending upon the size of the host egg. A female parasitoid can easily identify already parasitized eggs, thereby avoiding super parasitism or multiple-parasitism under natural conditions.

Trichogramma mass production

The selection of host varies with species and strain of Trichogramma. Different species and strains have different searching abilities and tolerance to weather conditions. Efficacy is improved by selecting the most appropriate, effective and adapted species for the specific crop / pest situation. The parasitoids are multiplied on Corcyra eggs in the laboratory. The eggs of Corcyra moths are collected, cleaned and sieved to remove the moth scales etc. The pure eggs thus obtained are exposed to ultra-violet light of 15 watts UV tube for 45 minutes to kill the host embryo but at the same time permit parasitization. The eggs are then sprinkled uniformly over a card of 15 x 10 cm size. The card is divided into two

halves of 15 x 5 (LxB). Label information on the manufacturer, species of the parasitoid, date of parasitization and expected date of emergence are given in the left-over spaces on the top and bottom of each half of the card.

Trichogramma Card

One tricho card contains approximately 20,000 eggs. A coat of 10% gum Arabic is applied on the grids of card and the eggs are sprinkled uniformly in a single layer with the aid of a tea strainer. The excess eggs pasted are removed by gently passing a shoe brush over the card after sufficient air drying under fan. The egg cards are placed into polythene bags of suitable size and the nucleus card of Trichogramma are introduced in it. The easiest way to accomplish this is to place a piece of 'Tricho egg card' containing parasitized eggs that are ready to yield the adults and to hold them in subdued light for 2 to 3 days. The emerged parasites readily parasitize the fresh eggs. The parasitoid - host ratio should be adjusted accordingly to 1:6 get effective parasitism. The parasitized eggs in the Tricho Card turn black in 3 or 4 days and the adult parasitoids emerge in 8 to 10 days from the date of parasitization. The parasitized eggs in which the parasitoids in the larval or pupal stage (i.e., before or after turning black) can be stored in the refrigerator (at 5^0C) for about 3 weeks without any loss in emergence. Trichocads have shelf life of 2-3 days.

Precautions to be taken during tricho card production

Poor quality of mass reared Trichogramma can result in control failures. The artificial conditions of mass rearing can select for genetic changes that reduce the effectiveness of the Trichogramma in the field. Suppliers also should assess the per cent host egg parasitization, adult emergence, and the sex ratio of emerged adults to be sure they are within acceptable standards. Standards for established cultures on Corcyra are 95±5 per cent egg parasitization, 90±5 per cent adult emergence, and a sex ratio of 1 to 1.5 females per male. Emergence data should be specified on cards for the guidance of users. Thrichocards should be stapled on the inner side of the leaf to avoid direct sun light

Delivery

Tricho cards are delivered for use in the field. The cards are assembled in aerated polythene bags and packed in paper cartons for transport. The cards have to be transported by the most rapid method of transport to reach the destination. During transport and holding the cartons should not be exposed to extreme conditions like toxic fumes, open sunlight, high temperature areas as the consignment could be damaged leading to mortality of the Trichogramma stages.

Field release

The parasitoids are released in the pharate stage or when few adults begin to emerge from the host egg during the morning or evening hours in windward direction and do not spray chemical pesticides before, during or after its use. The cards are cut into bits neatly along the grids with least damage to the eggs and stapled beneath the foliage in the upper canopy level. To maximize the field parasitization it is recommended to release the parasitoids is as many locations as possible. Recently scientists are beginning to advocate the release of cards @ 1/5m row length. Trichogramma is used to control shoot borer fruit borer, leaf folder insects of paddy maize, sugarcane, sunflower, cotton, pulses, fruits, vegetables and some spice crops. It can prevent 80-90% loss. Trichocard is applied in different crops 3-4 times at an interval of 10-15 days. The small pieces of cards should be tied in the field immidietely after the appearance of eggs of insect pests on lower surface of leaves or at the joints of leaf and stem. Use 5 cards/ha in normal crop.

Advantages

- Target specific and safe to other beneficial organisms.
- Cost effective and cost of management is very nominal.
- No harmful residues, environmental friendly.
- Field release is simple and easy as compared to other methods.

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HOW NUCLEAR RADIATION AND EXPLOSION AFFECT PLANTS ?

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Unlike the bombings of Hiroshima and Nagasaki, the Chernobyl accident - the world's worst nuclear disaster (according to the International Atomic Energy Agency) – resembled a strong "dirty bomb," with radioactive contamination as the principal fatality.

On the night of 25th April 1986, Chernobyl, which was home to millions of flora and fauna explodes, caused a large number of deaths converted a once-densely populated area into a ghost town, resulting in a population exclusion zone of 2,600 sq km (1,000 sq miles) in size. The radiation moves at the speed of the wind shortly after the reaction and reaches as far as Sweden. The explosion was caused in part by a fundamentally faulty reactor design combined with human negligence.

"Don't make the same mistake twice," the occurrence says. FUKUSHIMA, on the other hand, experienced similar events (Japan).

The nuclear plant disaster in Fukushima unleashed clouds of radiation that blanketed most of Japan's agricultural land. Crops became radioactive and dangerous to eat as a result of this. Irradiated soil produced irradiated plants or was rendered sterile. The radiation had an impact on almost 81,000 hectares of land. Unlike Chernobyl, where European soil absorbs radiation well, limiting the quantity absorbed by plants, Japanese soil is sandy, providing less radiation protection.

How plants are affected by Nuclear Explosions?

Radiation is harmful to plants like animals and humans. Plants can have long and short-term impacts when exposed to radiation, depending on the radiation particles. The following are a few of them:-

- DNA damage- defined as any damage to DNA molecules, including "inversion" of DNA sequences (TCAG to GACT) and "deletion" of parts of sequences.
- Growth reduction- defined as a decline in the rate of growth of organisms.
- Reproduction affects- including sterility, decreased reproduction rate, and the occurrence of developmental defects or decreased offspring viability.
- Seed germination is reduced.
- Mortality, which includes both immediate death and a drop in life expectancy over time.
- Exposed tissue is damaged by direct burns.

How Chernobyl explosion affected nearby plants?

Nuclear radiation has the potential to drastically alter a region's biodiversity. That is precisely what occurred. The radioactive particles were discharged during a time of year when natural growth is at its peak and reproductive organs are maturing, making flora and wildlife particularly vulnerable to radiation. A 4-5 square kilometer patch of pine trees near the power station was critically affected shortly after the reaction, absorbing a significant dosage of radiation from the accident. According to the nuclear power plant tragedy, the area is filled with radioactive material such as Iodine-131 and Cesium-137 due to the rust-red colouring of the withering trees that doesn't seem to be degrading, even 15 to 20 years after the meltdown.

For the next 5 to 7 years, trees in a larger 38 square km area (about 1.4 percent of the Exclusion Zone) produced few new seeds. Soil invertebrates were greatly reduced within a 3 to 7 km radius of the plant, but their numbers had mostly rebounded after 2-5 years.

According to the IAEA, decomposers-organisms that drive the decomposition process such as bacteria, fungi, and some types of insects have also been harmed by the pollution. These organisms are in charge of an important aspect of any ecosystem: Returning organic matter to the soil is a great way to help the environment.

How radiations affect soil?

The mineral and physical makeup of the soil, as well as its organic content, cation exchange capacity, and acidity, are the most critical factors that determine radionuclide migration. The migration of radionuclides into deeper soil layers, as well as a growing amount of dead vegetable biomass in the surface layer of the soil, determines their dispersion.

“Chernobyl-originated” 90Sr and 137Cs can be identified in peaty soils even at a depth of 20 cm. The vertical movement of 90Sr and 137Cs in the soil of various types of natural meadows has been gradual, and the majority of the radionuclides are still held in the upper layer of the soil (0-10 cm). In dry meadows, 90Sr and 137Cs migration rates are much slower than in wetlands. Radioactive migration occurs faster in peaty soils: the maximum radionuclide concentration was observed at a depth of 3–5 cm eight years after the disaster. In peat soils, 40–70% of the 90Sr and 137Cs is found in the 0–5 cm layer on average; in mineral soils, up to 90% of the 90Sr and 137Cs is found in this layer on average.

How soil is responsible for long-term effects on plants?

The available fraction of radionuclides in the soil for root uptake is determined by two parameters: the radionuclide content in the exchangeable form on the one hand and in mobile form on the other hand. The radioactive concentration in plants can be correlated with soil contamination per unit area using these criteria.

For example, in 1986, the greatest levels of contamination in soil were 370 MBq/m^2 (10 000 Ci/km^2) for 137Cs, 5 MBq/m^2 (135 Ci/km^2) for 90Sr and 0.1 MBq/m^2 (2.7 Ci/km^2) for Plutonium radionuclides.

Effect on reproduction and germination capacity

Nuclear radiation has a far larger effect on reproductive potential than ionizing radiation. Scientific research and analysis show a link between germination capacity of pine and fir tree seeds and consumed doses: seed quantity and size, germination power, and growth rate all decreased as absorbed doses increased, while the number of barren seeds increased accordingly.

Radiation sensitivity was shown to be high in reproductive organs. When 137Cs contamination of land is between 185 and 3700 kBq/m^2 (5–100 Ci/km^2), no substantial decline in fertility is detected, according to research. When 137Cs surpasses 18,500 kBq/m^2 (500 Ci/km^2), ordinary pine trees lose their capacity to reproduce for two to three years, and when 137Cs exceeds 18,500 kBq/m^2 (500 Ci/km^2), ordinary pine trees lose their ability to reproduce for two to three years.

The limbs of the pines that perished exhibited a brilliant reddish-brown colour about a year later, close to the first vegetation year following the reaction. Within the zone of complete coniferous forest, high ground desiccation, retarded growth processes, and damage to reproductive organs were seen in deciduous forests and scrublands, new grass growth, and the moss-lichen layer. . Five years after the accident, in the trees in plantations with a moderate cumulative dose (6–10 Gy), fertility had reached a normal level.

How it affects Coniferous Forest?

Coniferous forests are evergreen trees that grow in areas with long winters, such as the Northern Eurasian forest. The dominant trees in coniferous forests are pines, spruces, and firs. Near Chernobyl, the majority of the trees are pine trees with unusually high radiation sensitivity.

Small patches of deciduous forest were practically completely devastated in the area nearest to the reactor. Following the catastrophe downwind from the Chernobyl power plant, trees in an area of 5.8 km^2 absorbed doses of 80–100 Gy in the needles and over 20 Gy in the apical meristem, resulting in pine tree death.

From 1986 to 1987, in a 37.5 km^2 area where trees absorbed doses of 10–20 Gy in the apical meristem, 25–40% of the coniferous forest was wiped out; 90–95% of pine trees suffered from necrosis of buds and young sprouts, partial drying-out of their crowns to a near complete interruption of growth processes occured and radiation-induced morphological changes also happened.

Effects due to diseases

Helminthosporiosis (striated and reticular leaf spot), black spot, and stem (linear) rust are the most common diseases in cereals growing wild in the exclusion zone. Any changes that have arisen on wild Cruciferae can cause a considerable decline in the collection of seeds from farmed Cruciferae, especially cabbage, in situations when widespread rehabilitation is happening in the exclusion zone.T he study of various vegetable populations reveals that many plants appear to be resistant to the impacts of radiation in a variety of ways. Due to the activation of regeneration processes, the majority of representatives of the vegetative world found in the exclusion zone may survive.

Long-term phase

Because the soil is the principal reservoir of long-lived radionuclides deposited on terrestrial ecosystems, the interaction between radionuclides and diverse soil components has primarily dictated the radionuclide concentration in both plants and animals since 1987. This procedure regulates the bioavailability of radionuclides. Evergreen trees are particularly vulnerable to radiation, with coniferous forests suffering the most, but weeds are more resistant and will spread. Crops and the food chain are particularly vulnerable to radiation. Plants develop in a far more flexible manner since they are unable to move and must adapt to the conditions in which they find themselves. Rather than having a definite structure like an animal, the balance of chemical signals from other parts of the plant and surrounding plants, as well as light, temperature, water, and nutrient conditions, determine whether they produce deeper roots or a higher stem.

Recent Conditions

The radiological situation in the exclusion zone has stabilized in recent years, thanks to the decay of short and medium-lived radionuclides, reduced radionuclide migration from soil and water, primarily due to increased soil absorption and fixation, a decrease in radionuclide concentrations in soil and air particles, and a decrease in particle number dispersed by the wind.

Flora species that become extinct are replaced by species that are more adapted to the changing ecological conditions. Cereals, for example, have taken the role of dicotyledonous plants. In general, every ecological niche is filled, and the ecosystem reaches a new equilibrium level.

Conclusion

In light of the Chernobyl disaster's severity, the loss of life and property, and the cost borne by all until today. The existence of hazardous and harmful isotopes indicates that the land has been poisoned for at least 100 years.

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CANOPY DEVELOPMENT AND MANAGEMENT IN

RELATION TO GROWTH, FLOWERING, FRUITING AND FRUIT QUALITY IN STONE FRUITS

About the Author

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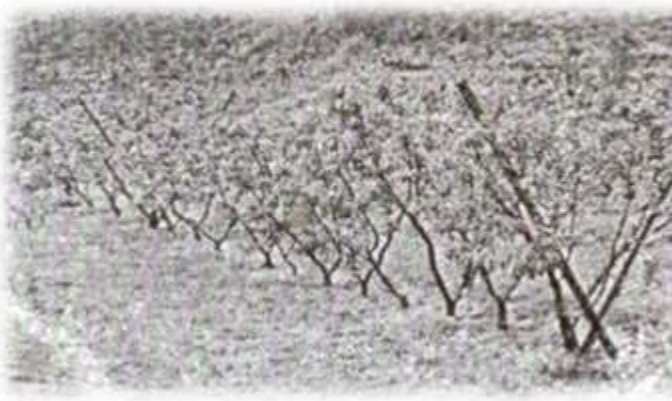
Canopy management is the manipulation of tree canopy to optimize the production of quality fruits. In deciduous fruit trees canopy management practices are done with objective to regulate the shape of tree and to enhance the production and quality of fruits. The training and pruning are the two important components in canopy management. It provides the strong frame works and particular shape to the tree with this sufficient sunlight can be intercepted for better tree and fruit development. Plants get proper aeration for better growth of fruits and fruit bearing parts. Training and pruning helps much in colour development of fruits. Incidence of insect, pest and diseases can be minimized with this practice. Quality of fruits in terms of fruit size TSS, flavour, maturity and shelf life is enhanced very much with this operation.

Canopy management of peach

- Peach(*Prunus persica* L. Batsch) is small to medium sized upright spreading, open topped branches, spreading upright growth habit amount of sunshine exposure is an important factor influencing flower bud initiation and fruit quality.
- **Training-** Open center system
- Where in other systems Open centre canopy has become very popular being very yield efficient. The centre leader is removed about IM above ground level and 3-5 well-spaced branches are retained both1 & 2 scaffold branches produce fruit bearing laterals.



- The other tree form v- shaped canopy or Tatura Trellis is becoming very popular in peach due to high yield efficient. In this tree forms two limbs of each tree are trained access the inter-row space at 60 angle from the horizontal forming a v- shaped canopy.

- The canopy is supported by permanent trellis. Secondary scaffold branches develop along with each primary limb form fruiting canopy.

In July Elberta peach, higher production of better quality fruit recorded in Tatura Trellis system of training.

Pruning

In July Elberta peach, pruning should be done to retain 40 fruiting shoots(600 node) per fully grown tree, Each headed back to 15 nodes for higher yield of better quality fruits. Where heavy pruning is required ¾ th heading back +40 percent thinning out should be done.

- In Australia different training systems were compared " Red Haven" peach and found that cumulative yield for six years was highest in palmette (149/t/hac) followed by Tatura Trellis(143/t/hac),lincon canopy(119/t/hac) central leader (109 t/hac) vase canopy (86 t/hac) however the colour development was most uniform in palmette .
- **Branch angle** - As angle to the horizontal increased b/w 15^0 and 90^0 the gradients were negative for flower density and fruit growth. The fruit weight and volume decreases lineary as the angle become more vertical. The flower density increased on shoots towards the tip and as the rod angle become more horizontal.
- In peach maximum fruit weight was obtained on training angle b/w 15^0 and 45^0(croch angle)

Canopy management of plum

- Two types of plum i.e. Japanese plum and its hybrid and European plums are grown in india.
- TRAINING:- Plum trees are mostly trained on open centre leader and modified centre canopy.
- In modified leader training the central leader dominate over the scaffold branches. Primary branches should be spaced 15 to 20 cm apart along the trunk. Secondary branches are to be selected during the 2nd, 3rd & 4th dormant seasons. At the end of 4 years growth and pruning 7-9 well spaced secondary branches are obtained which do not higher light penetration into the centre of tree and there by stimulate fruiting there.

Pruning

- In Santa Rosa plum, 25-30% thinning of 1-2 year old shoots plus 1/3 rd or ½ heading back of the remaining shoots .In old trees of Santa Rosa plum pruning involving removal of secondary scaffold branches be practiced to ensure adequate growth and higher yield.
- High density planting is being advocated in plum to accommodate large number of trees per unit area .Yield increase up to 168% by reducing the planting spacing to 6.2 m and training trees on Tatura Trellis .In plum St. Julian k is a tree dwarfing rootstock has been developed at the east malling research station. Pershore for semi-dwarf plum trees. These clonal rootstocks are high time helpful in order to keep the trees canopy in control and efficient exploitation of solar radiation.

Canopy management of apricot

- Various training system such as modified leader vase-palmette, kechement hedge and werder hedge systems are adopted training of apricot plants.
- PRUNING:- The apricot bears on spurs and laterally on one year old shoots. In New Castle apricot 25-30% thinning of shoots plus 1/3 heading back should be done for better fruit quality.

Canopy management of cherries

Pruning after one year of planting the central leader is retained and all other upright branches removed by cutting close to the trunk only 3-5 wide angled framework branches 20-25 cm apart and spirally around the tree are retained .The lowest scaffold branches may be kept 40-50cm above ground. Scaffold should be headed back only when they grow very long and willow and when it is desirable to have secondary shoots. When the trees grows larger the leader is cut back to an outward growing branch. In sweet cherry fruit is borne laterally on spur which arise on one year old shoots. The spurs grow less than 2.5cm in a year with a terminal leaf bud .In sour cherry annual shoot growth should average 10-20 cm long in fully grown bearing trees for maintenance of yield. Fruit buds of sour cherry are produce laterally on one year old terminal growth.

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Carbon Sequestration

A way to sustainability and future prospects

About the Author

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With passing decades, climate change has become a prevailing concern for world due to human activities. Carbon sequestration, an emerging technique, requires more consideration in the developing countries, where agriculture has a critical role in development of the people. With the increasing population, less per capita availability of natural resources and drastically declining environmental conditions, the concept of sustainability is the foremost belief. Soil contribution in carbon sequestration is mostencouraging and can be practiced by selecting certain agronomic and nutrient management practices.

Introduction

Although, the agriculture sector has accomplished the needs of the growing human population, this sector has to adopt 'sustainability', which clearly describes the satisfaction of human needs without depleting the natural resources for future generations and protecting the environment. Climate change due to a substantial increase in the atmospheric CO_2 causing an increase in temperature, variation in rainfall, and reduction in natural resources, has a deeper impact on agricultural productionand certainly food safety and security. In developing countries, there is a threat of land degradation and soil erosion. Land degradation by human activities is estimated at approximately 30%. Carbon sequestration and sustainable development have a direct relation to climate change adaptation and mitigation strategy. Therefore, there is a need to improve soil organic carbon (SOC) stock to create an impression towards mitigation and adaptation strategy on climate change, land restoration, improving the environment and accelerating food safety and security.

Reasons for climate change

GHG emissions take place by both natural and anthropogenic activities. Natural emission is through forest fires, volcanic eruptions, wetlands, and permafrost. Whereas the concentration of atmospheric GHG by anthropogenic activities, which accounts for 55.45% of total, has increased to an extreme level since the industrial revolution and green revolution by fossil fuel combustion, deforestation, cement manufacturing along with accessory agricultural activities like ploughing/tilling, fertilizers and manure manufacturing and application, and livestock which accounts for approximately 1/3rd of total GHG emissions. According to the global carbon project (GCP), the global annual GHG emission range is approximately 54.33 GT or 75.50 GT CO_2 equivalents.

N_2O emissions by application of synthetic and organic fertilizers, leaching of soil, N_2 fixing crops, B. CH_4 emission by the digestive processes of ruminants, enteric fermentation and traditional rice cultivation and C. Burning of crop residue, liming and urea application produces CO_2, CH_4, and NO_2.

Due to the emission of certain GHGs, global warming is peaking, resulting in an increase in temperature, erratic weather change, melting of glaciers and polar ice caps, rising sea level, heat waves, droughts and changing ecosystems.

Need for carbon sequestration

Carbon sequestration is a process of capturing atmospheric carbon and storing it in the form of a plant, plant biomass, and soil organic matter. It can occurthrough natural as well as anthropogenic activities and has a crucial role in climate change management which is the result of increasing GHGs in the atmosphere and in turn, increasing terrestrial temperatures.

According to the IPCC report (2019) global (land and ocean) mean surface temperature has increased by 0.87 C. In the year 2020, it has been reported that the contribution of GHGs by energy use is 73.2%, followed by agriculture; forestry and land use (18.4%). Among, all the greenhouse gases, (CH_4, CO_2, N_2O, CFCs, etc.) CO_2 is the fastest growing. On the other hand, land degradation, which is a driver of climate change through the emission of greenhouse gases and reduction of carbon uptake, can be avoided and reversed by adopting rehabilitation activities like conservation agriculture, reduced tillage, and biochar, etc.

Global contribution of GHG emission

GHG	Contribution %	Global warming potential
A. CO_2	76%	1
B. CH_4	16%	28-36
C. NO_2	6%	265-298
D. Fluorinated gas	2%	1000-10000

Importance of carbon sequestration

Climate change mitigation can be dealt with by adopting agricultural practices which help in carbon sequestration and storage and thus, providing a relationship between agriculture, carbon sequestration, and climate change. Land use, land-use change, and forestry (LULUCF) help reduce the emissions and have the maximum potential to withdraw carbon from the atmosphere and store it.

Carbon in the soil is influenced by dead and decaying plants and animals, carbon removed by decomposition of organic matter, respiration, and several other direct and indirect natural and anthropogenic practices. In India, CO_2 accounts for 7% of total global GHG emission and agriculture and livestock contribute 18% of the gross national emission. Agricultural techniques and practices help maintain soil organic carbon or soil organic matter, enhance soil biodiversity and reduce soil nutrients loss, decrease soil erosion, influence soil porosity, increase soil fertility, and sustainable food production. Moreover, much of the carbon from the atmosphere is taken up by the soil thus reducing the load of CO2 and maintaining the atmospheric temperature. Globally, agricultural soils are estimated to potentially sequester 0.4–0.8 Pg C/yr by undertaking recommended management practices on croplands, 0.01–0.03 Pg C/yr on irrigated soils, and 0.01–0.3 Pg C/yr on grasslands.

Agriculture techniques for carbon sequestration

Soil carbon management: Soil organic carbon (SOC) is an integral part of soil organic matter (SOM) is considered an elixir for terrestrial life. It is crucial to maintain SOM to the threshold level for all related processes and practices. SOM is restored by undertaking soil-specific best management practices (BMP) and land use. Appropriate land use is beneficial to maintain the 'C' threshold level and ecosystem services.

Some technical and managerial methods to enhance SOC which assist in climate resilience agriculture:

A. Residue management: Includes biomass left after crop harvesting in the field, mulching, animal by-product, cover cropping, and crop rotation with legume crops.
B. Soil management: Improving fertility and health of the soil by enhancing soil structure, porosity, and biodiversity.
C. Nutrient management: Emphasizing on the judicious use of organic as well asinorganic sources of manure and fertilizers, biofertilizers and micronutrients.
D. Soil biodiversity management: Comprises of soil flora and fauna, species diversity and improving microbial carbon biomass.

Technological options for improving SOM are no-till farming, manuring, aerobic rice cultivation, organic amendment and integrated nutrient management. SSNM (soil-specific nutrient management) is one of the promising technologies formitigation of climate change. Site-specific application of nutrients is helpful in decreasing GHG emissions from the soil and also aids in high productivity under high CO_2 level.

Agronomic and Nutrient Management approach for carbon sequestration

- **Conservation agriculture (CA)**: A resource conservation technology for crop production by enhancing biological and natural processes. Globally, CA is practiced on about 125mha and in India; it is still below, covering in an area 1.5 mha. The three main principles under conservation agriculture, crucial for carbon sequestration: minimum soil disturbance or reduced tillage, surface crop residue management, and cyclic crop rotation. Minimum tillage and zero tillage practices keep more crop residue on the soil surface and have more SOC concentration, improve soil structure, increase porosity and lower bulk density. Contrary to reduced tillage, conventional tillage depletes SOC stock by more decomposition and mineralization of organic matter. Crop rotation with leguminous cover crops augments in rich biodiversity and soil carbon pool. Unlike temperate and sub-tropical regions, tropical regions require the adoption of best management practices, like conservation agriculture which is helpful to sequester more carbon in high rainfall and high-temperature regions.
- **Crop residue management**: Crop residue is a detached vegetative part of the plant that is intentionally left in the field after crop harvest. The annual production of crop residue in India is about 500 milliontonnes and if 15% of this crop residue is applied in the soil, it increases C concentration of soil, hence, carbon sequestration. The application of crop residue in the soil and its gradual decomposition provide sufficient SOM that enhances soil biodiversity and overall soil quality. Organic mulch, which covers the surface of the soil, plays a key role in supplying nutrients, C and N cycle and sink of carbon, thus, significantly increasing SOM and carbon sequestration in the top layer of 0-5 cm.

Effect of CA practices influencing on carbon sequestration (Mg /ha) under rice based cropping system from 2010-11 to 2012-13:

Treatments	Carbon sequestration

Reduced tillage	13.6
Conventional tillage	12.9
Mulching	13.5
Rice-wheat cropping system	13
Rice-veg pea- greengram	13.8

Potential carbon sequestration potential by different crop residue:

Crop residue	Yield(t/ha)	Soc sequestration(kg C /ha)
Barley	2.44	247
Rice	3.96	401
Wheat	2.69	272
Sugarcane	65.3	1101
Potatoes	16	270

- **Nutrient management**: A combination of both organic and inorganic forms of fertilization in a balanced form must accomplish high productivity along with SOC sequestration to address climate change. In a long-term experiment with a variable combination of fertilization practices in the crop field, it is seen that high SOC sequestration was recorded for balanced organic fertilizer. Accordingly, continuous use of fertilizer is necessary for sustainable soil fertility and productivity of crops. Pulses/legumes as a component of crop diversification have N_2 fixing ability, leaf falling, deep root system and root exudation results in elevating SOC content in the soil (greater in the surface and then declining). Animal manure and compost application in the numerous types of cropping system of rice-wheat, maize- wheat proved to be a good practice of SOC gain.

- **Biochar**: A Carbon- rich, porous, fine-grained product produced through pyrolysis under oxygen deficiency at a temperature between 380-1000℃. When applied to the soil, has a variety of benefits to an ecosystem by improving soil fertility and build up carbon. Biochar carbon acts as C negative process i.e., it captures more CO_2 from the atmosphere and thus, enables long-term carbon sequestration and annually stores up to 0.55 Pg CO_2.

  According to different estimates, 72-127 Mt of crop residues are burnt on-farm in India.The Indo-Gangetic plains (R-W cropping system), generate much crop residue and the burning of this crop residue contains a large amount of GHGs like NO_2 and CH_4, having much more global warming potential (GWP) than CO_2. Biochar is an alternative solution that captures much CO_2 from the atmosphere when added to the soil. It reduces methane and NO_2 emissions through soil microbial degradation process as it is comprised of recalcitrant C, resistant to microbial decomposition. Biochar can be used for improving water quality, maintain CEC, low irrigation and fertilizer requirement and enhancing microbial activities.

- **Agroforestry**: A combination of land-use systems and technologies that include deliberate use of woody perennials on the same land management unit along with crops and animals in the same spatial and temporal sequence to sustain and diversify production. This system is believed to sequester more C than an only pasture of field cropland. It is considered as a win-win strategy for Carbon sequestration by counteracting anthropogenic emissions, improving the environment, soil quality, agriculture

productivity, and advancing food security. Carbon sequestration in agroforestry can be estimated above and below ground plant part. Above carbon sequestration is the total biomass of plant matter and it depends upon site selection, species, and its age and management practices. Below ground plays an important role which contributes to soil C depending on the land-use system. According to studies, C stores through agroforestry system in soil ranges from 30- 300 Mg C/ha up to 1m depth.

Reported potential carbon sequestration (Mg C/ha/year)

Location	Agroforestry system	Tree species	Soil carbon potential (Mg C /ha/ year)
1. Uttarakhand	Agrisilviculture	*Dendrocalamus hamiltonii*	15.91
2. Chandigarh	Agrisilviculture	*Leucanea leucocephala*	10.48
3. Hyderabad	Silviculture	*L. leucocephala*	10.32
4. Punjab	Agrisilviculture	*P. deltoids*	9.4
5. Haryana	Silviculture	*A. nilotica*	2.81

Conclusion

CO_2 is increasing at the rate of 2.31ppm annually, resulting in global warming, and carbon sequestration seems to be a cost-effective strategy to mitigate it.Sustainable agriculture is advancing and becoming essential for humankind's survival. Agricultural Land use management with proper techniques sequester SOC which retains up to 30-50 years in the soil. Adoption of different agronomic and nutrient management techniques that include conservation agriculture, integrated nutrient management, crop residue management, biochar, and agroforestry are helpful in carbon sequestration.

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ROLE OF TISSUE CULTURE FOR PRODUCTION OF DISEASE-FREE PLANTING MATERIAL

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Plant tissue culture is a technique of growing plant cells, tissues, organs, seeds or other plant parts in a sterile environment on a nutrient medium. Used to eliminate virus from infected germplasm as rapidly growing meristem of plants are usually free of viruses, or have much lower concentration. Commonly used in cassava, potato, sweet potato and ornamental plants.

Tissue culture had its origins at the beginning of the 20th century with the work of Gottleib Haberlandt (plants) and Alexis Carrel (animals). In 1952, Morel and Martin applied tissue culture techniques for elimination of viral infection in Dahlia. In 1962, Baker and Phillips, successfully eliminated the fungus *Fusarium roseum* f.sp. *Ceraialis* from carnation plants using meristem cultures. In 1965, Tramier obtained gladioli plants from meristem-tip cultures which were free from *Fusarium oxysporium* f. sp. *gladioli*.

Production of Virus Free Planting Materials

Meristem tip culture is generally employed in case where the aim is to produce disease-free plant,size of the explant is critical for virus elimination and various reasons attributed to the escape of the meristem by virus infection.

1. Viruses move readily in the plant body through the vascular system, which is absent in meristem.
2. A high metabolic activity in the actively dividing meristem cells does not allow virus replication.
3. A high endogenous auxin level in shoot apices may inhibit virus multiplication.
4. The virus inactivating system in the plant body, has higher activity in the meristem than in any other region (Hollings, 1965).

Steps Involved in Tissue Culture Techniques

1. Selection of plant. **2.** Isolation of explant. **3.** Sterilization of explant. **4.** Inoculation of explant. **5.** Incubation. **6.** Initiation of callus. **6.** Sub-culturing. **7.** Regeneration. **8.** Hardening.

Culture Indexing

1. Remove top cuttings (5-8 cm long) from the mother plant and number them. Excise the bottom 2 cm portion of each cutting with sterile knife in the laminar airflow blood. Surface sterilize for 10 min in a commercial bleach solution.
2. Wash the disinfected-cutting portions with sterile distilled water three times, slice each cutting portion aseptically into thin (2mm) sections.

3. Transfer sections onto a test tube containing sterile nutrient broth and incubated at 23°-25°C (ambient temperature) for 10-14 days; presence of bacterial or fungal pathogen is confirmed in case the nutrient broth turns cloudy.
4. Discard original numbered cuttings as well as the mother plant from which sections retest the tested pathogen-positive; retain only those cuttings (with mother plants), sections of which yielded no micro-organisms in the nutrient broth.
5. Grow all cuttings that tested pathogen (bacteria or fungi) free in the incubation greenhouse and after 3-4 months retest the plants obtained for detection of pathogens, following step 1-5, to ensure negative pathogenicity.
6. At least 3-4 culture indexing should be done in a year to confirm that plants are pathogen-free.

Production and Productivity of Tissue Culture Disease Free Planting Material in Different Crops

Sweet Potato:

a. Fuglie *et al*, concluded that the rapid diffusion of virus free sweet potato planting material in Shandong province of china, reaching 80% of the province`s small growers within the only four years, can be explained by several factors.
b. Most importantly, users of the new roots showed yield increment by 10 t/ha, or 30%. Further the technical package was simple and required only one small change in the farmers' production system.

Potato:

a. The production of potato seed under conventional system has not been effective in avoiding or reducing the buildup of pathogens and has consequently led to reduced quality potato seed and low crop yields.
b. Plants once cleaned through meristem culture and induction of tuberization under aeroponics system, produce high quality potato seed tubers rapidly that are free from contamination of pathogens.
c. Further multiplication of potato seed tubers under aeroponics also compliments tissue culture (micro propagation), as it clones mini tubers in a short time and reduces numerous labor steps associated with direct use of plantlets from tissue culture into the field in the post flask stage.

Musa Species:

a. To date, five viruses infecting Musa spp. have been reported ABMV, BBMV, BBTV, CMV and BSV. These viruses can be transmitted in vegetative planting material.
b. Successful control of virus diseases should begin with virus free planting materials. The solution is to develop cheap, efficient production of "clean" planting material through tissue culture.
c. Since the tissue culture program began in 1983, a total of 26 million banana plantlets have been produced for commercial planting in Taiwan.
d. This way, the farmers can now be able to replace their degraded orchards with superior material which is early maturing 12-16 months compared to the conventional banana of 2-3 years, bigger bunch weights of more than 30 kg and a higher annual yield per same unit of land, 40-60 t/ha have been observed.

Citrus:

a. Most of the citrus growing regions are experiencing decline in the population due to different reasons. This is mainly attributed to the different viruses which are spreading through planting of infected planting material.
b. Viruses like Tristeza, Posorosis and Xyloporosis, and Greening bacterium are causing decline in citrus and the need is felt to revive citrus plantations on sound footing with appropriate biotechnological interventions.

c. Meristem culture and shoot tip grafting have been trend in different citrus varieties and have become an important regulation in different citrus growing countries.

d. It is suggested that the desired scion varieties may be first made virus free using meristem culture, tested for virus detection using different serological techniques followed by shoot tip grafting (STG) to raise healthy specific-virus-tested (SVT) clones.

e. The mother plants regenerated so be then maintained in net-house containment and then multiplied on the desired rootstocks using micro-budding method.

Conclusion

The plant tissue culture technology has been greatly contributed to producing disease free planting materials of vegetative propagated crops in horticulture industry of many countries. Usage of tissue culture generated plants has increased productivity per unit area, particularly in horticultural crops but capacity is insufficient to fulfill the high demand for the plantlets. The technology has created several employment opportunities and opened up many entrepreneurial fields. Tissue culture has been one of the main technological tools and reasons that have contributed a lot to feed 7 billion people in the globe.

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CLIMATE CHANGE
AFFECTING DISEASE EPIDEMIOLOGY

About the Author

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Changes in human populations, geographical conditions, land use patterns, agricultural practices, habitat, and climate are the main drivers for the emergence or re-emergence of a disease agent (Reiter, 2004). Climate change has nowadays been a critical topic of discussion in the global scenario. It has posed to be a global risk various ecosystems. Climate change is modifying the environment which supports life and thereby this altered climate is causing a major effect in the temporo-spatial patterns of the living beings on earth. This change to a major extent is because of the different human activities like extensive urbanization leading to the decrease in the forest cover, increased automobile fumes causing, release of hazardous gases in the environment, all of which has contributed to the conditions like green-house effect and global warming. All this has an excessive impact on the health status of the living organisms and emergence of disease pathogens and changes in the spatial patterns of the disease causing a huge work load for the epidemiologists.

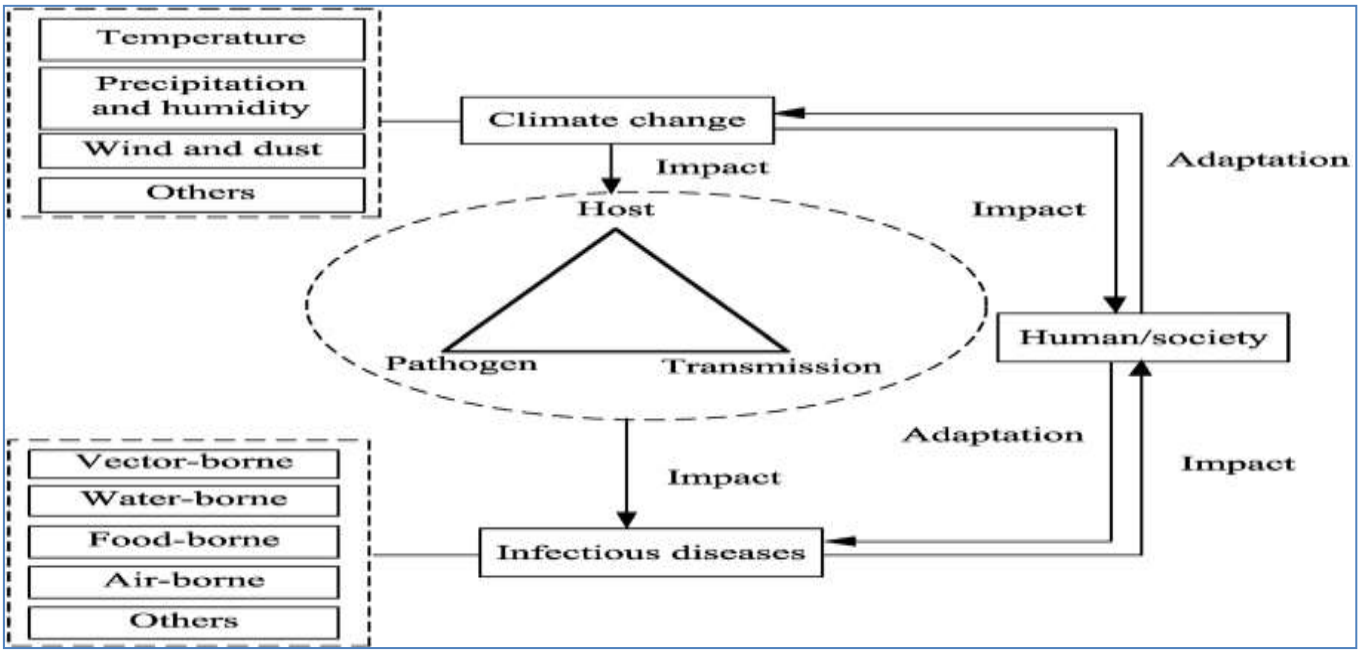
Climate change

Climate change refers to the shifts in the weather conditions over a long period of time and the occurrence of the extreme weather conditions like drought, flood, etc. As stated by the European Environment Agency (EEA, 2008), there is an increase of 0.74 °C in the global average surface temperature in the 20th century, the global sea level has been observed to be rising at the rate of 1.8 mm per year since 1961, and the Arctic sea ice has been shrinking by 2.7% per decade. The mountain glaciers are contracting, ocean water is becoming more acidic, and extreme weather events occur more often. The Intergovernmental Panel on Climate Change (IPCC) predicted an average temperature rise of 1.5–5.8 °C globally during the 21st century, along with increased extreme and anomalous weather events including heat-waves, floods and droughts (IPCC, 2001). Global warming has accelerated over the last hundred years with an average gain of 0.74◦C in 100years. Climate change refers to the change in temperature, precipitation and humidity, wind and dust, etc.

Impact of climate change on disease epidemiology

The changes in the various climatic variables such as temperature, precipitation, wind and sunshine may greatly influence the survival, reproduction, or distribution of disease pathogens and hosts, as well as the availability and means of their transmission environment. The effects on the health of such impacts tend to be expressed as shifts in the geographic and seasonal patterns of the different infectious diseases including

vector borne, water-borne, air-borne and food-borne diseases and as changes in their frequency and severity of the outbreak of the disease.



Link among climate change, infectious diseases and the society

These climatic changes may cause the change in the epidemiology of the vector-borne diseases in several ways:

- Spread of vectors and vector-borne pathogens towards the poles as climate warms in temperate zones and becomes more suitable for these species. This process may also be accompanied by poleward contraction of the most equatorial limits of these species if temperatures become too hot for them.
- Greater likelihood of establishment of tropical and subtropical vector-borne diseases into currently temperate regions due to firstly, rising temperatures in the receiving location, increasing vector and vector-borne pathogen survival; secondly, increase in the amount of vectors and vector-borne pathogens in tropical and subtropical source locations; and thirdly increase in rates of entry of tropical and subtropical vector-borne pathogens due to increased climate change-related human migration.
- Re-emergence of endemic vector-borne diseases associated with increasing temperatures and weather and climate variability.
- Emergence of novel genotypes of vector-borne pathogens as a result of changes due to climate change to animal host and vector dynamics. Warmer temperatures leading to warmer water and flooding might increase exposure to diseases in drinking and recreational water. Warm weather conditions may lead to the increase in air pollution and the pollen seasons leading to more allergies and respiratory affections. Vector-borne diseases such as dengue, malaria may increase due to increase in the humidity and heat. Moreover, hunger and famine may increase as food production may be destabilized by drought.

Effect of climate change on disease pathogens

The climate change can affect the pathogens directly by influencing the survival, reproduction, and life cycle of pathogens, or indirectly, by influencing the habitat, environment, or competitors of pathogens. It is observed that the rising temperature tends to influence the multiplicity and the extrinsic incubation period (EIP) of the disease agent. For example, the EIP for P. falciparum reduces from 26 days at 20 °C to 13 days at 25 °C. It is also seen that the malarial parasite do not multiply at a temperature more than 33°C-39°C. Changes in the rainfall pattern may cause a shift in the existence of the pathogens thereby having an important role in the epidemiology of water-borne diseases.

Climate Change and Pathogens

1. **Direct**: through influencing the survival, reproduction and life cycle of pathogens, or
2. **Indirect**: through influencing the habitat, environment, or competitors of pathogens

I. **Effects due to altered precipitation**: Rainy season is related to the increase of fecal pathogens as heavy rain may stir up sediments in water, leading to the accumulation of fecal microorganisms. Unusual precipitation after a long drought cause an increase of pathogens, causing a disease outbreak. Droughts/low rainfall lead to low-river flows, causing the concentration of effluent water-borne pathogens.

II. **Climate change and vectors/hosts**: Climate change may cause changes in range, period, and intensity of infectious diseases through its impacts on disease vectors. Temperature affects the spatial–temporal distribution of disease vectors. Larval development of some mosquito vectors accelerates with increased rain and rising temperature. Droughts - limit the breeding sites for mosquitoes - resulting in reduction in vector population and disease transmission. Heavy rains sweep away the breeding sites. The vector densities are expected to be their greatest at 30-32°C.

III. **Climate change and disease transmission**: Temperature or rainfall change, may alter the transmission of diseases. Pathogens can spread from endemic regions to other regions through interregional dust storms e.g. Influenza virus. Climate variation plays an important role in shaping the patterns of host activities and behaviors, such as seasonal occupation, migration, winter–summer lifestyles, and physical exercises. Climate change may lead to ecosystem degradation- which will possibly bring pressure on agricultural productivity, causing issues such as crop failure, malnutrition, starvation, increased population displacement, and resource conflict which may contribute to increased susceptibility to diseases.

IV. **Extreme weather conditions and disease epidemiology**: They include global scale extreme events e.g. El Nino, La Nina, and Quasi-Biennial Oscillation (QBO) and regional or local scale meteorological hazards e.g., drought, heat waves, flood.

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CLIMATE CHANGE

IMPACT ON AGRICULTURE AND PREVENTIVE MEASURE

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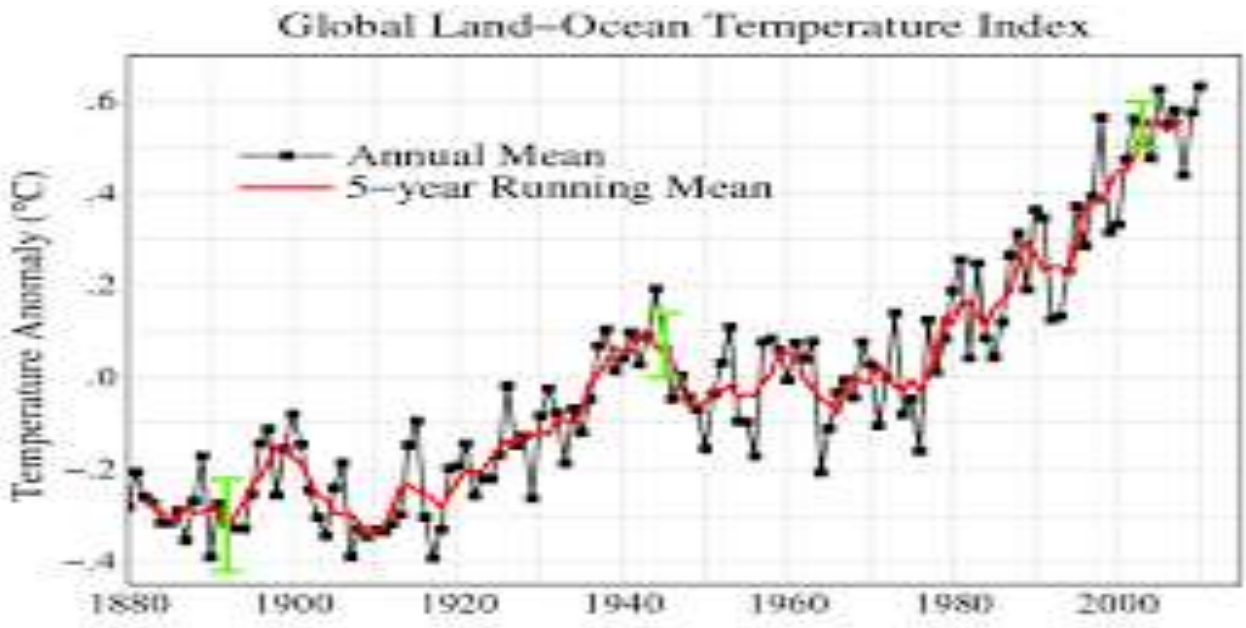
Today there will be hardly anyone in this world who has not been affected by climate change. Climate change has the potential to hurt everyone, but farmers are the most vulnerable and most affected by it. Agriculture in India is mainly based on weather and it is greatly affected by the seasonal changes caused by climate change. Agriculture is affected by the increase in temperature due to climate change, so it is important that farmers should know how to deal with this problem.

The demand for food grains is increasing continuously with the increase in the global population, the global demand for food is also increasing. The amount of protein in the diet of people living in developed countries is high. The Food and Agriculture Organization (FAO) estimates that global agricultural production will need to double by 2050 to bridge the gap between food supply and demand.



This index analyzes the quantitative impact of extreme weather events (hurricanes, floods, extreme heat, etc.) in terms of deaths and economic losses accounts of these effects in full as well as in accompanying terms and conditions. Bangladesh, Pakistan and Nepal have been placed above India in this index due to

adjustment of population. The CRI also looks at the loss per unit of GDP of each country to assess the economic impact. This year's index reaffirms earlier results from the Climate Risk Index that less developed countries are generally more affected by extreme weather events than industrialized countries.

The index report suggested that the Katowice Climate Summit should adopt a 'rulebook' necessary for the implementation of the Paris Agreement, including global adaptation targets and adaptation communication guidelines.

- There are 120 million hectares of land in India, which is suffering from some kind of degradation. Small and marginal farmers are most affected by this. According to one estimate, they may face 24 to 58% reduction in household income and 12 to 33% increase in household poverty due to severe drought.
- 67% of India's total agricultural land is dependent on the monsoon and other seasons. Agriculture's extreme dependence on weather results in higher costs for crops, especially coarse cereals, which are mostly cultivated in areas that are dependent on rainfall.
- The forecast of a 70% fall in summer (monsoon) rainfall by 2050 could spoil the health of Indian agriculture.
- It is estimated that the average temperature during the Kharif crop season may increase by 0.7 to 3.3 °C in the coming 80 years. Along with this, rainfall will also be affected more or less, due to which there may be a fall in the yield of wheat by 22% and the production of paddy may be reduced by 15% during the Rabi season.

Solution

- There is a need to promote conservation farming and dryland agriculture. Along with this, each village will get weather based early warning about crop pests and epidemics in different seasons along with timely rainfall forecast, district and block level agricultural weather advisory under Gramin Krishi Mausam Sewa, District Agricultural Weather Unit and Agromet Field. Issued by the unit every Tuesday and Friday. To achieve this, farmers can save crops, fruits, vegetables and animals from the damage caused by the weather by getting them regularly through the Bhai Meghdoot app.
- There is a need to re-focus on dry land research under agricultural research programmes. Under this, such seeds are encouraged. Which can reduce crop production risk by 50% in drought-like conditions.
- Consideration should be given to some modifications in the planting time of wheat crop. According to an estimate, by doing this the damage caused by climate change can be reduced by 60-75%.
- There is a need to increase the amount of crop insurance coverage and loans given to farmers. This scheme should be expanded to provide insurance coverage to all crops.

Along with promoting genuine compensatory afforestation, it needs to be closely monitored, as it is very important to conserve forest resources to reduce the effects of climate change. For this, the structure of the Indian Forest Service can be changed and it can be given powers like the police and the army, especially in the field of environment, this can be done easily. For this specialization in wildlife, tourism should be encouraged along with the best system of their training. Calling of officers on deputation from other services should be banned; it is inevitable to do so to make it a special service.

- More attention should be paid to the Wildlife Heritage Towns. Simultaneously, cities like Sawai Madhopur, Bharatpur, Chikmagalur and Jabalpur etc. located close to national parks and sanctuaries can be converted into green smart cities with advanced waste recycling processes.
- The way Van Dhan Yojana has been adopted by the state government in Rajasthan, it can be adopted as a green mission to save non-protected (outside existing national parks and sanctuaries) forests.
- Wildlife tourism should also be encouraged under public-private partnership. This will help in increasing the protected areas by distinguishing backward districts.
- The impact of climate change will affect the food security of India and it will also reduce the supply of fodder for our livestock.
- Prudential investment and policy reforms can help make India resilient to climate change.

Climate smart agriculture

Concrete initiatives have been taken to develop Climate Smart Agriculture (CSA) in the country and for this a national level project has also been implemented. It is an integrated approach, which provides for the management of crop land, livestock, forest and fisheries. This project is designed to meet the mutual challenges of food security and climate change.

Targeted at three outcomes

- **Increase in Productivity**: Increased production of food grains to improve food and nutritional security and increase the income of 75 percent of the world's poor who live in rural areas and mainly depend on agriculture for their livelihood.
- **Increased Resilience**: Improves adaptability to long-term hazards such as short duration climates and uncertain weather patterns, while reducing vulnerability to drought, crop pests, disease and any other hazards.
- **Low Emissions**: Less emissions for each calorie of food produced, no deforestation for agriculture, and identifying ways of absorbing carbon from the atmosphere. Climate smart agriculture involves adaptation, mitigation and other practices that enhance managerial capacity to respond to various climate-related difficulties by resisting climate change problems and re-adapting quickly.

Zero tillage technology and laser ground leveling

The technical efficiency is found to be higher in case of zero tillage and laser land leveling as compared to conventional farming. Laser ground leveling and zero tillage technology has been found to be more sustainable than conventional tillage. It has been observed that if the farmer adopts climate smart farming technologies, the expected income will increase with the reduction in his risk level. But despite the many direct and indirect benefits derived from climate smart farming technologies, it is yet to become popular in India.

Climate justice will be needed for any kind of transformation of the ongoing climate change, which includes policy reforms and which can help in making India resilient to climate change. This work can be accomplished by expanding joint research and development partnerships connecting India's emerging smart cities with green cities in the West. For example, the US and China have jointly established the Clean Energy Research Center.

Report of the European Commission Joint Research Center

Food production is not increasing at the rate at which the world's population is increasing. Along with this, the fertility of agricultural land is also decreasing. According to the data of the World Atlas of Desertification, a report by the Joint Research Center of the European Commission, there may be a food shortage worldwide in the coming two-three decades. The situation will be most severe in India, China and sub-Saharan African countries.

According to the report, pollution, soil erosion and drought due to climate change have reduced the quality of three-fourths of the earth's land area. If the quality of land continues to decline like this, it will lead to loss of agricultural yield and by 2050, global grain production could be significantly reduced.

The world's population will grow to about nine billion in 2050, and this will require twice the current food production. Agricultural countries like India will have to take new measures for this from now on. Along with this, its population will also have to be controlled.

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TRICHODERMA: A POTENTIAL ANTAGONISTIC FUNGI FOR SUSTAINABLE AGRICULTURE

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Trichoderma is a genus of free living fungi that are very common in soil and root ecosystems, where they are the most prevalent culturable fungi. *Trichoderma* spp. are frequently isolated from forest or agricultural soils and from wood. There are around 90 species in the *Trichoderma* genus. Typically, the fungus has an optimal growth range of 25–30 °C, and it will not grow at higher temperatures. The most suitable types of culture media for its cultivation are cornmeal dextrose agar, in which the colonies appear as transparent; and potato dextrose agar, in which the colonies appear white. A yellow pigment may be secreted into the agar. They also may be formed within hyphal cells. They are highly interactive in soil, root, soil and foliar environments and produce/release a variety of compounds that induce resistance in plants. The strains of *Trichoderma harzianum*, *Trichoderma viridae* and *Trichoderma hamatum* have long been recognized as useful biocontrol agents for the control of plant disease and for the ability to enhance the development of root growth, uptake and use of essential nutrients, resistance to biotic and abiotic stresses. The distribution of several phytopathogenic fungi, such as *Phythium*, *Phytophthora*, *Botrytis*, *Rhizoctonia* and *Fusarium*, has spread during the last few years due to changes introduced in farming, with detrimental effects on crops of economic importance. *Trichoderma* serves as the root shield against harmful fungus such as *Fusarium*, *Phythium*, *Botrytis*, *Rhizoctonia*, *Fusarium* and *Phytopththora*. Being environmental friendly and cost effective, they are compatible with agro chemicals and also reduce the cost of fungicides. The use of *Trichoderma* as bioagents is a less hazardous method for controlling plants pathogens. Almost 20 species of the genus *Trichoderma* like *Trichoderma harzianum*, *Trichoderma koningii*, *Trichoderma viride*, *Trichoderma atroviride*, *Trichoderma pseudokoningii*, *Trichoderma longibrachiatum*, *Trichoderma hamatum*, *Trichoderma polysporum* and *Trichoderma reesei* are the most important species, which act as potential antagonists against many soil-borne as well as foliar plant pathogens. Antagonism of *Trichoderma* against different fungal plant pathogens has been reported several times. Antagonists of phytopathogenic fungi have been used to control plant diseases, and 90% of such applications have been carried out with different isolates of the fungus *Trichoderma*. The most common BCAs of the *Trichoderma* genus are strains of *T. virens*, *T. viride* and, above all, *T. harzianum*, which is a species aggregate that includes different strains used as BCAs of

phytopathogenic fungi. The success of *Trichoderma* strains as BCAs is due to their high reproductive capacity, ability to survive under very unfavorable conditions, efficiency in the utilization of nutrients, capacity to modify the rhizosphere, strong aggressiveness against phytopathogenic fungi, and efficiency in promoting plant growth and defense mechanisms. These properties have made *Trichoderma* a ubiquitous genus present in any habitat and at high population densities. *Trichoderma* BCAs control ascomycetous, deuteromycetous and basidiomycetous fungi, which are mainly soil-borne. *Trichoderma* is more efficient in acidic than alkaline soils.

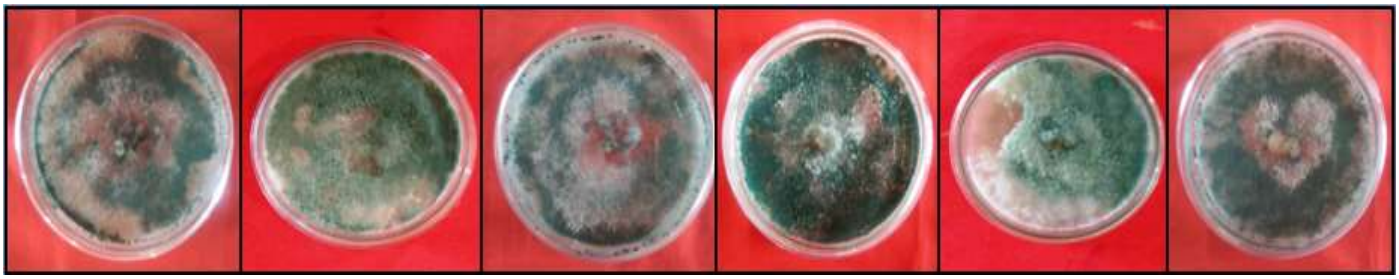

Fig. No. 01 - *Trichoderma* isolates

Methods of Application

Seed treatment

Trichoderma powder/formulations used for seed treatment/bio-priming, 10 gram of *Trichoderma* inoculants is mixed in 100ml distilled water to make slurry applied as seed dipping for two hrs. The seeds required for an acre are mixed in the slurry so as to have a uniform coating of the inoculants over the seeds and then shade-dried for 30 minutes. The shade-dried seeds should be sown within 24 hours. One package of the inoculants (200g) is sufficient to treat 10 kg of seeds.

Nursery treatment

Drenching of nursery beds with 5gm of *Trichoderma* formulation per liter of water or applies 10-25g of *Trichoderma* powder per 100 sq.m of nursery bed. For more efficacy, neem cake and FYM before treatment can be done.

Cutting and seedling root dip

Thoroughly mix 10g of *Trichoderma* powder with 100g of well rotten FYM per liter of water and dip the cutting and seedling for 10minutes before planting.

Fig. No. 02 Growth on FYM

Soil treatment

Application of 5Kg of *Trichoderma* powder per ha after turning of sun hemp or dhaincha into the soil for green manuring or mix 1kg of *Trichoderma* powder in 100kg FYM and cover it for 7days with polythene. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field.

Plant treatment

Drenching of soil near stem region with 10g of *Trichoderma* powder mixed in a liter of water.

Major Benefits of *Trichoderma*

- Used as disease control in vegetable crops like Chilli, Tomato, Potato, Brinjal against damping off of seedlings; Cereals crops like Rice and Wheat, fruit crops like, Banana, Guava against wilt; and rhizome crops like ginger, turmeric, onion against rhizome rot.

- *Trichoderma* strains solubilize phosphates and other micronutrients which accelerates the rate of plant growth and development.
- *Trichoderma* strains induce resistance in plant through production of ethylene, hypersensitive responses and other defence related reactions.
- Degrading wide range of pesticides like organochlorines, organophosphates and carbonates; helping bioremediation.

Biocontrol mechanism of *Trichoderma:*

Biocontrol results either from competition for nutrients and space or as a result of the ability of *Trichoderma* BCAs to produce and/or resist metabolites that either impede spore germination (fungistasis), kill the cells (antibiosis) or modify the rhizosphere, e.g. by acidifying the soil, so that pathogens cannot grow. Biocontrol may also result from a direct interaction between the pathogen itself and the BCA, as in mycoparasitism, which involves physical contact and synthesis of hydrolytic enzymes, toxic compounds and/or antibiotics that act synergistically with the enzymes. *Trichoderma* BCAs can even exert positive effects on plants with an increase in plant growth (biofertilization) and the stimulation of plant-defense mechanisms. The genus *Trichoderma* comprises a great number of fungal strains that act as biological control agents, the antagonistic properties of which are based on the activation of multiple mechanisms. *Trichoderma* strains exert biocontrol against fungal phytopathogens either indirectly, by competing for nutrients and space, modifying the environmental conditions, or promoting plant growth and plant defensive mechanisms and antibiosis, or directly, by mechanisms such as mycoparasitism. These indirect and direct mechanisms may act coordinately and their importance in the biocontrol process depends on the *Trichoderma* strain, the antagonized fungus, the crop plant, and the environmental conditions, including nutrient availability, pH, temperature, and iron concentration. Activation of each mechanism implies the production of specific compounds and metabolites, such as plant growth factors, hydrolytic enzymes, siderophores, antibiotics, and carbon and nitrogen permeases. These metabolites can be either overproduced or combined with appropriate biocontrol strains in order to obtain new formulations for use in more efficient control of plant diseases and postharvest applications.

- *Trichoderma* colonizes plants root system and reduces growth, survival or infections caused by pathogens by different mechanism like competition, antibiosis, Mycoparasitism, hyphal interactions and enzyme secretion.
- It decomposes and absorbs the organic material in which it grows. It competes and grows rapidly on substrates.
- It provides plant with systemic resistance against pathogens by releasing compounds that activate the defence mechanism of plants.

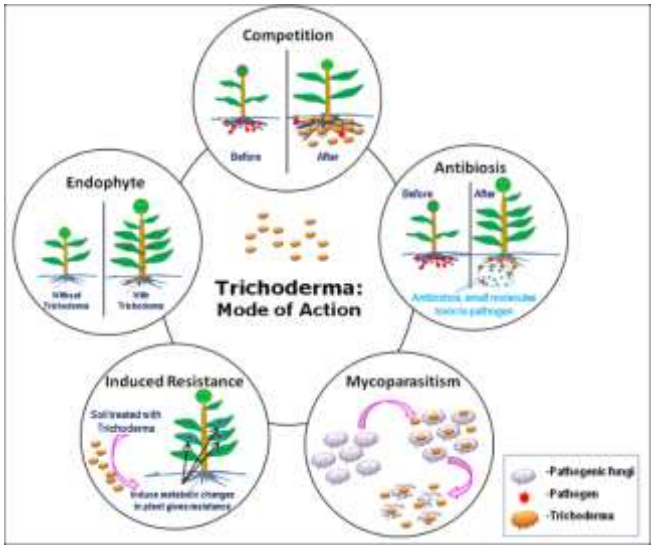

Fig. No. 03 Mechanism

Conclusion

Trichoderma being an efficient biocontrol agent, their characteristics and mechanisms should be well understood to apply them in field conditions to restrict the proliferation of phytopathogens.

ALTERNARIA LEAF SPOT

OF CLUSTER BEAN AND ITS MANAGEMENT TO IMPROVE PRODUCTIVITY

Cluster bean [Cymopsis tetragonoloba (L.) Taub.] Has become popular not only for consumption as vegetables but also as good source of useful industrial 'Guar gum'. Cluster bean commonly known as guar and it has come to be recognized as a summer, annual, drought tolerant, well adapted to arid and semi-arid climates with hot temperatures legume crop. This crop has a great industrial importance in recent years, mainly due to the presence of gum (galactomannan) in its endosperm, which constitutes about 30-32 per cent of the whole seed. It is grown in the ratio of 1:10 as a mixed crop. The cluster bean crop is grown for different purposes such as vegetable, green manure and seed production. Besides all these, it provides concentrate and fodder for cattle and adds fertility to soil by fixing considerable amount of nitrogen fixation (Yogi et al., 2016). Cluster bean is cultivated as pure crop in 75280 hectares and as mixed crop in 54782 hectares area.. Cluster bean crop suffers due to number of diseases like vascular wilt (Fusarium moniliforme and Fusarium sp.), Charcoal rot (Macrophomina phaseolina), Powdery mildew (Leveillula taurica), Anthracnose (Colletotrichum capsici) and Alternaria blight (Alternaria cyamopsidis).

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Distribution and importance

A great number of species were recorded from the genus Alternaria infecting different crops causing world-wide economic loss. Alternaria is a very destructive pathogen causing a widespread destruction in vegetables and other economically important crops. *Alternaria spp*. are economically important pathogens widely distributed throughout the world and cause devastating disease on field crops. Alternaria blight of cluster bean is also severe which was reported from Pusa (Bihar) and Madras. Reported. *Cyamopsidis tetragonoloba* grown as green manure crop in Arizona, USA. Luttrell (1951) tentatively identified the fungus as *Alternaria cucumerina*. A severe Alternaria blight of guar was observed in 1953. Later on the disease was also reported from Pakistan and South Africa. Among the different diseases caused by the genus Alternaria, blight disease is one of the most dominant one that causes average yield loss in the range of 32-57%.

Symptoms

Brown, necrotic leaf spot with concentric rings appear on infected foliage the spot enlarge and may coalesce to form larger necrotic area. Infected leaves eventually dry out and drop prematurely. The symptoms of the disease appear mainly on the leaf blade of leaves as dark brown, round to irregular spots varying from 2 to 10 mm in diameter. The water soaked spots later on turn grayish to dark brown with light brown lines inside the spots.

Symptoms of Alternaria leaf spot on leaf

Two main lesion types occur on guar leaves

- Brown, more or less circular lesions up to 10 mm diameter with distinct, darker marginal ridges.
- Medium brown, spreading lesions without definite marginal ridges and with or without chlorotic halos.

Black lesions are sunken, round or elongated up to 15 mm, with or without distinct ridges. Stem lesions appear to develop more rapidly after defoliation. Brown to black lesions is superficial to sunken, up to 5 mm in diameter, with or without distinct ridges. Symptoms on leaves were small, circular, necrotic spots that develop quickly forming typical concentric rings later, these spots coalesce and cause blighting of leaves. The spots were initially light brown which later turned dark brown. On stems, spots were sunken, with concentric rings.

Host range

The fungus readily infect brinjal (*Solanum melongena* L.), tomato (*Lycopersicon esculentus* Mill.) and black gram (*Vigna mungo*).

Biology and spread

Alternaria cyamopsidis is characterized by conidia with long filiform beaks, it was isolated from lesions of small type on leaves and stems, its spores are produced singly or occasionally (in artificial cultures only) in short chains of 2-3 spores.The plants are most susceptible at 8-10 weeks age. The disease spreads readily in areas with high rainfall, high humidity and high temperature (24-29C) as well as in semiarid climates where frequent and prolonged night dews occur.

Management

Efforts should be made to keep the field clean from infected plant debris of last year or crop rotation should be practiced. Seed borne infection can be minimized by use of healthy seeds or treating seeds with fungicides. Secondary spread of diseases can be checked by spray on mancozeb/zineb @2kg in 500 L of water per hectare should be done at an interval of 15 days at least twice.

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Implementation of Drone in Agriculture

About the Author

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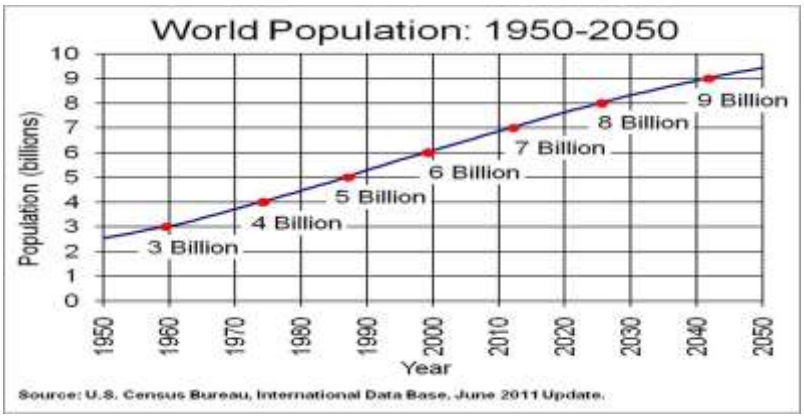
DRONE *(Dynamic Remotely Operated Navigation Equipment).Drones are formally known as unmanned aerial vehicle (UAV) which is essentially a flying robot. t can be controlled either by pilot from the ground or it can be autonomous. With the availability of so many sensors, drones can detect the things which are beyond the visible range of human sight. The drones which are used for agriculture purpose are called as agriculture drone. Therefore, real-time, more accurate, reliable and information can be derived from drones in greater detail and fewer errors.*

Why drones?

With the world's population projected to reach 9 billion people by 2050, experts expect agricultural consumption to increase by nearly 70 per cent over the same time period. Conventional agriculture systems (CAS) higher doses of fertilizers, pesticides and other agrochemicals. Climate change and environmental pollution are the major global issues of the current era and severely impacting agricultural productivity. More than 815 million people are chronically hungry and 64 percent of the chronically hungry in Asia. (FAO, 2018).

Bands of electromagnetic waves

- **Red, Green, and Blue (RGB) bands**: These bands are used for counting the number of plants, for modeling elevation, and visual inspection of the crop field.
- **Near Infra-Red (NIR) band**: This band is used for water management, erosion analysis, plant counting, soil moisture analysis, and assessment of crop health.



- **Red Edge band (RE):** It is used for plant counting, water management, and crop health assessment.
- **Thermal Infra-Red band**: This band has applicability in irrigation scheduling, analyzing plant physiology, and yield forecasting.

How can drones support Indian agriculture?

Soil and field analysis

After getting precise 3D maps for soil, planting can be planned and nutrient status can be analysed for further operations.

Seed sowing and planting trees

UAS shoot seeds and planting tree by throwing biodegradable seed pods or seed bombs with nutrients in the soil with an average uptake of 75 percent, thus bringing down costs for planting.

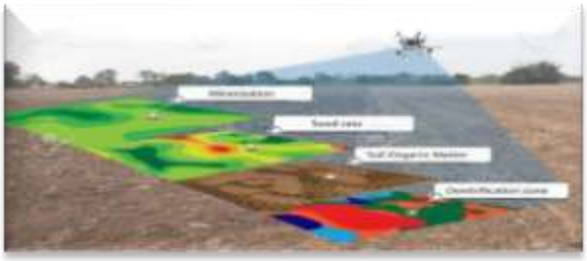
Crop spraying

Drones can scan the ground and spray the correct amount of liquid, modulating distance from the ground and spraying in real time for even coverage. Through drone crop spraying, human contact with such harmful chemicals is limited. Agri-drones can carry out this task much quicker than vehicles/airplanes. Drones with RGB sensors and multispectral sensors can precisely identify and treat problematic areas. Professionals say that aerial spraying is five times faster with drones when compared to other methods.

Crop Health Monitoring and Surveillance

By scanning a crop using both visible and near-infrared light, drone-carried devices can identify which plants reflect different amounts of green light and NIR light. This information can produce multispectral images that track changes in plants and indicate their health.

Weed identification



Drones can be used to identify the weeds present in the field. These weeds could be timely rooted out from the field so that they do not compete for resources with the main crop.

Water Management

Irrigation system are one of the most common features of any farm or agricultural site. In order to optimize irrigation system, farmers could access data collected from remote sensors and use it to analyze where their water resources should directed, in what kind of volume and for how long, and all from their connected laptop tablet or smart phone.

Fertigation

Fertigation is defined as the injection of fertilizers, soil amendments and other products typically needed by farmers into soil. With an IoT enabled fertigation solution, farmers could remotely control how many fertilizers are injected and within what volumes. It would also enable them to monitor fertilizer concentrations and other environmental condition, such as pH, in the soil using remote sensors and adjust to the required levels if necessary.

Crop insurance

In circumstances of crop failure, the farmer can also document the damages for accurate insurance claims. This technology has great potential in accurate and effective implementation of crop insurance scheme, namely **Pradhan Mantri Fasal Bima Yojana** in India without any bias.

Livestock Safety and Maturity Monitoring

Anyone who, even worked on a livestock farm will tell you that, sometimes, animals tend to wander off. With IoT – enable sensors producing real time biomedical data on livestock such as body temperature, pulse and even tissue resistivity. As innovators introduce new technologies, their commercial uses increase day by day. Some are as follows:

Enhanced Production

The farmer can improve production capabilities through comprehensive irrigation planning, adequate monitoring of crop health, increased knowledge about soil health, and adaptation to environmental changes.

Effective and Adaptive Techniques

Drone usage results in regular updates to farmers about their crops and helps develop strengthened farming techniques. They can adapt to weather conditions and allocate resources without any wastage.

Greater safety of farmers

It is safer and more convenient for farmers to use drones to spray pesticides in terrains challenging to reach, infected areas, taller crops, and power lines. It also helps farmers prevent spraying the crops, which leads to less pollution and chemicals in the soil.

Less wastage of resources

Agri-drones enables optimum usage of all resources such as fertilizer, water, seeds, and pesticides.

10x faster data for quick decision-making

Drone surveys back farmers with accurate data processing that encourages them to make quick and mindful decisions without second-guessing, allowing farmers to save the time invested in crop scouting. Various sensors of the drone enable capturing and analyzing data from the entire field. The data can focus on problematic areas such as infected crops/unhealthy crops, different colored crops, moisture levels, etc. The drone can be fixed with several sensors for other crops, allowing a more accurate and diverse crop management system.

Useful for Insurance claims

Farmers use the data captured through drones to claim crop insurance in case of any damages. They even calculate risks/losses associated with the land while being insured.

Evidence for insurance companies

Agricultural insurance sectors use Agri-drones for efficient and trustworthy data. They capture the damages that have occurred for the right estimation of monetary payback to the farmers. It will save 90% water and 30%-40% pesticide. Small droplet diameter make the pesticide more well-distribute and improve the effect. At the same time, it will make the people far away from the pesticide and reduce the pesticide remain of the crop.

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Drone in Agriculture: The Dream Fly High

Now-a-days, population explosion is a main problem in all over the world. Therefore, people do not get sufficient quantity of nutrition due to low availability of food. So, the impact of over-population on agriculture and natural resource management in developing country like India, where backbone of economy is agriculture, is very poor as it increases food demand. So, our target is to increase food supply to meet the demand by improving the cultivation practice using advanced tools like agricultural drone which may help in achieving the aim.

Now the question is- what is drone? Drone is an unmanned aircraft controlled by remote from the ground. That is why, its other name is unmanned aerial vehicle (UAV).

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We all often think of drone as a 'new technology', but its history can be traced back to the beginning of the 20th century. Now, the time passes, the drone become more developed, as it can be used in agricultural field also. Drones could potentially revolutionize crop production techniques. Agricultural drones are usually micro or small, low or very low altitude type. They have short endurance of around 30 minutes to 20 hours. They are normally light in weight.

In agriculture, the UAV or drone helps for crop inspection, pest and disease identification and their control, crop monitoring, crop estimation, irrigation control, monitoring the climate data etc. Not only these, it is also used in forestry, fisheries, wild life conservation, disaster risk reduction etc.

Working Principles of Drone

Drone a.k.a. UAV i.e., Unmanned Aerial Vehicles is an exceptional gift of modern-day science. In short, we can tell these aerial vehicles of different shape and sites are usually remote controlled from ground to carry out various functions specially surveillance work.

Components of Drone

The major components of a drone can be classified into,

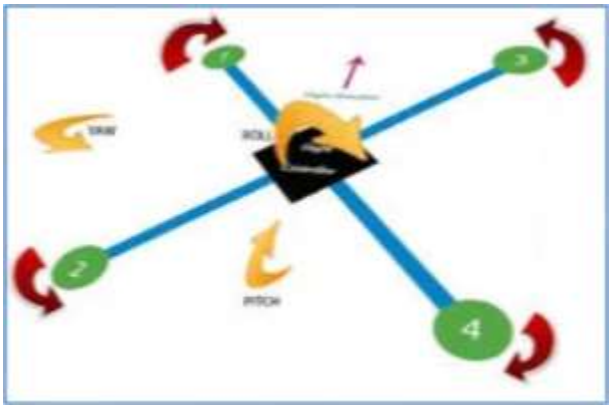
- Main body with tail
- Camera
- Sensor
- Inbuilt GPS system
- The control system

Types of drones

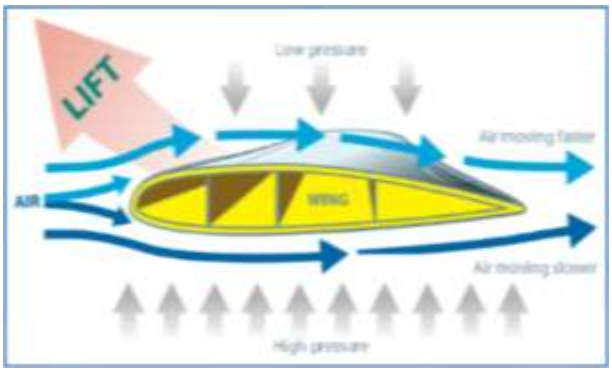
Agricultural drones are mainly categorized in 2 types on the basis of platform. These are- Rotary drones and fixed wing drones.

Rotary drone

Rotary drones are faster to set up in the field and can take off and land vertically. This type of drone is used for smaller field and good for scouting operation. It is further classified into helicopter and multi-rotor drones. Where the helicopter UAV is used in agriculture, the multi-rotor is used in extremely precise task like pollen moisture distribution and precision control.



The main feature of a multi rotor drone is that it can go up and down with the pulp of rotor. There is a proportional equation between the rotor and the lift of the drone. As more the rotor rotates the lift is greater and with the less amount of rotation of the rotor the lift decreases. The flying mechanism of this type drone is very much dependent on the air, i.e., relative nature of force, where the rotor rotates pressure on the air to fly and as the result of the pressure the air creates push back pressure on the rotor back. As a combined result of these actions the multi rotor drone fly.



Fixed wing drone

The working principle of a fixed rotor drone is very much similar to the working principle of an aeroplane based on the principles of Bernoulli's principles.

According to this principle, it flies because of the shape of the "wing", which split into two parts:

- Leading part or leading edge.
- Tailing part or tailing edge.

As we know high pressure always moves to low pressure, the air below the wing make a push, lifting the wing by the force of the air perpendicular to the wing. When the force of lifting exceeds the force of trailing, it makes the device flying. The device is capable of moving in forward direction in the flight because of thrust, while the wings moving through the air creates a lift which follows Newton's Third Law of Motion.

This drone has long range flight capacity and large areas could be covered. It has longer battery life and can fly with greater speed than rotary drones.

Vertical Take Off and Landing Drones (VTOL)

The working principle of VTOL follows the combination of multi rotor and fixed rotor drones. It shows the features of both other type drones as it makes take-off and landing in a similar force of multi rotor drones while flies as fixed wing.

Differentiation of Drones Based on Size & Weight

Nano Drone	≤ 250 g
Micro Drone	250 g – 2.0 kg
Small Drone	2.0 kg – 25.0 kg
Medium Drone	25.0 kg – 150.0 kg
Large Drone	≥ 150.0 kg

Application of drones

Agriculturist and especially the farmers always look for a cheap and effective method to monitor their crop on regular basis. So, agricultural drone is a unique tool according to their expectation.

Soil and field analysis-Drones are able to produce precise 3-D maps for soil and field analysis. Not only that, it also helps to detect soil erosion, fertility of soil, nutrients content of soil, terrain and soil condition etc.

Planting-Drone-planting system achieve a decrease rate of planting costs. This technique saves labour. Budget-friendly drones can be replaced huge-tractor also.

Crop spraying- Drone can be used for spraying purposes. It can scan the field, spray the correct amount of fertilizer or pesticides on the crop from the modulating distance in real time for even coverage.

Crop monitoring- Crop monitoring is a biggest headache. But by using drone, it become easier. Drones can be used to set in monitoring route by gathering multispectral geospatial and temporal data-base at pre-defined scales which is crop development related.

Irrigation- Drones with hyper-spectral, multi-spectral or thermal sensor can identify the dry and needy part of the field. Drone allow the calculation of the vegetative index, which describes the relative density and crop health.

Crop health assessment- Sensor fitted drone are capable of scanning crops using visible and near infrared light which can be used to track crop health over time and also to monitor the responses to remedied measures.

Controlling weed, pest and diseases- Drone can detect and inform farmers about the field areas infected by weed, pest and diseases. Based on which, farmers can optimize the use of the chemicals.

Advantages of Drone technology in agriculture

- Agricultural consumption is projected to increase by nearly 70 percent by 2050 according to experts due to increased population. So, the farming industry needs to be increased abruptly by minimising the obstacles they face during monitoring the crop fields. The images captured and sent by drone helps the grower to quickly and easily analyse the field, the current status of crops, underdeveloped crop areas, infested areas, healthy plants, etc.
- The effects of climate change are creating many obstacles to productivity. Storm, drought, flood etc create huge damage to the crops. But these drones come handy with the situation where special sensors of the drones can predict the extent of crop damages, water logged areas, drought areas etc. So, the grower can quickly take decisions to use the resources sustainably.
- Agricultural industrial wates, chemical runoffs are a major health concern. These drones check the crops properly and pinpoint the troubled areas. So that the farmer can use proper amount of fertiliser, pesticide and other chemical where needed. Thus, reducing the waste usage influence the environment positively. Specially equipped drones can also scan the field and spray the chemical where needed automatically.

- It has special sensors that can detect dry and wet patch. Thus, can indicate proper use of water in the field.

Disadvantages of Drone technology

- Drone technology is helping the farmers to gather knowledge easily and act accordingly. But it is also taking over many human resources thus reducing job opportunities in this field.
- Specific knowledge and skills are required to use drone in the field.
- Drones which have more flight time, special feature are very costly for most of the farmers.
- Special govt. clearance needs to be obtained to use which sometimes becomes a difficult process,

Conclusion

It is no secret that modernization in agriculture has brought good days in this industry. If the farmers get real time information, they can automatically improve the crop health and production by using the information in correct time. So, drones can help the farmers in different ways to uplift the agricultural production. Though this technology is still not mature enough to be implemented in large scale though out the country, it can grow with support of govt., agricultural stakeholders and none other than farmers.

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VERTICAL GARDENING

AN ADVANCED APPROACH FOR URBAN LANDSCAPING

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Vertical gardening is the practice of growing ornamental plants vertically on vertical surfaces, such as a home's wall, an office's wall, a hospital's wall, or a huge building's facade. Installation of a vertical garden is surely a promising solution to add some greenery in the house / building, as horizontal space is a limitation for gardening in many metropolitan places in today's times. To reduce the negative effects of noise pollution, vertical green walls can be built along roads, expressways, metros, railway lines, airports, and other locations. Vertical gardening can help with cooling and insulation of buildings, as well as reducing the demand for and cost of high-voltage air-conditioning devices. Plants in the building can also aid to filter air particles, enhance air quality, and provide humidity. By lowering the need for irrigation and watering, vertical gardening also helps to save water. The vertical landscape system's vegetation also softens the hard, abrasive appearance of concrete buildings in metropolitan environments.

Introduction

Urban gardening in the form of vertical gardening is a relatively recent concept. It's ideal for embellishing walls and roofs in a variety of designs in small spaces. Wherever there is a lack of room, vertical space can be used to grow plants. Horizontal area for outdoor gardens is quite restricted in today's period of growing urbanization. Due to increased urbanization and industrialization, poor air quality has been linked to health concerns all across the world. Air pollution in cities is a global health issue. A number of attractive plants are thought to be potential unpleasant gas scavengers, helping to enhance air quality. Plants can grow vertically on walls and other non-horizontal surfaces in vertical gardens. In addition to the basic photosynthesis that takes carbon dioxide and returns oxygen to the air, plants in vertical green wall systems may remove toxicants and unpleasant chemicals from the air. The adoption of vertical green wall systems can significantly enhance air quality. Vertical green wall systems decrease dust, maintain humidity and temperature stability, reduce noise, and give a refreshing environment. Vertical landscaping systems with vegetation create a sense of pleasure, quiet, and stress alleviation. Plants that are placed at eye level gain a new feeling of appreciation, especially groundcovers, succulents, and small perennials, which are difficult to view up close. People's wellbeing and performance / job productivity are thus improved by vertical landscaping systems or green wall systems that feature ornamental crops.

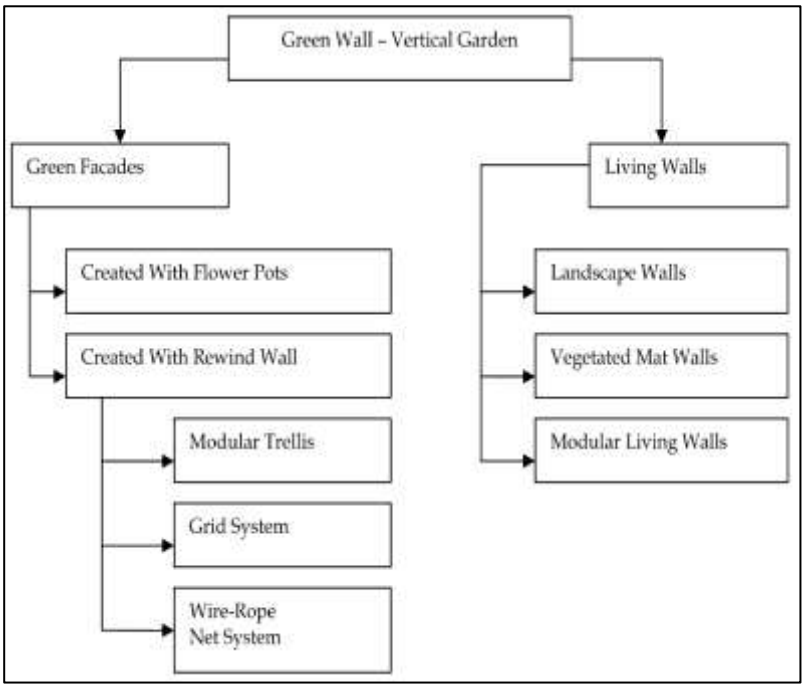
Benefits of vertical gardening

Vertical Gardens have economic and environmental benefits in addition to aesthetic appeal. Distinct structures, green wall technology, plant selections, and plant coverage all have different benefits.

- Adds visual drama and beauty
- Blocks views of plain or unsightly walls and provides building protection
- Reduces noise volume
- Saves water and requires less effort to water.
- Lowers CO_2 levels while increasing oxygen levels, resulting in better air quality.
- Keep dust and dangerous microbes at bay.
- Acts as a natural insulator for hot and cold air, as well as a source of energy for your building.
- Diseases and pests are less accessible to plants.
- Live plants reduce tension and create a relaxing environment.
- Increases the value and marketability of your home or business.
- Assist in the restoration of habitats where wildlife can thrive.

Classification of vertical greening system

One of the most popular gardening trends in the globe is the vertical greening system. Vertical gardens can be categorized as green façades or living wall systems, depending on how they are grown. The term "vertical greening systems" is used to describe a variety of different types of vertical greening



A. Green facades

Climbing plants or cascading groundcovers are trained to cover specifically constructed supporting structures in a vertical greening system known as a green facade. Plants can be planted in the ground or in elevated pots or containers that are irrigated and fertilized. Plants will be rooted in the ground or in intermediary containers / planters at the base of specifically built supporting structures. Green facades can be erected as an independent construction, such as fences or columns, or they can be attached to existing walls (TNAU, Agritech Portal). Green facades can be made in a variety of methods.

a. Can be created with Pots
b. Can be created with Rewind walls.

The three systems which can be used to create Green facades with Rewind walls are:

i. Modular trellis system - The sturdy, light-weight, three-dimensional panel constructed of powder-coated galvanized and welded steel wire that supports plants with both a face grid and a panel depth is the foundation of this modular system. This technique is intended to keep a green facade off the wall surface so that plant

Modular trellis system

components do not adhere to the building, to offer a "captive" growing environment for the plant with several supports for the tendrils, and to assist maintain the integrity of the building membrane.

Grid system

ii. Grid system - Cables and wires were utilised in grid planning and wire-rope net systems. Grids are used on green façade to support climbing plants that grow quicker and have denser foliage. Wire-nets are frequently employed to support slower-growing plants that require the additional support that these systems provide at more frequent intervals.

iii. Wire-rope net system

B. Green walls / Living walls

Green wall or living wall systems require more attention and upkeep, such as fertilizer and water, than green facade systems that are planted in the ground. Pre-vegetated panels, vertical modules, or planted blankets (vegetated mat walls) are connected vertically to a structural wall or frames in the green wall or living wall system.

Green walls / Living walls are further subdivided into:

i. Landscape walls- Noise reduction and slope stabilization are the principal functions of landscape walls, which are often sloping rather than vertical. They're usually composed of some kind of stacking material, such as plastic or concrete, and provide space for growing media and plants.

ii. Vegetated mat walls- Two layers of synthetic fabric with pockets filled with plants and growth material make up this system. The synthetic fabric walls are supported by a framework and protected against the building wall by a waterproof membrane. An irrigation system at the top of the fabric wall provides nutrients and water.

iii. Modular living walls / Modular green wall- It's constructed of polypropylene, plastic, or polystyrene that's been recycled. It has an appealing appearance and is extremely tough and long-lasting in nature. Modular living walls / modular green walls are simple and quick to install. It has a steel or plastic frame and supporting panel. It comes with readily removable cups, pots, and containers for growing plants.

Planning for the Vertical Garden

The selection of a suitable location, the local temperature, the availability of plant material, the construction of supporting structures, including the necessary preparations for integrated drip-tube irrigation, and so on are all part of the planning process. A vertical garden may be erected almost anywhere, and the key to success is choosing the correct species for the proper environment.

Green wall consists of……


Green wall cup type/ Biowall cups

- **Plant Material:** Light availability, location, size, colour, texture, and growth patterns all play a role in plant choosing.
- **Planting Matrix:** This is a medium that allows plants to root and anchor themselves to a vertical surface. Organics, such as soil, and inorganics, such as plastics and synthetic fibres, are examples of these.
- **Irrigation System:** Provides water and nutrients to the plants for healthy growth.
- **Waterproof Barrier:** To keep moisture out of the building's façade.
- **Structural Support:** For supporting the vertical garden system's structural weight on the building façade.
- **Lighting:** Provide enough light for plants to photosynthesize and foster natural growth tendencies. Lighting can come from either a natural (the sun) or an artificial source (metal halide, high-pressure sodium, and LED lights).

Some Suitable Plants for Vertical Garden

For the longevity of a living wall system / green wall system, selecting the proper plants is critical. Plants for a vertical garden wall system should be dense, compact, well-formed, slow-growing, and have a strong root system. The plants should be evergreen in nature, beautiful and graceful in appearance, and visually pleasing. The pattern of sun exposure should also be considered when choosing plants for a vertical green wall system. Plants should be placed in various locations on wall units based on their moisture-loving capacity.

Plants for Outdoor Green walls / Exterior Green walls

Herbaceous perennials: *Alternanthera sessilis*, *Asparagus densiflorus* "myers", *Asystasia gangetica*, *Duranta variegate*, *Eranthemum nigrum*, Ipomoea (Golden), Ipomoea (Purple), Irisine, *Mentha spp. Pilea*

microphylla, *Pittosporum tobira*, Rhoeo golden, Rhoeo green, *Rhoeo tricolor* (variegated), *Russelia euisetiformis*.

Succulents: Geraniums, Jade plant, Portuluca, Aptenia, Sedums.

Shrubs: *Barleria cristata*, *Buxus microphylla*, Cuphea, Dusty miller, *Ficus species*, *Plumbago auriculata* (sky flower), *Plumbago indica* (Lal chitrak), Ruellia, Song of India (Pleomele), *Trachelospermum jasminoides.*

Ground covers: Baby‘s tear, *Callisa repens*, *Tredascantia zebrine*, *Wedelia trilobata*.

Grass like foliage forms: *Dianella tasmanica*, Ophiophogon, *Pandanus tectorius*, *Pennisetum setaceum* (Fountain grass) *Phalaris arundinacea*.

Plants for indoor green walls / for shaded areas

Herbaceous perennials: Aglaonema, Aralia, Begonia, Bromeliads, *Chlorophytum comosum*, Cryptanthes, Epipremnum, Erasinae (Reep), Fittonia, Heart leaf Philodendron, *Monstera species*, *Neoregelia peperomia*, Philodendron Ceylon gold, Philodendron selloum, Pilea, *Rhoeo discolor*, *Sansevieria hahnii compacta*, *Sansevieria trifasciata robusta*, Schefflera, Spathiphyllum, Syngoniums.

Shrubs: Schefflera, *Ficus spp* , *Cordyline terminalis*

Succulents: *Rheo discolor*, *Setcreasea purpurea*, *Zebrina pendula*

Ferns: *Nephrolepis exaltata*, *Nephrolepis biserrata furcans Nephrolepis cordifolia*

Growing Media for Vertical Garden

The growing media used in vertical garden should meet the following requirements:

- ✓ Weightless media
- ✓ High Water holding capacity
- ✓ High Nutrient holding capacity
- ✓ Good Porosity
- ✓ Neutral pH.

Cocopeat, Perlite, Sphagnum moss, Vermiculite, Vermicompost, Shredded bark, and Leaf moulds are some of the most popular media combinations. Because soil adds to the weight of the green walls, it is rarely employed in living wall / green wall systems.

Irrigation in Vertical Garden

An automation-unit with technology for controlling fertilizer injection and irrigation cycles makes up the vertical living wall system's irrigation network. In a vertical green wall system, water use ranges from 2 to 5 litres per square metre per day. Weekly watering is ideal for green walls that use a high-quality, water-retentive growing medium and are not in an exposed or exceptionally hot and sunny position.

Some of the problems encountered while creating Vertical gardens are:

- The performance of Vertical gardening systems has begun to be impacted by climate change.
- The quality of planting materials offered by some private nurseries for Vertical gardening is unreliable.
- Despite continued attempts, disease and pest concerns in vertical gardens have yet to be resolved.
- Given the enormity of advancement in the country, much work needs to be done to create inputs such as Vertical gardening structure fabrication, media, drip irrigation system, and so on.
- The current marketing system for Vertical Gardens lacks a scientific approach.

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GHERKIN:
A NUTRITIONAL CROP FOR HEALTH

The crop is usually known as "bur gherkin," "West Indian gherkin," or just "gherkin," has been cultivated since before 1650.The gherkin (Cucumis anguria L.) belongs to the Cucurbitaceae family. The plant is likely native to southern Africa and is grown in warm climates around the world. Gherkin fruits are served raw, cooked, or pickled, though the "gherkins" sold in commercial pickle mixtures are usually small, immature fruits of the common cucumber (C. sativus). It is an annual and monoecious plant with an indeterminate and prostrate growth habit, lobed leaves and fruits that are highly variable in shape and in the presence or absence of spicules. It is common to find gherkin plants growing sub spontaneously among other crops whose production meets the demands for domestic consumption and international markets.

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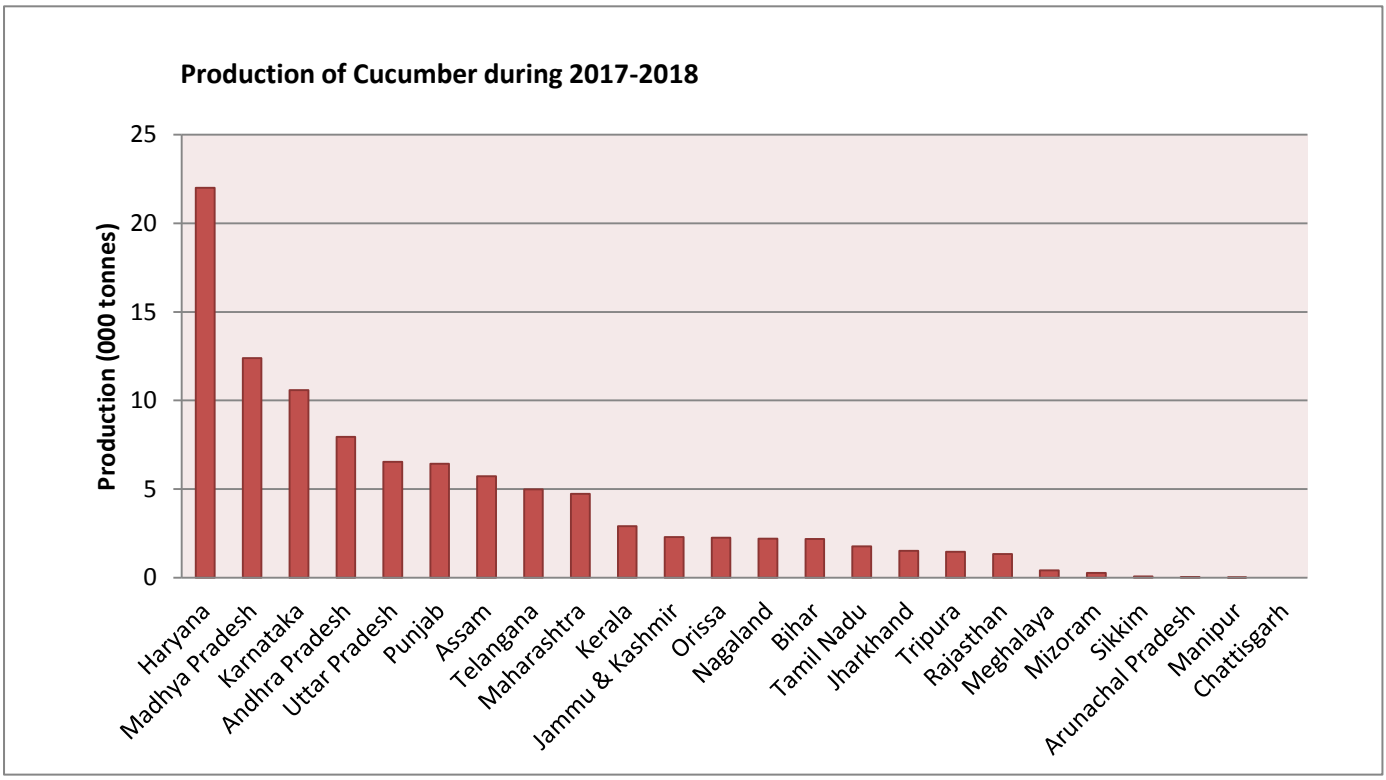
Cultivation in India

It is commonly grown in USA, Australia and Sri Lanka and was introduced in India during late eighties for export oriented production. The production of gherkins in India is concentrated in the three southern states, *viz*. Karnataka, Tamil Nadu and Andhra Pradesh. It is a major dietary constituent to many European countries and the USA. Hence, almost the entire volume of gherkins produced in India is exported, with little or no domestic demand, except for some five star hotels. There is a growing worldwide demand for pickled gherkins, more and more food companies have started to explore opportunities for producing gherkins. This is mainly true of India given the favorable growing conditions in that country. Gherkin plants can be grown throughout the year in all seasons. It provides mainly employment opportunities to the family members of both the landholders and landless laborers in rural areas.

Table-1: Indian Production of Cucumber

Sr No.	State	Production	Share (%)	Sr No.	State	Production	Share (%)
1	Haryana	274.40	22.01	**13**	Nagaland	27.46	2.20
2	Madhya Pradesh	154.52	12.39	**14**	Bihar	27.14	2.18
3	Karnataka	131.96	10.58	**15**	Tamil Nadu	21.93	1.76
4	Andhra Pradesh	99.16	7.95	**16**	Jharkhand	19.01	1.52
5	Uttar Pradesh	81.47	6.53	**17**	Tripura	18.19	1.46
6	Punjab	80.02	6.42	**18**	Rajasthan	16.64	1.33
7	Assam	71.30	5.72	**19**	Meghalaya	5.03	0.40
8	Telangana	62.04	4.98	**20**	Mizoram	3.29	0.26
9	Maharashtra	58.95	4.73	**21**	Sikkim	0.74	0.06
10	Kerala	36.28	2.91	**22**	Arunachal Pradesh	0.43	0.03
11	Jammu &Kashmir	28.59	2.29	**23**	Manipur	0.12	0.01
12	Orissa	28.23	2.26	**24**	Chhattisgarh	0.04	0.00

Source: National Horticulture Board (NHB)



Edible uses

Fruit raw cooked or pickled. The best forms have a very agreeable cucumber flavour without any bitterness. It can be used in salads or as part of a savoury dish. The fruit is frequently soaked in vinegar to make a pickle; it absorbs a large quantity of vinegar. Young leaves - cooked. In Africa the leaves of bitter forms are more likely to be eaten. The Gherkin fruit similar in form and nutritional value to a cucumber.

Table-2: Nutritional value Cucumber (Sliced & Raw)

S.N.	Nutrient	DRI/DV
1.	1 cup (104g)	16 Calories
2.	Vitamin K	19%
3.	Molybdenum	12%
4.	Copper	4%
5.	Phosphorus	4%
6.	Vitamin C	4%
7.	Biotin	3%
8.	Vitamin B1	3%
9.	Potassium	3%
10.	Magnesium	3%

Soil and land preparation

Gherkins can grow in various types of soil but they prefer light, humus-rich, well-drained soil. The gherkin is extremely sensitive to soil salinity, low temperature and slack water. If the soil has weak water permeability then it is advisable to fill the ridge with 15-20cm of well-rotted compost or organic manure and cover it with 10cm of soil. Slow-release fertilizer and a fumigant must be incorporated in the top layer. The next step is to lay the irrigation tubes and, if they are laid on the top of the ridge, fix them to the poles. The black mulch film should be laid on the ridge two to four weeks before sowing/transplanting and it should be perforated directly before sowing/ transplanting.

Climate requirements

The Gherkin plant is frost-sensitive and its thermophily is, among others, demonstrated by the fact that it develops physiological disorders (e.g. stunting) at a night temperature of below 5°C. The Gherkin plant germinates and grows at a minimum temperature of approximately 12°C and opens its

Propagation seed

Sow seeds in containers in light shade using a rich soil. Germination should take place within 2 weeks. Sow 2 or 3 seeds per pot and thin out to the best plant. Grow them on fast and plant out when the plant has at least 4 true leaves.

Transplanting

A uniform crop is a precondition for profitable and intensive vertical cultivation, and that cannot be obtained through direct sowing due to variables such as depth of sowing, soil-borne pests, changeable weather, etc. The ideal gherkin seedling is 10-14 days old, has a 2 to 3cm-long stem, cotyledons (not true leaf) and is well-rooted. To raise the plants, 4cm peat cubes or plastic trays with 30-50cm^3 cells are sufficient. Since gherkin plants are sensitive to deep planting, the top of the substrate should not be covered by soil. Moisture rich soil conditions are necessary for a quick start. If the plants are close to the irrigation tube, poor root development and weak activity can occur in the summer months. The optimum distance between the irrigation tube and the plants is 8-10cm.

Support system

Vertical gherkin cultivation is the best way of producing fine-grade, high-value pickles. The processing industry needs a stable, year-round supply of fresh gherkin in small calibres. The vertical production of gherkins is traditionally spread across Central/Eastern Europe in countries. Vertical gherkin production started in the mid-1980s. The launch of black mulch and drip irrigation along with the switch to parthenocarpic varieties caused a rapid increase in yield in the 1990s. Furthermore, the implementation of agricultural fleece and the change from direct sowing to seedlings in the early 2000s contributed to a 3-week-longer harvesting season.

Manuring

Apply N - 150 kg, P - 75 kg and K - 100 kg/ha in 3 equal splits i.e., basal, three and five weeks after sowing. After cultivation, practice the earthing up to the plants 25 days after sowing. Provide support to plants as and when vines start trailing.

Fertigation

Generally speaking, 1,000 litres of irrigation water should contain 1.0-1.2kg of fertilizer comprising the ideal percentages of nutrients in line with the plant's growth period. There are several types/brands of fertilizer which are suitable for use in gherkin production.

Pest: To control leaf miner, white fly, aphids and thrips spray Dimethoate 1.5 ml/l or Malathion 1.5 ml/l.

Diseases: Spray Carbendazim 0.05 % (0.5 g/l) to control diseases.

Harvest

The crop is ready for harvest in 30-35 days. As the tender immature fruits are meant for canning the price of the produce is decided by the stage of maturity. Smallest fruit which will weigh approximately 4.0g (250 fruits per kg) will fetch the maximum price followed by stage 2 and stage 3. To maintain the grade the harvesting of fruits should be done every day. A day's break would end up with outsized or overgrown gherkin means loss to farmer. Avoid sharp sun and high temperature while harvesting. For this picking of fruits must be none in the very early morning or late evening. Harvest the fruits by retaining the stalk on the plant. Harvested fruits must be collected under shade. Flower head has to be removed from fruit. Water should not be sprinkled on harvested fruits at any stage. Even if there is surface water during harvest it should be dried by aeration. For collection of fruits jute bags alone have to be used and plastic bags should be totally avoided. The harvested produce should be transported to the factory on the same day before dusk. Leaving the gherkin unprocessed overnight would result in poor quality produce. The yield is about 10 - 12 tonnes/ha in 90 days in Indian climatic conditions.

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GROW COFFEE IN SHADE TO SUPPRESS LEAF RUST

***Causal Organism**: Hemileia vastatrix*

***Name of the disease**: Coffee rust*

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Coffee is the most important agricultural commodity, with an estimated retail value of 70 billion US dollars. It is crucial for the economy of more than 60 countries and is the main source of income for more than 100 million people. The two main cultivated coffee species, C. canephora (Robusta coffee) and C. arabica, account, on average, for 40% and 60%, respectively, of the world's coffee production. Coffee rust destroyed the once-flourishing coffee plantations of Sri Lanka and Java in the late 1800s, and an epidemic in Central America and the Caribbean has decimated numerous plantations in the region since 2012.

Symptoms and Signs

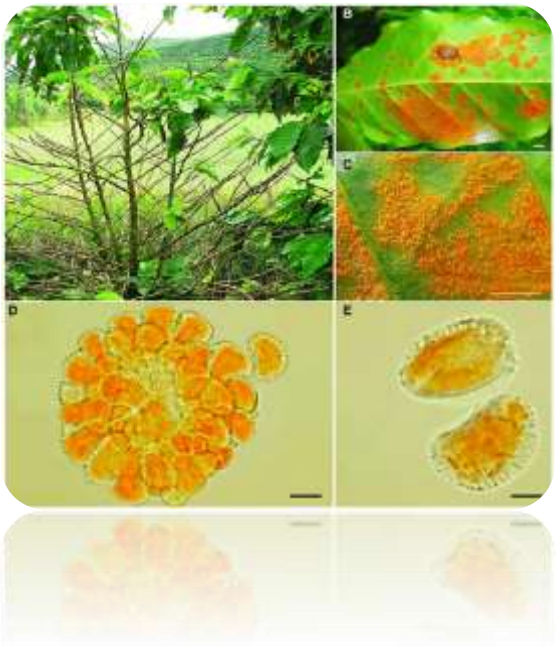
Infections occur on the coffee leaves. The first observable symptoms are small, pale yellow spots on the upper surfaces of the leaves. As these spots gradually increase in diameter, masses of orange urediniospores (uredospores) appear on the undersurfaces. The fungus sporulates through the stomata rather than breaking through the epidermis as most rusts do, so it does not form the pustules typical of many rusts.

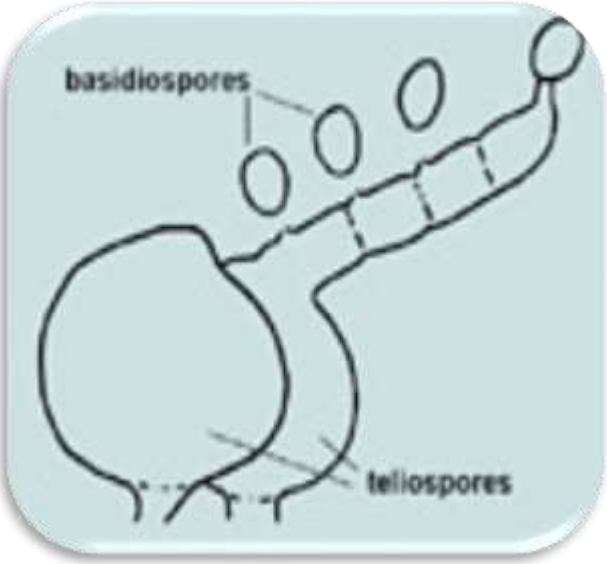
The powdery lesions on the undersides of the leaves can be orange-yellow to red-orange in color, and there is considerable variation from one region to another. While the lesions can develop anywhere on the leaf, they tend to be concentrated around the margins, where dew and rain droplets collect. The centers of the spots eventually dry and turn brown, while the margins of the lesions continue to expand and produce urediniospores. Early in the season, the

first lesions usually appear on the lowermost leaves, and the infection slowly progresses upward in the tree. The infected leaves drop prematurely, leaving long expanses of twigs devoid of leaves.

Pathogen Biology

Urediniospores of other rust fungi are typically round to oval, not kidney-shaped, and have fine spines over their entire surface. It belongs to the class Basidiomycetes, the order Uredinales, and the family Pucciniaceae. *emileia vastatrix* exists primarily as dikaryotic (having pairs of haploid nuclei that divide in tandem), nutrient-absorbing mycelium ramifying intercellularly within the leaves of its coffee host. Clusters of short pedicels bearing dikaryotic urediniospores protrude through the stomata on the undersides of the leaves.





Defoliation in a coffee. Leaf symptoms on abaxial surface uredinial pustules coalescing over lower leaf surface. Uredinium showing arrangement of spores. Urediniospores-showing the thickened, heavily-ornamented.

Grow Coffee in shade' to suppress leaf rust

A slight variation in the environmental requirement of the rust and the hyperparasite. The rust can thrive in low moisture conditions whereas the hyperparasite, favors areas characterized by moist and shaded habitats. Coffee needs shade and growing the crop under shade could buffer the microclimate around the coffee shrub.

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TIPS

TO EAT HEALTHY DURING QUARANTINE OR ISOLATION (COVID–19)

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COVID-19 affects different people in different ways. Most infected people will develop mild to moderate illness and recover without hospitalization. Most common symptoms of COVID–19 are: Fever, dry cough and tiredness; less common symptoms are: aches and pains, sore throat, diarrhea, conjunctivitis, headache, loss of taste or smell, a rash on skin and/or discolouration of fingers or toes.

Simply put, there are no foods that will 'boost' our immune system and prevent or treat COVID-19. However, eating a healthy balanced diet is still essential for good health and normal immune function. Therefore, following your country's dietary guidelines is still the recommended way to meet your nutrient needs and keep you healthy during isolation. Here we will discuss the principles of healthy eating during quarantine.

Eat Plenty of Fruits and Vegetables

Fruits and vegetables are among the most important foods for supplying the vitamins, minerals and fiber our body needs for good health and normal immune function.

We should aim to eat at least 5 portions (equivalent to around 400g) of fruits and vegetables every day. Fresh, frozen, canned, dried and juiced (maximum 1 serving per day) versions all count as a portion.

As different coloured fruits and vegetables provide different combinations of vitamins, minerals and phytochemicals, make sure to add variety to your daily meals where possible.

Choose whole grains over refined grains

Whole grains, unlike refined grains, maintain most of the structure of the grain, keeping the layers that hold the vitamins, minerals and fiber.

In addition, whole grains also provide an important source of carbohydrates which give us energy and can help us feel fuller for longer periods.

Replace saturated with unsaturated fat

Fats are an important part of a healthy diet. However, not all fats have the same effect on our health. Swapping saturated fats with unsaturated fats can help to lower our LDL (bad) cholesterol levels and reduce our risk of heart disease.

We can do this by reducing our intake of foods such as fatty meats, high fat dairy products and tropical oils like coconut oil and adding foods such as nuts, oily fish and plant oils such as olive and rapeseed oil.

Limit foods and drinks high in fat, sugar and salt

Foods and drinks high in fat, sugar and salt such as cookies, potato chips, chocolate and sugary drinks, when eaten in high amounts can lead us to consume more calories than we need.

As these foods often provide little nutritional benefit, they are not needed for a healthy diet and should only be enjoyed in small amounts and eaten occasionally.

Control Portion Sizes

It can be difficult to get portion sizes right, especially when cooking at home. Understanding what the right portion looks like can help us stay in energy balance and avoid under – or overeating. Not all foods have the same portion sizes.

"Handy" tricks to portion sizes to get a better understanding of what a healthy portion is for different foods. Remember, children's portions should be smaller!

Choose both Plant and Animal-Based Proteins

Protein is essential for the healthy functioning of our body and immune system. We can get protein from both animal- and plant-based sources, such as beans, pulses, fish, eggs, dairy products and meats. Our protein requirement changes depending on our stage of life. Adults are recommended to eat at least 0.83 g of protein per kg body weight per day, equivalent to 58 g/day for a 70 kg adult.

We should choose protein-rich foods that not only help us meet our needs but also support a healthy and sustainable diet.

In case of limited access to fresh meat and fish, frozen and canned versions can provide convenient and nutritious alternatives. However, as the fat and salt content can be high in some canned meats and fish it is important to check the label and choose lower fat and salt varieties. Plant-based proteins such as pulses, cereals, nuts and seeds also have a long shelf-life and can provide convenient protein-rich and nutritious meals or snacks.

Stay Hydrated

Keeping hydrated is essential for overall health. How much water we need depends on our age, sex, weight, height, level of physical activity and environmental conditions (i.e. hot weather will likely require you to drink more water). Considering that around 20-30% of the water we need comes from our food.

If you have access to safe tap water, this is the healthiest and cheapest drink. For a refreshing boost, you can add slices of lemon, cucumber, mint or berries. Other drinks such as unsweetened coffee, sparkling water, unsweetened tea, iced tea or unsweetened infused or flavoured water are also good choices for hydration.

Get Your Dose of Vitamin D in Isolation

The sun is the best source of vitamin D. However, during quarantine or self-isolation it may be more difficult to get enough sun exposure to meet our needs. Therefore, it is recommended that individuals who are unable to go outside eat plenty of vitamin D rich foods and consider taking a daily vitamin D supplement.

The recommended vitamin D intake for different age groups are:

- 15 µg/day for adults (18+ years), children (1 – 17 years) and pregnant individuals.
- 10 µg/day for infants (7 – 11 months).
- 10 µg/day for breastfeed infants (0 – 7 months).

If you are in self-isolation and have access to an open window, garden or balcony, then short periods (15-30 minutes) of daily sun exposure to the arms and face without sunscreen can help you meet your daily vitamin D needs. However, we should not forget that for good sun protection we should avoid unprotected sun exposure for more than 30 minutes.

Stay Safe While Food Shopping

Grocery stores remain open during the COVID 19 pandemic and there is no need to stockpile foods as the supply of food to stores remains stable.

The risk of contracting COVID-19 from touching contaminated food packaging is very low and this form of infection has not been reported. In stores, the biggest risk of contamination remains contact with other people and 'high-touch' surfaces such as weighing scales, shopping-cart handles or elevator buttons, although many stores are taking measures to sanitize these surfaces. We should, keep the appropriate distance from other people, avoid touching our faces while out shopping, and wash our hands both after returning home from the shop and after handling newly purchased food packaging.

Don't forget about food safety

According to EFSA, there is currently no evidence that COVID-19 is transmitted through eating food. However, good food safety practices are important to minimise the risk of foodborne illnesses.

When handing or preparing food, make sure to:

- Wash your hands for 20 seconds with soap before and after preparing or eating food.
- Cover your mouth and nose with a tissue or your sleeve when you cough or sneeze and remember to wash your hands.
- Wash fruits and vegetables with water before eating them.
- Disinfect surfaces and objects before and after use.
- Keep raw and cooked foods separate to avoid harmful microbes from raw foods spreading to ready-to-eat foods.
- Make sure to cook and reheat foods to adequate temperatures (≥72°C for 2 mins).

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IMPACT OF DURING AND POST COVID-19 ON INDIAN DAIRY SECTOR: CHALLENGES, OPPORTUNITIES AND FUTURE PROSPECTS

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India has been the leading producer and consumer of dairy products worldwide since 1998 with a sustained growth in availability of milk and milk products. COVID-19 has affected the lives and livelihood of millions across the world. More than 70% of milk is being produced by small farmers; milk provides immediate cash for their livelihood. Milk is a perishable product and it can't be stored without any cold storage facility or proper processing. That is why reports of dumping of fresh milk are coming in from different parts of the world. It's tough for diaries around the country to handle a surge in fresh milk supply on the one hand and a concurrent major drop in demand for milk and milk products on the other.

IMPACT ON INDIAN DAIRY SECTOR DURING AND POST COVID-19

In India's milk industry, a new crisis is brewing. The causes are two factors the current lockdown conditions and a milk surplus. Many people can't go to shops to get milk. It's now only available in a few locations. Many restaurants are closed, and only carry-out services are available. As a result, consumption of tea, coffee, curd, buttermilk and lassie has also declined. Added to this fact, the Indian milk production has been rising faster than demand.

COVID-19 may be beneficial to the dairy industry, and consumers could switch from meat to dairy. The government may consider reducing GST on ghee and milk fat from 12% to 5%.When the entire nation continue to be in lockdown due to covid-19 pandemic our dairy industry has proved to be more resilient than many other sectors in terms of extent of supply chain disruption. Of course during the initial phase of lockdown restrictions to both milk procurement and sales of milk were impacted due to supply chain disruption. Information collected by NDDB from the dairy cooperative show a decline in daily liquid milk sales by dairy cooperative by about 15% in covid-19 lockdown period and a drop in proportion of sell to procurement by about 8.8% during the same period.

In comparison to other industries that were hard hit by the lockdown constraints, such as construction, manufacturing, hotels, travel & tourism, and so on, the dairy industry appears to have fared remarkably well.

Covid-19's effect has driven many large commercial dairy farms to the verge of closure across the world, including in the most dairy-developed countries, forcing policymakers to declare bailouts. The Trump administration recently proposed a $15.5 billion bailout package for the US dairy industry. The United States is considering buying milk and converting it into goods that could be used for international humanitarian relief.

To meet the rising demand for milk and milk products, it makes good business sense for our dairy industry to increase milk procurement for making SMP. Despite market shocks, milk procurement during the Covid-19 lockdown suggests that dairies have begun building up commodity stocks to meet lean season requirements. SMP stockpiles were around 25,000 MT higher on April 1 than on March 1, and estimated daily average SMP production increased from 790 MT on March 1-15 to more than 1,000 MT on April 8-14. COVID-19 raised public awareness about the importance of eating a balanced diet. Milk procurement is currently being done in order to make SMP in order to satisfy the increasing demand for milk and milk products.

CHALLENGES

The virus has major challenges to dairy farmers in a number of ways-

1. The first being the management of dairy animals and second the marketing and sale of milk and other by-products.
2. National Dairy Development Board (NDDB) from the dairy cooperatives shows a decline in daily liquid milk sales by dairy cooperatives by about 15% in the COVID-19 lockdown period.
3. Due to supply chain disturbances, milk production and sales were affected in many parts of the country during the initial phases of the lockdown restrictions.
4. The dairies around the country cannot handle the surge in fresh milk supply.
5. All eaters and sweets shops are closed, leading to low demand for milk and other dairy products.
6. Dairy plants cannot afford to handle the delivery of surplus milk due to the liquidity crisis and a lack of working capital.
7. Dairy farmers are finding it difficult to dispose off their milk.
8. During the whole shutdown in country, there is a fall in milk prices and farmers may be disposing the milk at a price lower than the cost of production.

OPPORTUNITIES

COVID-19 benefits the dairy industry as consumers shift towards it. Ghee and milk fat may be subject to lower GST in India. This had been long standing demand of the dairy industry and ultimately benefit milk producer, increase rural income, spur demand and hasten economic recovery. To enhance the marketing of milk and milk products, many dairy organizations, initiated home delivery of milk and milk products through mobile carts, vans, e-commerce, etc. All these measures helped stabilize milk sales,

opening up opportunities to use e-commerce. Many smart and progressive dairy farmers converted their surplus milk into khoa, paneer, ghee, etc, and sold it to the neighborhood markets through informal channels. All these measures helped sustain dairy industry.

Whole milk can be fermented with starter cultures found locally. It can be utilized for ghee production and by product butter milk can also be packed and sold. The unsold butter may be fed to calves. The byproduct skimmed milk can be fermented for curd/lassie or may be used for flavored milk production or may be fed to calves if remains unutilized or casein can be prepared to sale later on. Kulfi or other frozen dairy products may also be prepared depending upon the skills available among farming families. Curd may be prepared and sold. Khoa can be prepared by desiccating the milk, which can be sold as such or can be used to prepare the khoa-based dairy products.

CONCLUSION

Dairy farming is a vital part of the rural Indian economy, providing both jobs and revenue. India also has the world's largest bovine population. However, when compared to other major dairy producers, milk production per animal is slightly lower. As a result, the dairy industry has a huge opportunity for value addition and overall development. According to the IMARC group's latest study, Dairy industry in India 2020 Edition: Market size, development, prices, segments, cooperative, private diaries, procurement and distribution, the dairy market in India reached a value of INR 10527 billion in 2019, so we should keep this in mind as we move forward in this difficult period.

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INTRODUCTION TO MANGO STEM BORER AND THEIR MANAGEMENT APPROACHES

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Mango originated in the Indo-Burma region and has become naturalized and adapted throughout the tropics and subtropics. India ranks first and accounts for about fifty percent of the world's mango production with 2.5 million hectares producing annually eighteen million tons. Major mango producing countries are India, China, Thailand, Mexico, Pakistan, the Philippines, Indonesia, Nigeria, Brazil and Egypt. India has the richest collection of mango diversity with more than 1000 named varieties.

Distribution

Beside mango, they attack fig, jackfruit, mango, mulberry, papaya, apple, etc. The species recorded in India include *Batocera rufomaculata* (De Geer), *B. rubus* (Linnaeus), *B. roylei* (Hope), *B. numitor* (Newmann) and *B. titana* (Thomson). Of them, *Batocera rufomaculata* De Geer is the most destructive and frequently found borer in mango orchards. In a recent study, Reddy *et al*. (2014) reported that besides *B. rufomaculata*, mango is attacked by two other cerambycids, *viz*. *Glenea multiguttata* Guerin-Meneville and *Coptops aedificator* (Fabricius), and one buprestid in Karnataka. In Pakistan, the scolytid, *H. mangiferae*, was reported to be associated with sudden death disease of mango. Stem borers of the genus *Batocera* are one of the serious pests of mango in India.

Biology

The insect one generation per year. Adults are stout, dark brown beetles with a body length of 50–55 mm in case of males and 55–60 mm in females. Adults emerge with the onset of monsoon and start mating. Female beetle lays eggs singly on the main trunk of relatively older mango trees between June and August. A single beetle lays up to 200 eggs, which hatch in 7–13 days. Eggs are shiny white in colour, oval shaped, 5–7 mm long. Full-grown grubs are 85–95 mm long, stout, yellowish ivory in colour with well-defined segmentation. Pupation takes place in the tunnel and lasts for 20–25 days. Total life cycle takes 170– 190 days, and adult longevity is 60–100 days.

Nature of Damage

After hatching from the egg, the neonate larva initially feeds under the bark. Generally more than 15-year-old trees or those already weakened from other causes, either pathological or environmental, are more vulnerable to attack by stem borers. The larvae tunnel through the sapwood and make tunnels of about 2–3

cm width, which interfere with sap flow and affect foliage and production. The tunnels may either be in the peripheral region or may go deep down into the core of the tree. The size of the tunnel gradually increases as the grub develops. The damage in the early stage is not perceptible, but it can be noticed by the oozing of sticky fluid from several places of the tree trunk and branches. Normally the attack goes unnoticed till a branch or two starts shedding leaves and drying up. A hole with dripping sap and frass on the bark are symptoms visible in advanced stages of infestation. The damage results in yellowing of branches followed by drying and dieback of terminal shoots and branches ultimately leading to the death of the whole tree. Varietal preference of borer is evident with *Alphonso*, *Langra* and *Jehangir* being the most susceptible (25–50% damage) and *Himayuddin* and *Banganapalli* the least susceptible ones. Rootstock and spacing are other factors supposed to influence the borer infestation levels.

Management

- Pruning the affected branches.
- Stem wrapping with a nylon mesh during May–August helps in capturing freshly emerging adult beetles.
- A formulation called 'sealer cum healer' has been developed by IIHR, Bengaluru, which when applied on the stem along with an insecticide (dichlorovos) and a fungicide (Copper oxychloride) helps to protect trunks from egg laying by adults.
- Plugging the holes with cotton dipped in dichlorovos 76% EC or petrol or kerosene kills the active larvae inside the stem.
- Spray trunk portion with chlorpyrifos 20 EC at 3 ml/l or imidacloprid 17.8 SL at 1 ml/l or thiamethoxam at 1 g/l five times at weekly intervals by changing the chemicals after the onset of monsoon to prevent the infestation.

Conclusions

Climate change-driven shift in crop phenology is another factor, which contributed to the complexity of pest problems in mango. Growing mangoes to meet international standards demand residue-free product, and hence there is a need to strengthen good agricultural practices, and research in this direction is essential. Indiscriminate use of broad-spectrum insecticides has taken a toll of natural enemies, leading to a spurt in sucking pests like thrips, mites, mealy bugs, etc. Host plant resistance and semiochemicals are underutilized components of IPM and deserve immediate attention.

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OXIDATION OF PRODUCT CHOLESTEROL

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Cholesterol ($C_{27}H_{46}O$) is one of the main sterols found in animal tissues and the high molecular weight alcohol sterols are the major components of the unsaponifiable fraction of oils and fats. Cholesterol can appear in the free form, combined with long-chain fatty acids or as cholesterol esters, making it an essential structural component of membranes and plasma lipoproteins, modulating their fluidity, as well as being a precursor in the synthesis of steroid hormones, acid, and vitamin D.

Cholesterol oxidation products or cholesterol oxides are part of a group of sterols with a structure similar to cholesterol (cholest-5-en-3b-ol); however, they contain an additional hydroxyl, ketone or epoxide group in the sterol nucleus or a hydroxyl group found on a side chain of the molecule. The formation of cholesterol oxides is system dependent; that is the products originated as well as their relative concentrations vary depending on temperature, oxidation time, presence of water, pH, type of buffer and form of substrate.

In food, cholesterol oxides are formed by nonenzymatic oxidation or autoxidation processes and as the cholesterol is an unsaturated lipid, autoxidation takes place through a complex chain of reactions based on the development of free radicals**.** Room temperature, light, and the presence of oxygen are the critical factors in the degradation processes.

Oxidation of Product Cholesterol

Salted and dried fish

Salt-dried and dried fish preparations require several steps: cooking in brine (1 part salt and approximately 3 parts of fish), draining of the brine, and subsequent drying. These steps can induce cholesterol oxidation. After salting, the direct exposure to light and the surface of the food being in contact with oxygen for long periods are both pro-oxidant factors**.** Thus, numerous studies have been conducted to determine the formation of COPs in salted and dried fish. The salted and dried, and the cooked and dried products showed relatively high levels of COPs. The boiled and dried shrimp samples had levels of 8.3 µg/g and the boiled and dried anchovies had levels of 188.0 µg/g, although the smoked samples had an average of 26.8 µg/g. Mechanism of cholesterol oxidation in processed fish using different model systems: triolein, cholesterol, and cod liver oil, all of which were stored separately at 25 °C, in dry air, for 104 d. The researchers observed an increase in the formation of COPs as well as a decrease in the concentrations of the polyunsaturated fatty acids present in these systems, suggesting that the oxidation of cholesterol in processed and storage fish takes place together with the oxidative degradation of the PUFAs of fish lipids.

Fish are not usually eaten raw, but are subjected to different forms of heat treatment. The different heating methods are a key factor in the cholesterol oxidation process. Greater quantities of COPs are formed when the food is subjected to direct heat. High temperatures produce large quantities of free radicals due to the acceleration of propagation reactions and the decomposition of lipid hydroperoxides**.** During storage, lipid oxidation in fish results in reduced PUFA levels, increasing the concentration of COPs.

Milk and milk Products

Cholesterol is rich in animal food products like milk and milk products. Cholesterol accounts for 0.25-0.40% of the total lipids in milk. In milk, it is present in the fat globule membrane (FGM), in the fat core and in association with milk protein particularly in skimmed milk. Any process disrupting the membrane structure will result in the transfer of cholesterol along with ruptured membrane material to the aqueous phase**.** The cholesterol content of ghee with the highest content in winter and lowest in summer. 80-90% cholesterol initially present in cream passed into butter and 10-20% to buttermilk.

Removal of cholesterol in these Products

Physical, chemical, biological and complexation processes, biochemists, food chemists, food engineers, processing technologists and food industry, must be prepared to develop and implement new technologies to inhibit /or minimize cholesterol oxidation formation.

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PEST MANAGEMENT OF YELLOW STEM BORER *Scirpophaga incertulas* IN RICE

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Rice is the most important cereal crop in the developing world and is the staple food of over half the world`s population. This crop is cultivated in at least 114, mostly developing countries almost 90% of the rice is grown and consumed in Asia. Rice contains less protein from other cereals crop 6-7% and 2-2.5% fat. India has the largest area under rice crop and ranks second in production next to china. West Bengal has the largest area and largest production under Rice crop in India. Rice is grown in almost all the state. West Bengal, Uttar Pradesh, Madhya Pradesh, Bihar, Rajasthan, and Andhra Pradesh, lead in the area. West Bengal and Uttar Pradesh have the highest rice production. The average yield in Punjab 3346 kg/ha.

Insect pest are severe constraints to rice production throughout the world. Rice is affected by more than 100 insect among which 10-12 an economic threat to rice cultivation. Rice stem borer occupy the major status as pest and cause considerable damage to the rice cultivation in almost in all rice growing stage. The status of stem borer incidence in 21 states of India. The yellow stem borer, which infest the plant from seedling to maturity stage. The yellow stem borer has been found in predominant in India. It is caused 1 to 19% yield loss in early planted and 38 to 80% loss in late transplanted in rice crop. Dead heart and whitehead caused by yellow stem borer in rice crop. It caused 3 to 95% grain yield loss in India.

Life cycle of stem borer

Rice stem borer passes its life cycle through four stage viz, egg, larva, pupa and adult. May get prolonged depending on the weather condition. The entire life cycle complete in 35- 70 days. Generally two or three generation of this pest is complete during single crop.

Mark of identification

Eggs laid on upper leaf surface in masses of 15-80 and covered with buff-coloured hairs. The number of eggs laid by a single female moth is up to 150. Eggs hatch in about 5 to 10 days. The instar larvae on dispersed with the help of silken threads and wind. Then they bore into the rice stem. Generally, only one larva enters in plant. The larvae feed on the internal tissues of the stem and undergo 5 to 6 moulting. A fully-grown larva formed in about 20 to 40 days depending upon the climate condition. A developed larva

measures about 13 mm in length and is white and yellowish white in colour. Larva makes an exit hole and pupates within the larval turned, usually at the base of the plant. The cocoon is silky white in appearance. It remains in pupal stage for 6 to 12 days. Adult are dirty white or greenish yellow front wings. The adult moth is small size measuring about 10 to 15 mm with wing expanse of 25 to 45 mm and black spot on each of the forewing.

Nature and damage

The caterpillar causes the damage. Which borer into from the growing point to downwards. Because of feeding, the central shoot killed causing dead hearts (vegetative stage). The dry of growing part of plant cause dead heart. The larva attack in early stage produce are devoid of grain and known as "white ear" or white head" (reproductive stage).White ear due to drying of entire panicle. Basmati varieties suffer heavy damage then coarse varieties. Caterpillar alone is destructive. It bore and feed inside the stem and construct an emergence hole that always located above the water level.

Management

- Resistant varieties like ratna, jaya, IR20, IR26, IR36, IR50 and Chandina, may be grown.
- Close planting and continuous water stagnation at early stage should be avoided.
- The egg masses may be collect from plant and destroyed.
- Ploughing and irrigating the fallow rice paddy in early spring to kill over wintering larva and pupae.
- To use and apply enough fertilizer to have a healthy crop so those to stand the pest attack.
- Removal and destruction of all the dead hearts and infected plant show early pin holedamage.
- Release of egg parasitoid *Trichograma japonicom* @ 50,000/ha. During egg laid period. A weekly intervals.
- The stubbles should be removed and destroyed by the ploughing the field immediately after the harvest.
- Use the light trap to attract nocturnal moth. Pheromone traps @ five traps/ha.
- the yellow stem borer lay eggs near the tip of leaf hence clipping and leaning of tip of seedling before transplanting to eliminate the egg mass.
- Apply *bacillus thuringiensis* kurstaki and neem seed kernel extract in the combination of 2.5kg/ha. Moreover, reduce to 1% oviposition.
- Application of cartap hydrochloride 4G @ 2.5kg a.i. /ha.
- Spray of triazophos 40 EC @1 liter/ha.
- Nursery protection by applying phorate @ 12.5kg/ha. Of nursery bed.

SMART AGRICULTURE

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Smart or Precision Agriculture is a cyclic optimization system wherein statistics have to be accumulated from the field, analysed and evaluated and eventually used for selection making for site-precise control of the field. Smart farming technology (SFT) cowl a lot of these components of precision agriculture and may be labelled in statistics acquisition, statistics evaluation and assessment and precision software technology. Data acquisition technology encompass GNSS technology, mapping technology, statistics acquisition of environmental residences and machines and their residences. Data evaluation and assessment technology contain the delineation of control zones, decision support system and farm management information system.

Introduction

Agriculture is an important source of food in the world. Recently, climate change and variability have exacerbated the potential adverse effects on global agriculture. It is estimated that by 2050, there will be more than 2 billion people in the world. However, climatic uncertainty in certain regions has a negative impact on agriculture and food production. In order to achieve sustainable food production, global agriculture must use agricultural resources wisely. Better decision-making accuracy and current events can maximize productivity. Resource utilization [1]. Starting from the farm, the farm is recorded and operated. Now, the management of the farm includes electronic equipment with higher accuracy and decision-making capabilities. By combining available resources with their judicious and timely use, the bottom line of the server farm can be increased. Now, computers and electronic devices can do this. In order to get the maximum food and net profit.

Techniques used in Smart Farming

There are so many techniques which are used in farming which makes our agriculture smart. Some very important techniques which are used in smart farming are as follows:

Autonomous and Robotic Labors

The labour scarcity is being taken into consideration as a primary obstacle in crop cultivation in latest years. The incidence of the professional labour scarcity affected meals production in nearly all vegetation or even remodelling everlasting adjustments within side the cultivation sequence. That could be a primary danger to sustainable meals production. The important reasons for the labour scarcity encompass better wages for labours

within side the close by towns and towns. To address this trouble for sustainable meals safety and current agriculture seeking to use self-sufficient robots and exertions. Robotics and Autonomous Systems (RAS) are set of digital and mechanical equipment's that operates through the software program generation for unique purposes.

Automatic Watering and Irrigation

Agricultural irrigation water is turning into scared now no longer most effective in arid and semi-arid areas however additionally with inside the excessive rainfall areas. Because of the choppy distribution of rainfall sample now no longer efficaciously utilized by maximum of the crops. In this contemporary age, subsurface drip irrigation (SDI) performs a crucial position for really appropriate use of water as per the requirement of the crop. But this gadget nonetheless wishes to maintained through the operators.

IoT Enabled Sensors for Moisture Determination

In order to collect greater precision in water utilization (**Internate on Thing**) solution, involves unique ground-primarily based totally sensors for information recording and processing, are narrowing the gaps among the pc utility and implemented science. IoT primarily based totally clever irrigation device beneficial to simulate the irrigation desires of the crop and area with sensing of edaphic elements like soil temperature, moisture and evaporation rate, and temperature air humidity and can also are expecting destiny water requirement of the crop linking with the climate forecast from the Internet in precise a region. The shape of this device is predicated omen algorithm, which detects sensors information and integrating with climate factors e.g. rainfall, humidity, temperature, and UV for destiny prediction. This stepped forward era has the capability to increase really apt water utility and use consistent with crop level and requirement.

Crop Health, Weeding and Spraying

Innovation in agricultural takes the far-flung farming network from antique agricultural techniques. Integration and alertness of gadget studying and Artificial Intelligence (AI) make it smooth for farmers to locate diseased patch, heavy weed infestation, and crop fitness through photograph processing. Along with this innovation, drone generation is likewise extensively followed in lots of clever farms for spraying of herbicides, pesticides, fertilizer broadcasting with the aid of using the photograph processing through Normalized Difference Vegetative Index (NDVI) or near-infrared (NIR) sensors that are connected with crop fitness index.

Field Drones

In the latest past, the drones have made an access into human lifestyles and augmented way of life in lots of approaches which includes insecurity, agriculture and plenty of more. An autonomous flying device that has a pre-deliberate flight or managed via way of means of far flung is referred to as a drone. In agriculture, particularly drones are used for imaging for the identity of weeds, planting area, fertilizer and weedicide application, and real-time weather forecasting.

Harvesting

Harvesting from the sphere entails selecting best the ones elements of the vegetation that are economically viable, in keeping with the desired size, shape, shadeation and the, more importantly, maturation level of the fruit. Harvesting via robotics entails in particular objectives, (i) the green capacity of the robotic to feel the fruit component and quality (i.e. maturity), (ii) selecting of fruit without detrimental the fruit.

Yield analysis

Yield mapping is devised control approach to deal with grain scarcity and availability. This approach isn't being utilized in this period of technology. Previously it is used for estimation via the waft of the grain within side the integrate and primarily based totally on rotations the yield estimated. Greater fluctuation in environmental situations needs to estimate yield manufacturing from the sector after every and each climate disaster. Although, on this stage, yield mapping is changed via GPS, satellite tv for pc and drone imaging.

Future Challenges

Smart or precision agriculture is very innovative as well as very expensive. The farming community is not well aware about this system, especially in our country. The main challenge is the small landholdings and the farmers are unable to adopt these technologies with limited knowledge and skills.

Conclusion

The technological revolution in agriculture led by the enhancements in robotics and sensing technologies seems set to disrupt the superior practices. Use of cutting- edge agricultural technologies is should due to the fact it could growth manufacturing and might lessen the input cost. Several elements of modern autonomous machinery can supply high quality advantages while applying them in agriculture, especially in skill farming. In the future, smart farming can be an effective device for farmers for efficient use of resources and real- time management.

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Water management in Cucurbits, Legumes and Leafy crops - A guide to farmers

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Irrigation water plays a vital role in Indian agriculture and in horticulture also. Water availability in the soil is one of the most important requirements for successful crop production. Good growth of the totally depend upon the adequate moisture percent present in the soil. Adequate moisture percent present in the soil directly helps in growth, yields and quality of vegetable crops. Irrigation water should be applied to the crop in particular stage when it is really require. Applying irrigation water in perfect stage can minimize the disease incidence and it will also reduce the spreading of few pathogens. The irrigation water is the vector of off-site nutrient movement of nitrate in solution and phosphate in sediments as well as other soluble chemicals, proper irrigation management directly affects the efficacy of a best management practices (BMP) plan. Different crops have growth characteristics that result in different relative water use rates. Requirement of water differ crop wise as well as growth stage of the vegetables. For flowering vegetables, such as pea, beans, cucurbits and tomatoes critical stage of water requirement is at flowering and fruit or seed development stage. An adequate supply of water is essential for root crops once the roots start enlarging. For heading crops, such as lettuce and cabbage, the most critical period for water is at heading stage. The availability of water in soil for crop growth is very crucial factor so that the suitability and the quality of water available for irrigation should be tested before sowing and transplanting of vegetable crops.

Need for water requirement

- Vegetables contain 80 to 95 percent water. Because they contain so much water, their yield and quality suffer very quickly from drought.
- For good yields and high quality, irrigation is essential for the production of most vegetables.
- If water shortages occur early in the crop's development, maturity may be delayed and yields are often reduced.
- If moisture shortage occurs later in the growing season, quality is often reduced even though total yields are not affected.
- Most vegetables are rather shallow rooted and even short periods of two to three days of stress can effect marketable yield.
- Irrigation is likely to increase size and weight of individual fruit and to prevent defects such as toughness, strong flavour, poor tip fill and pod fill, cracking, blossom-end rot and misshapen fruit.

- On the other hand, it reduces soluble solids in muskmelons and capsaicin in hot peppers if applied during fruit development.

Water management in cucurbits

Cucumber: In dry weather the crop is irrigated every 4th or 5th day but during rainy season, the interval may be increased depending on rainfall distribution. Drought during flowering results in deformed, non-viable pollen grains leading to poor yield. Irrigation decreases bitterness in fruits. Cucumber is generally irrigated by furrow or basin methods. While irrigating, care should be taken to see that the water from the basin or furrows do not overflow.

Muskmelon: It is deep rooted plant sending roots up to 180cm depth. Muskmelon cannot withstand water logging & prefers well drained soil. Being summer crop, it requires considerable amount of moisture from the time it makes most vigorous growth up to the time the fruits mature to get good yield. Irrigation to maintain 50-75% of available soil moisture during blossoming period was found optimum. Great care should be taken to avoid over watering just before the ripening period as it results in poor quality fruits. Furrow & basin irrigation are commonly adopted for watering muskmelon. In regions of extreme scarcity pitcher irrigation can be followed.

Watermelon: Watermelon planted on river beds does not require any irrigation as it obtains sufficient moisture through capillary action from the sub-soil water. In other places, crop is irrigated soon after sowing if the field is deficient in moisture, they are watered by pitcher or by water can. Soil moisture stress during pre-flowering, flowering or fruit development stages drastically reduces the yield. During ripening, irrigation has to be stopped as dry conditions are required for ripening, as otherwise, cracking of skin occurs together with a deterioration of the flesh which becomes more fibrous & less juicy.

Bottle gourd: The summer crop requires frequent irrigations after every 3rd or 4th day while the crop sown in rainy season is irrigated whenever required. Winter sown crop is irrigated sparingly once in 10 to 12 days. Basin & furrow irrigations are commonly adopted to raise bottle gourd. Pitcher irrigation can also be practiced to grow a profitable crop which greatly reduces water requirement compared to conventional basin irrigation.

Table 1. Critical periods for irrigation of vegetable crops.

Vegetable crops	Critical period (s)
Amaranthus	Throughout growth
Ash gourd	Flowering and fruit development
Asparagus	Spear growth, fern growth
Bitter gourd	Flowering an fruit development
Bottle gourd	During fruit development
Broccoli	Transplanting, flower bud production
Cabbage	Transplanting and head development
Carrot	Root enlargement
Cauliflower	Transplanting and curd development
Cluster bean	Flowering and pod development
Cow pea	Flowering and pod development

Cucumber	Pollination and fruit enlargement
Eggplant	Transplanting, flowering and fruit development
French bean	Flowering and pod development
Lettuce	Throughout growth.
Lima bean	Blossom and pod development
Muskmelon	Pollination and fruit enlargement
Onion	Transplanting and bulb enlargement
Pea	Pod development
Pepper	Fruit development
Pointed gourd	Flowering an fruit development
Potato	Tuber development
Rhubarb	Petiole formation for harvest
Snap bean	Blossoming and enlargement
Sponge and ridge gourd	Flowering an fruit development
Spinach	Throughout growth
Spinach beet	Throughout growth
Sweet corn	Silking and tasseling ear development
Sweet potato	Root tuber development
Tomato	Transplanting, early flowering, fruit set and development
Turnip	Root enlargement
Watermelon	Pollination and fruit enlargement

Bitter gourd: It is shallow rooted vegetable with roots mostly concentrated in top 60cm soil layer. It is grown during both rainy & summer seasons. During summer, crop is irrigated immediately after planting. Subsequently irrigations are given every 4th or 5th day until flowering.

Sponge gourd: It is medium rooted crop & needs well drained soils. 1st irrigation is given immediately after sowing & subsequent ones every 4th or 5th day during summer. Basin or furrow irrigation commonly adopted.

Ridge gourd: The crop is shallow rooted & responds well to irrigation. 1st irrigation given immediately after planting if there is insufficient moisture in soil. Later frequent irrigation once in 4 to 5 days given in summer.

Ash gourd: It has shallow but extensive root system and responds well to irrigation. Irrigations are given at 8 to 10 days interval during summer. Over watering results in excessive vegetative growth**.**

Snake gourd: It is deep rooted crop & prefers well drained conditions. In summer irrigate immediately after sowing & later foe every 4th or 5th day. Snake gourd is irrigated by basin or furrow method. Pitcher method increases water use efficiency.

Pointed gourd: This is a deep rooted vegetable, fairly resistant to drought. The crop is irrigated once in 10-15 days depending on soil moisture.

Water management in legumes

Peas: Pea is a medium rooted crop sending roots up to 120cm. Peas responds well to irrigation when there is soil moisture deficit. Soil moisture deficit greatly reduces nodulation & growth rate.

French bean: The crop is medium rooted with roots usually in top 120cm of soil. French bean is very sensitive to soil moisture stresses. A shortage of moisture between sowing time & flowering reduces vegetative growth. Irrigate once in 7-10 days interval according to season. It is wise to irrigate after each picking if the field is picked once or twice a week.

Cow pea: It is medium rooting crop which prefers well-drained soils. Crop is very susceptible to water logging but can withstand drought fairly well. If the crop is grown earlier, irrigate once in 8-15 days. About 4-6 irrigations may be required.

Lima bean: It is a deep rooting crop extending root system beyond 120cm depth. Heavy rains or sprinkler irrigations at the start of flowering seriously limit basal pod set apparently by favouring the rupture of pollen grains prior to or during their germination. It is desirable to irrigate at an interval of 8-10 days during cool season from October onwards.

Cluster bean: The crop is fairly resistant to drought. There is no need of irrigation in rainy season. Water stress decreases nitrogenase activity & nitrogen fixation but upon rewatering there will be rapid recovery.

Water management in leafy crops

Amaranthus: It has shallow rooting with most of the roots confined in top 60cm of soil. Plants should never be allowed to wilt, beds should not be flooded. The crop is irrigated every 4th or 5th day after cutting. There is no need of irrigation during rainy season if there is good distribution of rains.

Spinach: It is shallow rooted crop & thrives best in a uniformly moist soil. The first irrigation immediately follows planting & 2nd may be necessary very soon to get the seedlings above ground. Soil should not be allowed to dry during the growing season. Ample moisture is very important near harvest which will improve yield & quality. Spinach is irrigated by flooding or by furrows.

Fenugreek: It is a cool season crop fairly resistant to frost. First irrigation given just after sowing. Weekly irrigation after germination keeps plants succulent & gives more cuttings. During hot weather, frequent irrigations are necessary for obtaining quick growth of crop & for getting more cuttings. The crop is irrigated by furrows or flooding in basins or beds.

Spinach beet: It is a shallow rooted crop & responds well to irrigation. Seeds require good moisture for germination, so it is preferable to give a light irrigation immediately after sowing. Later, give light but frequent irrigations to give adequate & constant supply of moisture. Over irrigation should be avoided as plants cannot withstand water logged conditions.

Conclusion

Irrigation water is most important factor in crop growth. Water stress during critical growth periods reduces yield and quality of Crops. Crop water use (ET) at critical growth stages can be used in irrigation scheduling to avoid stressing Crops. Crop water use (ET) is weather dependent as well as soil, water and plant dependent. Periodically check soil water at different depths within the root zone and at different growth stages to avoid stressing the crop during critical growth stages.

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USE OF NANOFERTILIZERS IN AGRICULTURE

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Agricultural land is decreasing day by day due to erosion, environmental pollution, unconscious irrigation and fertilization. On the other hand, it is necessary to increase agricultural production in order to meet the needs of the developing industry as well as the nutritional needs of the growing population. In the recent years, nano fertilizers have begun to be produced to obtain the highest amount and quality of production from the unit area. Previous research shows that nano fertilizers cause an increase in the use efficiency of plant nutrients, reduce soil toxicity, minimize the potential adverse effects of excessive chemical fertilizer use, and reduce fertilizer application frequency. Nano fertilizers are important in agriculture to increase crop yield and nutrient use efficiency, and to reduce excessive use of chemical fertilizers. The most important properties of these fertilizers are that they contain one or more of macro and micro nutrients, they can be applied frequently in small amounts and are environmentally friendly. However, when applied at high doses, they exhibit decreasing effects on plant growth and crop yields, similar to chemical fertilizers.

Nano Fertilizers

Nano-fertilizers are nutrients encapsulated/coated with nanomaterial for the control and slow delivery of one or more nutrients in order to satisfy the imperative nutrient requirements of plants .Nano-fertilizer is used for both materials of a physical diameter between 1 and 100 nm in at least one dimension (e.g., ZnO nanoparticles) and those existing at the bulk scale with more than 100 nm in size but that have been modified with nano scale materials (e.g., bulk fertilizer coated with nanoparticles). The exceptional properties of nanoparticles, such as high surface area/volume size ratio and enhanced op to electronic and physicochemical properties, compared to their bulk counterparts, is now emerging as a promising strategy to promote plant growth and productivity. As a result of their unique properties, nanoparticles may influence metabolic activities of the plant to different degrees compared to conventional materials and have the potential to mobilize native nutrients, such as phosphorus, in the rhizosphere.

Slow release: The nanocapsule slowly releases nutrients over a specified period of time.

Quick release: The nanoparticle shell breaks upon contact with a surface (such as striking a leaf).

Specific release: The shell breaks open when it encounters a specific chemical or enzyme.

Moisture release: The nanoparticle degrades and releases nutrients in the presence of water.

Heat release: The nanoparticle releases nutrients when the temperature exceeds a set point.

pH release: The nanoparticle only degrades in specified acid or alkaline conditions.

Ultrasound release: The nanoparticle is ruptured by an external ultrasound frequency.

Magnetic release: A magnetic nanoparticle ruptures when exposed to a magnetic field.

Benefits of nanofertilizers over conventional chemical fertilizers

- Their nutrient delivery systems as they regulate the availability of nutrients in crops through slow/control release mechanisms. Such a slow delivery of nutrients is associated with the covering or cementing of nutrients with nanomaterials. By taking advantage of this slow nutrient delivery, growers can increase their crop growth because of consistently long-term delivery of nutrients to plants. For example, nutrients can be released over 40–50 days in a slow release fashion rather than the 4–10 days by the conventional fertilizers.
- In addition, nanofertilizers required in small amount which reduce the cost of transportation and field application.
- An additional major advantage is over accumulation of salt in soil can be minimized as it required in small amount.
- Another advantage for using nanofertilizers is that they can be synthesized according to the nutrient requirements of planned crops. In this regard, biosensors can be attached to a new innovative fertilizer that controls the delivery of the nutrients according to soil nutrient status, growth period of a crop or environmental conditions.
- The miniature size, high specific surface area and high reactivity of nanofertilizers increase the bioavailability of nutrients.
- Providing balanced nutrition, nanofertilizers facilitate the crop plants to fight various biotic and abiotic stresses.

Use of Nano-Fertilizers in Sustainable Crop Development

Scientists believe that zinc nano-fertilizers are responsible for robust plant growth (shoot and root system) and increase the leaves' chlorophyll content.

In a previous study, the amendment of zinc nano-fertilizers significantly increased the yield of peanuts. These nano-fertilizers also improve seed production of vegetables. Similarly, carbon nanotubes containing fertilizers were reported to decrease the days to germination. These nano-fertilizers were also found to promote the development of plant root systems in rice seedlings.

Nano-fertilizers also reduce the crop cycle period and increase crop yield. For example, the amendment of nanoparticles carrying NPK (nitrogen, phosphorus, and potassium) to wheat showed an increase in grain yield and reduced the crop cycle of wheat by 40 days. Similar results were obtained in the maize cropping system.

Environmental and health concern of nanofertilizers

The application of nanostructures or nanoparticles as agrochemicals (fertilizers or pesticides) is systematically being explored, before nanofertilizers could be used in agriculture or farming for a general farm practice. The properties of many nanoparticles are considered to be of potential risk to human health, viz., size, shape, solubility, and crystal phase, type of material, and exposure and dosage concentrations. However, expert opinions indicate that food products containing nanoparticles available in the market are probably safe to eat, but this is an area that needs to be more actively investigated. To address the safety concern detail studies are required to know the impact of nanoparticles within the human body once exposed through nanofood. Researchers have to assess and develop proper assessment strategies to assess the impact of nanoparticles and nanofertilizers on biotic and abiotic components of ecosystem. Among the various issues, the accumulation of nanomaterials in environment, edible part of plants might be the important issues before use in agriculture.

Limitations of Nano-Fertilizers

Despite aiding in sustainable crop production, limitations of nano-fertilizers should be carefully considered before marketing. The limitations of using nano-fertilizers mainly arise due to the absence of rigorous monitoring and research gaps.

Some of the drawbacks associated with the use of nano-fertilizers for sustainable crop production are enlisted below:

- Lack of a nano-fertilizer risk management system
- Lack of production and availability of nano fertilizers in required quantities. This limits the wider scale adoption of nano-fertilizers as a source of plant nutrients.
- The high cost of nano fertilizers
- Lack of standardization in the formulation process. This brings about different results of the same nanomaterial under various pedoclimatic conditions.

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Kafal (*Myrica esculenta*): AN UNDERUTILIZED PLANT FOR NUTRITIONAL SECURITY

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Kafal is an important indigenous crop of the Himalayan region. It is a popular, potentially income-generating wild edible tree species. Almost all the parts of the tree are used for different purposes. The fruit is eaten as raw and can be used for the preparation of several value added products. It is widely used in folk medicine to treat several ailments. This article contains information about several aspects of Kafal i.e. classification, origin, distribution, species, varieties, botany, nutritional and medicinal value and value added products.

Introduction

The genus Myrica is a large group comprising more than 97 species in the Myricaceae family.M. esculenta commonly known as Boxberry, Kaiphal and Kathphala has been reported to be the only species found in India. Its synonyms are M. Nagi Hook. F. non Thunb, M. Sapida Wall.,M. Farqhariana Wall. andM. Integrifolia Roxb Morella esculenta (Buch.-Ham. ex. D. Don) I.M. Turner is the newly accepted name for Myrica esculenta Buch.-Ham. ex. D. Don, and the later name is treated as a basionym of Morella esculenta. In the Western Himalaya, the species grow mainly in Pinus roxburghii, Quercus leucotrichophora and mixed oak forests and is popular among local people for its delicious fruits and processed products.This fruit tree carries a lot of commercial importance. The popularity of the species can be judged from the fact that local people of the region can earn over Rs. 14.00 lakh/season by selling its fruits. Besides, it is also considered as a good fuel source and used as fodder and a source of medicine and oil.

Classification: Taxonomic classification of Kafal is **:**

Kingdom: Plantae,
Phylum: Tracheophyta,
Class: Magnoliopsida,
Order: Fagales,
Family: Myricaceae,
Genus: *Morella*
Species: *esculenta*

Origin and distribution

It is native to India and is found in Himachal Pradesh, Uttrakhand and north eastern region including Assam Arunachal Pradesh, Sikkim, Manipur, Uttranchal and Khasi, Jaintia, Naga and Lushai hills of Meghalaya in between 900-2100 m above the sea level. Apart from India, it is also found in Nepal, China, Japan, Pakistan, Singapore, and Malaya Islands.

4. Species and varieties

According to "*The Plant List" database* includes 115 scientific plant names of species rank for the genus *Myrica* out of them 20 are accepted species names (http://www.theplantlist.org/) and few of the important species are mentioned in Table 1. Since it grows in wild form and no systematic breeding effort has been done yet. However on the basis of flower color, Ayuveda claims that there are two varieties i.e. Shweta with white flower and Rakta with red flower (www.ayushveda.com)

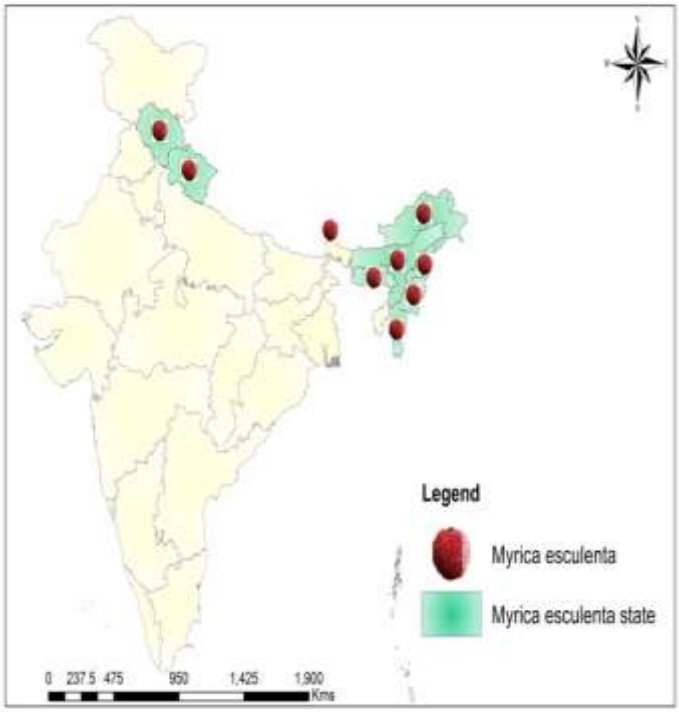

Figure 1. Natural distribution of *Myrica esculenta*. The shaded area represents the natural habitat of*M. esculenta* in India

Table 1.The important *Myrica* species and their distribution

Common name	Scientific name	Distribution
Box myrtle	*M. esculenta*	India, Bhutan, China, Japan, Malaya Island, Nepal, Pakistan, and Singapore,
Candleberry, Wax myrtle, Southern wax myrtle, bayberry tree, and tallow shrub	*M. cerifera* L.	Bermuda, North and Central America and Hawaii, Illinois, the Caribbean
Northern bayberry	*M. persylvanica* Mirb.	North America, Ontario, Ohio, Canada and south to North Carolina
Chinese bayberry	*M. rubra*	China and Japan
Evergreen bayberry, pocosin bayberry, southern bayberry,	*M. caroliniesis*	USA
Waxberry/candle berry	*M. cordifolia*	South Africa
Odourless bayberry, odorless wax-myrtle	*M. inodora W. Bartram*	USA
Bog-myrtle, sweet gale, sweet willow and Dutch myrtle,	*M. gale* L.	USA
Sierra babyberry/ mountain wax myrtle	*M. hartwegi* S. Watson	Belgium, Canada, Germany, and Netherland
Swamp bayberry	*M. heterophylla* Raf.	USA
Chinese Bayberry	*M. rubra*	India, china

Source:Huguet *et al.*, (2005), Kumar and Rana (2013), Silva *et al.*, (2015), http://edis.ifas.ufl.edu/pdffiles/ST/ST41100.pdf.

Botany:

Tree: It is a small to moderate sized, evergreen, dioecious tree, which can reach up to 10 to 15 m height with 80 to 95 cm trunk diameter. Bark is brownish, rough and vertically wrinkled. The bark is soft, brittle, rough, vertically wrinkled with greyish dark colour from outside, and dark brown from inner side with smooth surface.

Leaves: Leaves are almost crowded towards the end of branches with pale green lower surface and dark green upper surface. Leaves are lanceolate to oblanceolate or obovate with entire or serrate margin, nearly entire or sharply spinous-serrate, obtuse, coriaceous, glabrous above with resinous dots beneath.

Flower and inflorescence: Trees come to flowering during last week of October and continue up to December. Its flowers are white in color and born in clusters. Inflorescence is a catkin; male flower spikes are reddish, in branched axillary clusters; female flowers in slender spike or occasionally at the end of male spikes. Pistillate flowers are very small, sessile, solitary and bracteates with sepals and petals either absent or not visible. Staminate flower has 12 stamens, each with a very short filament.

Fruit: Tree starts fruiting after 6-8 years and ripening occurs from April to June. Fruit is globose, succulent, ellipsoid, drupe with hard endocarp, almost the size of cherry, tubercled, reddish or cheese coloured when ripe with rugose nut. Individual fruit weight ranges from 5.1 to 12.6 g, while fruit length and width vary from 2.2 to 3.2 cm and 1.7 to 2.8 cm, respectively. There is 30 to 40% juice recovery from the fruits.

Seed: Seeds of kaphal are triangular in shape with astringent taste and their weight ranges from 0.82 to 2.02 g with dimension of 1.1 to 1.9 cm × 0.8 to 1.4 cm.

Table 2 Range of nutritive value in Kafal fruit

Parameters	Value
Ash (%)	1.91-2.18
Moisture content (%)	72.33
Crude fat (%)	4.93
Crude fibre (%)	5.22-7.53
Crude protein (%)	9.62
Carbohydrates (%)	76.33-78.03
Energy (kcal/g)	386.80-395.04
Protein %	9.28
Calcium (mg/g)	4.23-4.63
Magnesium (mg/g)	8.4
Potassium (mg/g)	7.63-7.75
Phosphorus (mg/g)	0.24
Sodium (mg/g)	0.75-0.81
Manganese (mg/g)	0.032-0.041
Zinc(mg/g)	0.22-0.32
Iron(mg/g)	0.404-0.417
Copper (mg/g)	0.004-0.005

Source : Seal (2011), Sood and Shri (2018)

Importance and uses:

Medicinaluses: The tree has great importance since from the ancient Ayurveda and Yunani system of medicines where most of the part of the tree is utilized as a medicine (Chatterjee and Pakrashi, 1994). The bark of the tree is traditionally used as antiseptic, washing putrid sores, fish poisoning and external plaster in rheumatism. It is also used for tanning and dying yellow colored dye (Jeeva *et al.*, 2011). An aqueous extractof the bark showed anti-hyperlipidemic effect and have chemoprotective and antioxidant properties. The oil of the flower is a tonic useful inearache, diarrhoea, inflammation and paralysis (Jeeva *et al.*, 2011). The fruit of *M. esculenta*have high amount of phenolics, flavonoid and natural antioxidants which can play vital role

in reducing the oxidative stress and preventing from certain degenerative diseases and possess anti-inflammatory and antimicrobialproperties.

Nutritional value:

Myrica esculenta fruits has TSS (5.7-6.5 %), acidity (2.5-4.8 %), vit. C (17.6-28.2 mg/100 mL pulp), reducing sugar (1.0-3.5 %) and total sugar (3-7.7l %) (Rymbai *et al* 2016). The nutritional profile of the fruits is presented in Table 2.

Value addition: It can be utilized for the preparation of variety of good quality and nutritionally enriched processed products i.e.pickles,syrups, jams and refreshing drinks (Ksanbok, *et al* 2014).

Other uses:

The tribal people use Kafal plant for diverse purposes such as fruit, fuel, fodder, wood. Beside these it can also be used for tanning and obtaining yellow colored dye **(**Kumar and Sinha, 2004; Jeeva *et al*., 2011).

Conclusion and Future prospects

The above information indicates that Kafal is an important and multipurpose plant for nutritional and economical security of the local people of the Himalayan region. Hence, there is utmost need to focus on its breeding to develop ideal varieties which can serve the multiple requirement of not only human but also for animals and environment.

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BENEFITS OF MULCHING ON FRUIT CROPS PRODUCTION UNDER RAINFED CONDITION

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Looking to the several biotic and abiotic challenges in fruit production, adoption of mulching technique at large scale might be helpful to mitigate several problems considering the advantages of mulching. Mulching in fruit crops has positive impact on soil moisture status, soil temperature along with weed suppression thus on rhizosphere of the plants. These rhizospheric conditions favor the vegetative as well as yield and quality parameters of the fruit crops. Judicious use of water is essential for increasing area under fruit crop production in water deficit area and this is the most important aspect of crop production, therefore, essential measures of moisture conservation are used. Mulching is an agricultural and horticultural technique in which organic materials like- plant residues-straw, hay, groundnut hulls, leaf and compost, peat, wood products-saw dust and animal manures, and synthetic materials paper, polyethylene, wax coated papers, aluminum, steel foils and asphalt spray emulsions etc. are used for insulating barrier which checks evaporation from soil surface, protecting the roots of the plants from heat, cold or drought or to keep fruit clean, modifies the soil and air microclimate in which a plant is growing. Mulch is used to cover soil surface around the plants to create congenial condition for the growth. Mulching is also applicable to most field crops. However, it is preferred in fruit orchard. Most commonly used agricultural mulch is black plastic. White or aluminum reflective mulch is used where soil cooling is desired, such as establishing fall crops during the heat of summer.

Introduction

The word mulch is the German word "molsch" which means soft to decay referred to the use of straw and leaves by gardeners as a spread over the ground as mulch. Mulches are either organic or inorganic. Organic mulches are those derived from plant and animal materials. Organic mulch properly utilized can perform all the benefits of any mulch with the possible exception of early season soil warming. Mulch should be applied immediately after germination of crop to achieve optimum advantage from the mulch like- water conservation, soil temperature modification, soil conservation, nutrient addition, improvement in soil structure, weed control preventing the runoff and soil loss checks the water evaporation and crop quality control in dry regions. Mulching facilitates more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops. Inorganic mulch includes plastic mulch use in commercial crop production which are poly vinyl chloride or polyethylene films it is preferred as mulching material for

crop production. Black plastic mulch film is becoming popular and very good results under rainfed agriculture. The black polyethylene mulch also checks all types of weeds in addition to soil moisture conservation, therefore, black plastic mulch is more beneficial. Organic mulches have the advantage of being biodegradable, but decomposition may result in a temporary reduction in soil mineral nitrogen. Black polyethylene mulches are used for weed control in a range of crops under the organic system of fruit crop production. There are additional environmental benefits if the mulch is made from recycled materials.

Precautions for Mulch Laying:

- Do not stretch the film very tightly. It should be loose enough to overcome the expansion and shrinkage conditions caused by temperature and the impacts of cultural operation.
- The slackness for black film should be more as the expansion, shrinkage phenomenon is maximum in this color.
- The film should not be laid on the hottest time of the day, when the film will be in expanded condition.

Advantages of mulches on soil and plants:

1. **Moisture Conservation:**

During summer, the crop should be mulched with paddy straw or wheat straw at the base of the fruit tree up to 15-20 cm from the trunk. The conservation of soil moisture through mulching is one of the important purposes. This can reduce irrigation frequency and amount of water; it may help reduce the incidence of moisture related physiological disorders such as fruit cracking in lime and pomegranate. Stewart et al. (1926) evaluated asphalt-impregnated paper for in-row weed control for pineapple (Ananas comosus (L.) Merr). At planting time, provide two to four inches of organic mulch such as wood chips, pine needles, or compost. Mulching cools the soil, conserves water, and suppresses weeds. Black polythene mulch application in aonla during April–June is found most effective to moisture conserved.

2. **Reduce infiltration rate:**

Mulching increases the total intake of water due to formation of loose soil surface. The rain drops on mulched soil do not seal the particles as they do on un-mulched soil. This sealing effect of rain drops results in more loss of water through erosion. The water infiltrated in soil can be utilized by crops there-by crop yields are increased. Infiltration and soil evaporation are among the key processes that determine soil water availability to crops in semi-arid agriculture. Mulch cover reduces surface runoff and holds rainwater at the soil surface thereby giving it more time to infiltrate into the soil. Straw mulch conserved higher soil moisture to an extent of 55% more compared to control. Application of black plastic mulch along with irrigation at 60% field capacity in kiwi was to be the best treatment as its effect nearly similar to that of standard irrigation.

3. **Reduce run-off and soil erosion:**

Soils from dry region are highly susceptible to water erosion and wind erosion because rainfall occurrence is frequent during intense storms and surface is not adequately protected by vegetation which effectively retards runoff. Therefore, to reduce erosions by wind and water is an important reason for using mulches in dry regions. Crop residues when applied at adequate level increase infiltration rate. Decomposition of these residues results in improving soil aggregation and suitability for crop production. Mulching the soil surface reduce velocity of runoff, evaporation and increase the amount of water stored in the soil profile. Mulch can effectively minimize water vapour loss, soil erosion, weed problems and nutrient.

4. **Reduce weed growth:**

The mulching favors the reduction of evaporation leading to reduce the germination and nourishment of many weeds, if somehow weeds are growing, they become pale and ultimately die. White and green covering had little effect on weeds, whereas brown, black, blue or white on black films prevented weeds emerging. The guava treatment with black polythene produced maximum number of fruits as well as highest yield per plant. Organic mulches, such as straw, dried grass or compost, are excellent for use under guava trees to eliminate weeds and to conserve moisture. Raspberry growing in straw mulch yields better than on hand-weeded plots, in herbicide fallow (simazine) or when using synthetic mulches such as black polyethylene, or white on- black polyethylene.

5. Pest control:

Transparent polyethylene mulch reduced whitefly populations, aphids caught in yellow traps and virus diseases incidence, in comparison to bare soil. Transparent mulch has a reflective effect and reduces the incidence of virus diseases by confusing aphids, which vector the virus. The mode of action of the transparent mulch is probably the result of high reflectance of UV light. These results agree with those of several other investigators. Apple fruits should be mulched to the drip line with 6 to 8 inches of straw or hay in May. Mulch should be reapplied periodically and pulled away from trees at the end of August or early September.

6. Maintain soil temperature:

Mulching reduces soil temperature in summer and raises it in winter. It prevents the extremes of temperatures. The cooling effect of soil promotes root development. In general, the effect of mulching on the temperature regime of the soil varies according to the capacity of the mulching material to reflect and transmit solar energy. However, effects on soil temperature are highly variable. White mulches decrease soil temperature while clear plastic mulches increase soil temperature. The soil temperature can be higher up to $7^{o}C$ under clear mulch compared to bare soil. In regions with a longer growing season, it may be possible to grow two or more crops on the mulch within a single calendar year.

7. Plant growth and development:

Lordan et al. (2015) observed mulching significantly improve the physical properties of the topsoil in peach, which in turn enhanced the hydraulic properties of the matrix, improved crop response, crop growth and fruit yield. Organic mulching techniques in peach cultivation should be considered as a beneficial practice to apply in fruit-trees production under limiting soil conditions (Lordan et al., 2015). The effects of mulches on plants are operative through the effects of mulches on soil water, soil temperature structure and erosion. Reduced evaporation is major reason for the growth of the plants and there by high crop production due to mulch. Increase in soil temperature and moisture content stimulate root growth which leads to greater plant growth. Using black plastic mulch for growing dahlia is also beneficial as it improves growth, flowering and tuberous root formation, as well as cuts down weeding.

8. Improved quality and yield:

Use of wheat straw and banana straw as a mulch material (12.5 kg. /plant) in banana orchards is useful in increasing the bunch weight and conservation of soil moisture in banana. The leaf yield of mulberry increased significantly due to better soil moisture retention, creation of favorable soil temperature, suppression of weed growth, improved soil structure, high status of nutrient in soil and well development of root system. The use of mulching in high-bush blueberry, the soil with pine bark, sawdust and needles improves the chemico-physical properties and is a routine treatment. High-bush blueberry grows and yields better in organic mulches like peat, sawdust, and woodchips. At CISH, Lucknow, plastic mulch enhanced flowering in mango. The response of black plastic mulch (100 μ) was evaluated against root growth, nutrient status of soil and plant, flowering and yield of mango Chausa. Mulching was done during flower-bud

differentiation (October–November) stage. Enhancement in flowering and yield (38–70 and 40–60%) were also recorded in 'off' and 'on' year because of mulch. Black plastic sheeting and weed-barrier meshes are used under young olive trees.

9. Promote earlier harvest:

Black mulch applied to the planting bed prior to planting will warm the soil and promote faster growth in early season, which generally leads to earlier harvest. First harvest acceleration of 7 to 14 days is not uncommon, depending on weather conditions. Clear mulch warms the soil more than black and usually provides even earlier harvest. An earlier maturity is probably due to maintenance of favorable temperatures during growing season. Earlier harvest is among the most important advantages of polyethylene mulch application. Organic mulches induced earliness in flowering, less days to fruit set and days to harvest, also increased number of flowers and per cent fruit set in tomato crop over control. Beneficial effect of polyethylene mulch on the increase of the early yield was also found for watermelon, zucchini, tomato and pepper. Mulching helps to maintain an even soil temperature, induce early flowering and better blooms.

10. Reduced fertilizer leaching:

As excessive rainfall is shed from the root zone, fertilizer loss due to leaching is reduced. This is particularly true in sandy soils indicated faster plant growth, early fruiting, reduced P concentration and increased N concentration in leaves and fruits and also increased fruit weight and yield of hot pepper with straw mulching compared to control. Further, they reported that rice straw mulch increased K- content and decreased Phosphorus concentration in leaves of bell pepper over no-mulch. They are also efficient in reduction of nitrates leaching and contamination of surface and ground waters by these compounds. The influence of plants left as a mulch has many positive aspects: mulches improve soil physical properties, prevent erosion, supply organic matter, regulate temperature and water retention, improve nitrogen balance, take part in nutrient cycle as well as increase the biological activity.

11. Increase organic materials:

Organic mulches return organic matter and plant nutrients to the soil and improve the physical, chemical and biological properties of the soil after decomposition, which in turn increases crop yield. Soil under the mulch remains loose and friable. Aeration and soil microbial activity are enhanced. In heavy black soil also, application of mulches like coir pith @ 20 t/ha, press mud @ 10 t/ha decreased the bulk density over control. Organic mulches have the advantage of being biodegradable, but decomposition may result in a temporary reduction in soil mineral nitrogen. Mulching increased soil moisture, organic matter contents leading to suitable environment for root penetration.

12. Stimulation of soil micro-flora:

Mulching stimulates soil micro-organisms such as algae, mosses, fungi, bacteria, actinomycetes and other organisms like earth worms etc., owing to loosen, well aerated soil conditions, uniform moisture and temperatures thus resulting in a more rapid breakdown of organic matter in the soil and release of plant nutrients for crop growth. Under the mulch layer earth worms proliferate and help to improve the soil aggregate stability and infiltration etc. In addition, mulches are also reported to enhance soil microbial activity. Mulching practices gave positive effect on the soil biota. Important role of mulch to support existence of most species of soil macroinvertebrates. Crop residue mulch supplied a lot of food for soil macroinvertebrates and nutrient to ensure the vegetation growth and created suitable environment for soil macroinvertebrates.

Limitations of Mulches:

- They are costly to use in commercial production when compared to organic mulches.
- Probability of ‘burning’ or ‘scorching’ of the young pants due to high temperature of black film.
- Difficulty in application of top-dressed fertilizer
- Reptile movement and rodent activities are experienced in some places.
- Environmental pollution.
- Difficult in machinery movement.
- Cannot be used for more than one season using thin mulches
- Weed penetration with thin films • Toxic to livestock

Conclusion

In India, productivity of most of the fruit crops is quite low as compared to the other major producers and world averages. The main cause behind low productivity is poor orchard management practices which results into biotic and abiotic stresses in fruit crops. Further, among orchard management practices, the floor management is least cared in India with just 2-3 times soil tilling per year to control weeds in most of the orchards, as its direct impact is not visible. It might be one of major causes of low productivity of fruit orchards in India. The cheapest way to manage optimally the orchard floor for soil hydro-thermal regime, weed suppression which ultimately favors optimum growth with higher yield and quality, is mulching. Mulching is better for plant growth and fruit production by maintaining soil moisture, temperature, soil nutrients, protects from weed, insect, disease and other climatic factors. Although, mulching treatments in general showed a positive response to plant growth, fruit yield and superior quality of fruits. Finally, we concluded, mulching is an excellent horticultural technique that is beneficial to improving the growth, quality and productivity of fruit crops. Therefore, it can be adopted by growers to achieve more returns.

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GREEN MANURE

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The practice of turning or ploughing undecomposed green plant matter or tissues into the soil for the purpose of improving physical condition as well as fertility of soil is referred to as green manuring and the manures obtained by this method is known as green manures. The use of green manure in crop production is recorded in China as early as 1134 BC.

Types of green manuring

1. Green manuring In-Situ

- Any crop or plant (generally leguminous) grown and ploughed in situ is called green manuring in situ.
- E.g.: Sesbania (*Sesbania speciosa*), Dhaindia (*Sesbania aculeate*), Sunhemp (*Crotolaria juncea*), Phillipesara (*Phaseolus trilobus*), Cowpea (*Vigna anguiculata*), Green gram/Mungbean (*Vigna radiata*), Black gram (*Vigna mungo*), Berseem (*Trifolium alexandrium*) etc.

2. Green Leaf Manuring

- Consists of gathering green biomass (tender leaves and twigs) from nearby location (bunds, field boundaries) and adding it to the soil.
- E.g.: *Cassia auriculata*, Neem (*Azadiracta indica*), Glyricidia (*Glyricidia maculate*), *Leucaena leucocephala*, *Cassia tora*, *Tephrosia purpurea*, *Vitex nigundo*, Karanj (*Pongamia glabra*), Calotropis (*Calotropis gigantea*) etc,.

3. Green manures Green Leaf Manures (Leguminous)

- E.g.-Dhaincha, Sunhemp, Glyricidia, Cassia, Green gram, Cowpea, Soybeam *Pongamia glabra*, Subabul.

4. Green manure Green Leaf Manure (Non-leguminous)

- E.g. Sunflower, Sesbania, Calotropis, Adathoda, Buck wheat, *Desmodium thespesia*, Centroseme, Crotolaria

Green manure crops can also be classified based on their purposes

1. **Cover crops**: These are crops sown to cover soils and prevent erosion. These include vetch, Sirius peas, oats, clovers, winter rye, and lentils.
2. **Break crops:** These are crops that interrupt the lifecycle of pests or diseases. These are alfalfa, mustard, brassica and rye.

3. **Nitrogen-fixing crops**: These are leguminous crops planted to enrich soils in terms of available nitrogen . Some examples include beans, vetches, clovers, peas, soybeans, lupins, and alfalfa.
4. **Nutrient conserving crops**: As the name suggests, they minimize nutrient leaching and add more nutrients into the soil. These are ryegrass, oil radish, buckwheat and red clover.
5. **Smother crops**: These are crops grown to outcompete weeds in growth and these include winter rye, buckwheat, yellow sweet clover and oil radish.

Nutrient content in different Green Manure crops

Plant	Scientific name	Nutrient content (%) on air dry basis		
		N	P_2O_5	K
Gliricidia	*Gliricidia sepium*	2.76	0.28	4.60
Pongania	*Pongamia glabra*	3.31	0.44	2.39
Neem	*Azadirachta indica*	2.83	0.28	0.35
Gulmohur	*Delonix regia*	2.76	0.46	0.50
Peltophorum	*Peltophorum ferrugenum*	2.63	0.37	0.50
Weeds				
Parthenium	*Parthenium hysterophorus*	2.68	0.68	1.45
Water hyacinth	*Eichhornia crassipes*	3.01	0.90	0.15
Trianthema	*Trianthema portulacastrum*	2.64	0.43	1.30
Ipomoea	*Ipomoea*	2.01	0.33	0.40
Calotrophis	*Calotropis gigantea*	2.06	0.54	0.31
Cassia	*Cassia fistula*	1.60	0.24	1.20

Desirable characters of green manure crops

1. Crop must be fast growing and of short duration so that crop can be fitted in a crop rotation and have high nutrient accumulation ability.
2. Crop should tolerant to shade, flood, drought and adverse temperatures.
3. It should yield abundant biomass and should be succulent to have rapid decomposition
4. It should have the ability to grow on poor soils.
5. Wide ecological adaptability, have high water use efficiency
6. Crop should be of multipurpose use.
7. The crop should have high Nitrogen accumulation rates and should timely release nutrients.
8. Crop should be photoperiod insensitive.
9. Crop should have high seed production and high seed viability as well
10. Ability to cross inoculate or responsive to inoculation.
11. Crop should be insect and disease resistance.
12. Crop should have high Nitrogen sinks in underground plant parts.

Advantages of Green Manure

1. Green manure helps in improving physical and chemical properties of soil. E.g. It builds up soil structure, improves tilth, form crumbs in heavy soil, increases soil porosity ,water infiltration and increases water holding capacity.

2. **Improving the Soil's Structure** Green manure significantly improves the soil structure by adding organic matter into the soil. Helps to maintain organic matter status of soil.Such organic matter binds soil particles together and creates soil aggregates. The clusters of the improved larger particles allow for the formation of pores, which allows for proper soil aeration, nutrient distribution and water retention. Any plant grown on such soils develops a strong root system and utilizes the available resources with higher efficiency.
3. Green manure crops absorb nutrients from the lower layer of soils and leave them in the soil surface layer to be use by the succeeding crops.
4. **Prevents Leaching** Green manure also minimizes the leaching of nutrients into the soil. It draws nutrients into their bodies and locks them until the crop is dug into the soil. The plants decompose and nutrients are slowly and gradually released into the soil, just in time for the next crop to utilize them for their growth.
5. **Preventing Erosions** It reduces soil temperature and protects the soil from the water erosion as it forms canopy cover on the soil. Green manure is also known as cover crops, as it covers soils, preventing it from exposure to harsh elements. Roots hold on to soil particles and hold them in place, while plant bodies shield the soil from extreme rains and the scorching sun, thereby preventing erosion. If the soils are left uncovered, the nutrients will be washed off into the soil, depriving the necessary nutrients from the soil, as well as causing damage to water systems.
6. **Providing Nutrients and Organic Matter to the Soil** using green manure results in increased levels of key plant nutrients. Leguminous green manure such as clover and vetch can grab nitrogen from the air and add it to the soil. Nitrogen, for example, is a key nutrient that promotes the healthy growth of the crops that will be planted after. Other green manure, such as buckwheat and lupin, enriches the soils with phosphorous. Lupin, in particular, has been found to draw in and utilize 10 times more phosphorous than a common grain or wheat does. As such, phosphorous from the body of the lupin will be released to the subsequent crop if it is incorporated into the soil.

   Other green manure crops supply potassium, iron, calcium and other trace minerals. High amounts of organic material, improved by green manures, ensure soil fertility is improved by bettering the soil's physical and biological properties.
7. **Suppressing weeds** Green manure is favoured by many farmers as it can suppress weeds. Green manure does this by disrupting the growing patterns and cycle of weed plants. They also out-compete weeds for both water, nutrients and space. Also, some species can release chemicals from their roots, which inhibit the growth of weeds and germination of seeds in the soil, in a process known as the allelopathic effect.
8. **Supporting Beneficial Microbes and Soil Organisms** Beneficial soil microbes and other organisms are crucial for the formation of good soil structure. These organisms and their activities, aid in the creation of soil aggregates, enhancing soil porosity and mixes in the organic matter.

   Green manuring increases the numbers of such organisms and encourages their high diversity. The roots of these green manure crops serve as a source of nutrition for soil microbes. Once a crop is tilled into the soil, the green matter's decomposition encourages further microbial activity in the soil. Some green crops can also support healthy soil *mycorrhiza*. These fungi play an important role in the intake of nutrients by crops, and their overall growth and resistance. By being present, the soil structure benefits, and as such, all caring farmers and gardeners should maintain their presence in the soil.

9. **Providing Habitat For Natural Predators:** There are different ways of controlling pests, including boosting the number of their natural predators. Green manure crops can serve a home for predatory insects, such as ground and rove beetles.

   These two species of beetles are well known for being skilled hunters of pests and caterpillars. Blue flowers of Phacelia can also act as a home for hoverflies, which feed on aphids, a widespread and resistant pest to gardeners and farmers.

10. **Interrupting Pest Lifecycles and Diseases** Green manure is liable for breaking the lifecycle of pests and diseases. The rye sown in the fall, for instance, decreases the populations of major pests that attack potatoes and vegetables. The cereal rye's roots trap nematodes and when the pests enter the roots, as they would with other crops, they are trapped inside without a chance of escaping.

11. **Providing Habitat For pollinators**: Pollinators, such as bees, can also grab the required nutrition from flower nectar and pollen of many commonly planted green manures. For e.g., the white, pink and red clover flowers, yellow mustard flowers, and yellow, blue or white lupin flowers, attract pollinators, such as butterflies and bees, encouraging their activities.

12. Green manure also loosens compacted soil clumps, which are impenetrable for some gentle crop roots, inhibiting their growth. The alfalfa, red clover and chicory varieties have sturdier tap roots which are perfect for breaking compacted soils, helping other plants grow.

13. Helps in release of nutrients in available form for use by the crops. E.g. Green Manure crop increases the solubility of lime phosphate because of increase in microbial activity.

14. Increases aeration of rice soils by stimulating the activities of surface films of algae and bacteria.

15. It also increases biochemical activities in soil.

16. Certain green manure like pongamia and neem leaves are reported to control insects.

17. Increases yield to the extent of 15-20 % as compared to no green manuring.

As we have mentioned above are all different advantages of Green Manuring .And below tables represent the Organic Matter Yield / ha /year and Nitrogen Yield /ha /year through two different tables ,Table 1 & Table 2.

Table 1. Soil rganic matter yield of several legume green manure crops

Green Manure Plant	Scientific Name	Organic MatterYield (kg ha^{-1} year^{-1})	Reference
Common vetch	Vicia sativaL.	2500	Astier et al., 2006
Hairy vetch	Vicia villosa	1395	Florentin et al, 2010
Pigeon pea	Cajanus cajan L.	5153	Florentin et al, 2010
Black-seed mucuna	Mucuna pruriens	3911	Florentin et al, 2010
Jack bean	Canavalia ensiformis L. DC.	3863	Florentin et al, 2010
White lupine	Lupinus albus L.	1925	Florentin et al, 2010
Field Pea	Pisum sativum L.	3590	Piotrowska & Wilczewski. 2012
Alfalfa	Medicago satviaL.	2410	Guan et al., 2016
Bush clover	Lespedeza davurica S.	1990	Guan et al., 2016
Milk vetch	Astragalus adsurgens Pall.	1460	Guan et al., 2016
Yellow lupine	Lupinus luteus L.	1355	Pietrzykoski et al., 2017

Table 2. Approximate soil nitrogen yield of several legume green manure crops

Green Manure Crop	Scientific Name	Nitrogen Yield (kg ha^{-1} year^{-1})	Reference
Alfalfa	Medicago satviaL.	125-600	Widjajanto, 1996; Rosenfeld & Rayns, 2011;Bilgili, 2018
Red clover	Trifolium pratense	73-460	Rayns &Rosenfeld, 2008; Rosenfeld & Rayns, 2011
Crimson clover	Trifolium incarnatum	100-150	Rosenfeld & Rayns, 2011
White lupine	Lupinus albusL.	75-300	Rayns &Rosenfeld, 2008; Florentin et al, 2010
Common vetch	Vicia sativa	90-250	Rosenfeld & Rayns, 2011;
White clover	Trifolium repens	50-450	Rosenfeld & Rayns, 2011
Pea	Pisum sativum L.	80-160	Widjajanto, 1996; Bilgili, 2018
Yellow sweet clover	Melilotus officianalis	15	Rosenfeld & Rayns, 2011
Soybean	Glycine max L. Merr.	65-200	Widjajanto, 1996; Bilgili, 2018
Persian clover	Trifolium resupinatum	100	Rosenfeld &Rayns, 2011;
Hairy vetch	Vicia villosa	40-208	Rayns &Rosenfeld, 2008; Florentin et al, 2010
Fanugreek	Trigonella foenum-graecum	30	Rosenfeld & Rayns, 2011
Lentil	Lens culinaris	13	Bilgili, 2018
Forage bean	Vicia faba L.	97-152	Widjajanto, 1996
Subterranean clover	Trifolium subterraneum	4-320	Rayns &Rosenfeld, 2008

Structure and function of R – genes

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Resistance genes (R-Genes) are genes in plant genomes that convey plant disease resistance against pathogens by producing R proteins. The main class of R-genes consist of a nucleotide binding domain (NB) and a leucine rich repeat (LRR) domain(s) and are often referred to as (NB-LRR) R-genes or NLRs. Generally, the NB domain binds either ATP/ADP or GTP/GDP. The LRR domain is often involved in protein-protein interactions as well as ligand binding. NBLRR R-genes can be further subdivided into toll interleukin 1 receptor (TIR-NB-LRR) and coiled-coil (CC-NB-LRR).

Resistance can be conveyed through a number of mechanisms including:

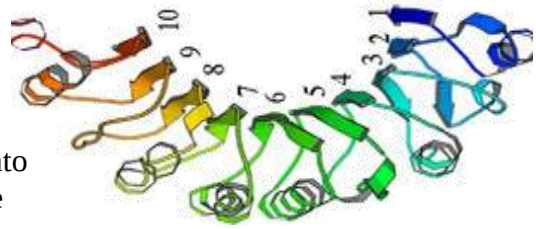
- The R protein interacts directly with an Avr gene (Avirulence gene) product of a pathogen.
- The R protein guards another protein that detects degradation by an Avr gene. The R protein may detect a Pathogen-Associated Molecular Pattern or PAMP (alternatively called MAMP for microbe-associated molecular pattern).
- The R protein encodes enzyme that degrades a toxin produced by a pathogen.

Once the R protein has detected the presence of a pathogen, the plant can mount a defence against the pathogen. Because R genes confer resistance against specific pathogens, it is possible to transfer an R gene from one plant to another and make a plant resistant to a particular pathogen. The plant kingdom contains thousands of R genes with specificities for particular viral, bacterial, fungal, or nematode pathogens. Although there are differences in the defense responses induced during plant-pathogen interactions, some common themes are apparent among R-gene mediated defences. Most significantly, the function of a given R-gene is dependent on the genotype of the pathogen. First cloned R-gene was *Hm1* from MAIZE while First Avr specific R-gene cloned was *Pto* from tomato.

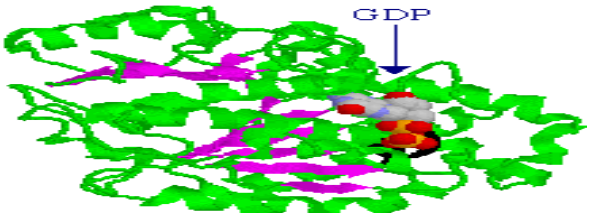
Unique features of R-genes

- Monogenic
- Dominance
- Restricted taxonomic functionality
- Gene clusters
- Nuclear/ Cytoplasmic
- Dualism
- Gene clusters
- Resistant gene analogues

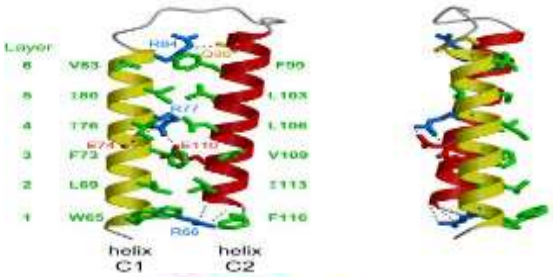
R-GENE STRUCTURE : R-genes consist of different domains. The great majority are intracellular NBS-LRR. The few members possess extracellular LRR-domain.



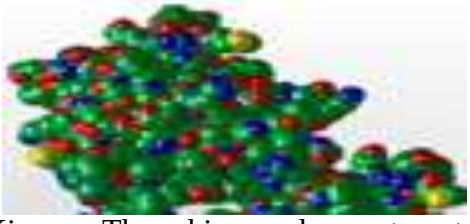
1. **LRR (Leucine rich repeat) DOMAIN:** LRR consists of 2-45 motifs of 20-30 amino acid in length that generally folds into an arc or horseshoe structure. Each motif contain leucine residues at regular interval. It is involved in protein-protein interactions.



2. **NBS (Nucleotide binding site) DOMAIN :** NBS is present in several protein families including ATPases and G-proteins and may affect R-protein function through nucleotide binding or hydrolysis. It may be involved in regulating programmed cell death.

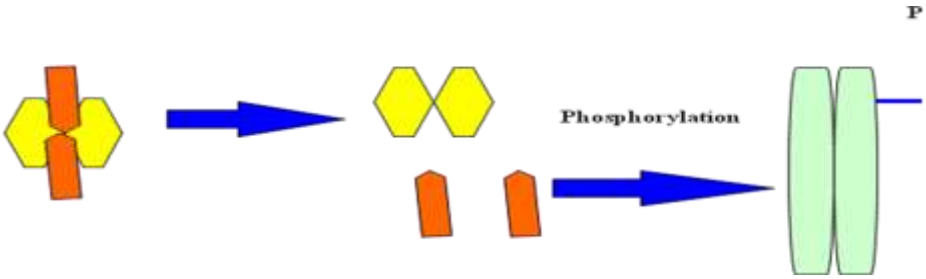


3. **CC (Coiled coil) DOMAIN :** The CC-structure is repeated heptads sequence with interspersed hydrophobic amino acid residues. It consists of two alpha or more alpha helices that interact to form a supercoil. This domain may be involved in downstream signaling

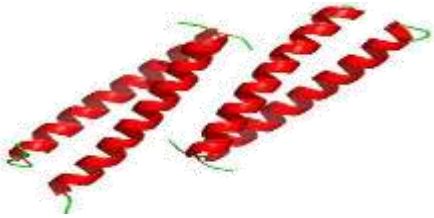


4. **TIR (Toll interleukin receptor) DOMAIN :** The TIR domain is implicated in signalling by its similarity to the cytoplasmic domain of Toll and IL-IR. It may also play role in pathogen recognition.

5. **STK (Serine threonine kinase) DOMAIN :** Kinases are heterodimer with catalytic and regulatory site. The most common protein kinases present in plants are CDKs and MAP Kinases. These kinases does not contain the site for receptor of the protein origin but still can interact directly.



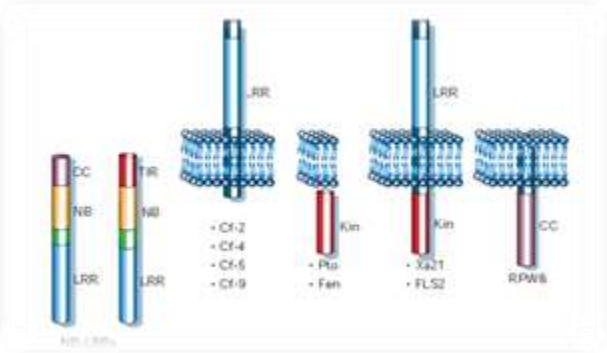
6. **LZ (Leucine Zippers) DOMAIN** : These work like molecular switches binding to DNA and switching on or silencing the genes ability to synthesize a particular protein



R-Gene Classes

Functions of R-genes

1. R-genes help in recognition process upon detection of corresponding Avr-gene.
2. Initiate signal transduction to activate defences.



Examples of R-genes

CLASS	R-gene Structure	R-Gene Name	PLANT	PATHOGEN
I	STK	*Pto*	Tomato	*Pseudomonas syringae*
II	LRR-NBS-CC	*Bs2* *Pi-ta*	Pepper Rice	*Xanthomas campestris* *Magnaporthe grisea*
III	LRR-NBS-TIR	*L* *RPS4*	Flax Arabidopsis	*Melampsora lini* *Phytopthora parasitica*
IV	LRR-TM	*Cf2* *Cf4*	Tomato	*Cladosporium fulvum*
V	LRR-TM-STK	*Xa21*	Rice	*Xanthomonas oryzae*
VI	Unknown	*Hm1*	Maize	*Cochliobolus carboum*

AVIRULENCE GENES

A pathogen gene is called an Avr gene if its expression causes the pathogen to produce a signal that triggers a strong defense response in a plant with the appropriate R gene. However, expressing an Avr gene does not stop the pathogen from being virulent on hosts that lack the corresponding R gene. Thus, Avr gene are the mild genes of the pathogen which are responsible for activation of certain defense responses of the host plants.

- ✓ More than 40 bacterial Avr genes have been cloned and sequenced, primarily from the genera *Pseudomonas* and *Xanthomonas*.
- ✓ Plant viral Avr genes encode essential virus components, such as the coat protein, replicase and movement protein.
- ✓ The majority of fungal Avr genes were cloned from fungi that colonize intercellular spaces in plant tissues.

Examples of avirulence genes

Plant	*Avr Gene*	Pathogen	Corresponding R Gene
Tomato	*Avr2*	*Cladosporium fulvum*	*Cf2*
Tomato	*Avr4*	*Cladosporium fulvum*	*Cf4*
Rice	*AvrPita*	*Magnaporthe grisea*	*Pita*
Flax	*AvrL*	*Melampsora lini*	*L6*
Barley	-	*Erysiphe graminis*	*Mla*
Potato	*AvrPto*	*Phytophthora infestans*	*Pto*

Advantages of R -genes

- When induce in timely manner, the concerted response effectively halt pathogen growth with minimal collateral damage to the plant.
- No input is required from the farmer and no adverse environmental effects.
- Efficient reduction of pathogen growth.
- Minimal damage to host plant
- Zero input of pesticide from farmer and most important the environment friendly nature of such crops.

Disadvantages of R -genes.

- R genes are quickly defeated by co-evolving pathogen.
- Many R genes recognize only a limited number of pathogen strains.
- R genes do not provide board spectrum resistance.
- Introgression of R gene into elite cultivars by convention breeding is a lengthy process.

Conclusion

In plants, resistance (*R*) genes play a key role in their remarkable immune responses. *R* genes are usually dominant (but sometimes recessive) genes that provide full or partial resistance to one or more pathogens. We include receptors of pathogen-associated molecular patterns (PAMPs) as *R* genes because they provide partial and sometimes even full resistance *R* genes exist in natural plant populations and have been used by humankind since early crop domestication. With the isolation of the first few plant *R* genes, immense opportunities now unfold for protein biochemists, biologists, physiologists, and geneticists alike to elucidate how these gene products function and the gene families evolve. With help of knowledge of structure and functions of R-gene in brief make us all understand R- gene little closely and help us to take more interest to know much more about R- genes.

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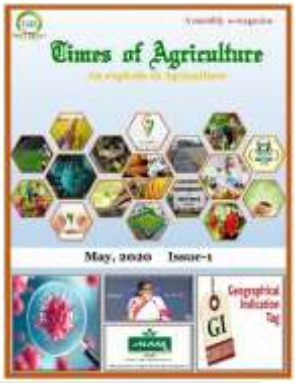
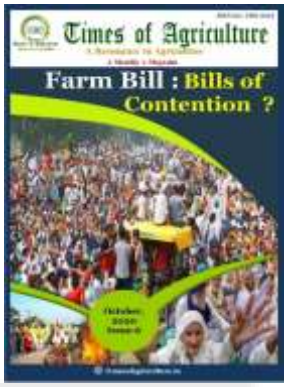


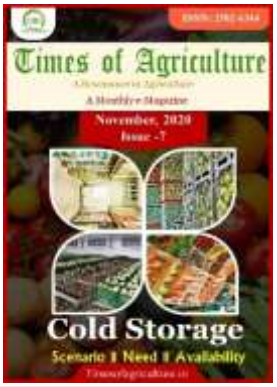
3-July

4-August

5-September

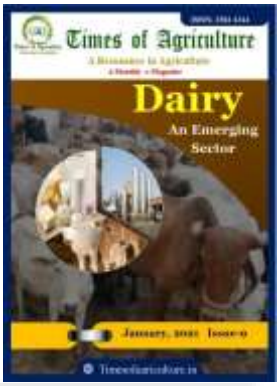


6-October



7-November

8-December



9-January

10-February

11-March

12-April