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Food processing minister launches 6 brands under One District-One Product

Union Minister for Food Processing Industries **Pashupati Kumar Paras** launched **six brands**, including **Kashmiri chilli,** developed as part of the **'One District-One Product' (ODOP)** approach under a central scheme PMFMES. These six brands are out of 10 that the ministry has signed up with cooperative NAFED for branding and marketing of ODOPs under the Pradhan Mantri Formalization of Micro food processing Enterprises Scheme **(PMFMES)**.

The six brands launched are **Amrit Phal**, **Cori Gold, Kashmiri Mantra**, **Madhu Mantra**, **Somdana**, and **Whole Wheat Cookies** of Dilli Bakes.

Vijay Paul reappointed CACP chief

The Centre has **re-appointed Vijay Paul Sharma** as the chairman of the Commission for Agricultural Costs & Prices **(CACP)** after he relinquished the post in May last year following completion of the **five-year tenure**. He is an alumnus of **Palampur Agriculture University** and has served as the CACP Chairman from **June 2016 to May 2021**. He was reappointed on **January 3**.

Sharma, a professor at the Centre for Management in Agriculture at the **Indian Institute of Management, Ahmedabad**, was appointed CACP Chairman for the first time in June 2016.

"CRIJAF Advice" Android App for Growers of Jute & Allied Fibres

ICAR-CRIJAF Barrackpore has developed an android app - **"CRIJAF advice"**. The application is **fully dynamic** and **agro-advisories** on jute and allied fibre corps issued by ICAR-CRIJAF, Barrackpore are being updated **every fortnight** in the app.

The information provided through this app comprehensively covers the improved technologies related to seed, variety, inter-cultural operation, mechanization, integrated nutrient management, integrated pest management, post-harvest technologies of the jute and allied fibre crops.

This is one of the first programs developed for the farmers, which is available in **three languages** *viz*., **English**, **Hindi**, and **Bengali** in a single platform

Advanced Analysis Lab for Rubber Products

The **Rubber Board** plans to open an **advanced analysis laboratory** for rubber products at the Rubber Research Institute to comply with EU Regulations.

"The new facility will allow exporters to conduct independent third-party testing of rubber products for REACH compliance, as well as MSME manufacturers to design REACH compliant product formulations," said **Siby Varghese**, **Joint Director, RRII**.

REACH is a European Union regulation that governs the registration, evaluation, authorization, and restriction of chemical substances.

The goals of the REACH regulation are to protect human health and the environment by improving and expediting the identification of residual chemical substances in industrial products.

Assam government signed a MoU with (NDDB)

The **Assam government** signed a MoU with the National Dairy Development Board **(NDDB)** in **Guwahati** to set up a joint venture worth **Rs. 2,000 crore** with the target of processing **10 lakh litres** of milk at **6 new milk processing units** over seven years. As part of the development project, more than **15,000 high milk-yielding Gir cows** will be inducted into Assam.

Two cattle-feed and **organic manure manufacturing units** would be set up under this MoU.

Assam Chief Minister **Himanta Biswa Sarma** stated that six new milk processing units would be set up in seven years to increase the earnings of the dairy farmers.

In the six new proposed milk processing units, milk from more than **4,100 dairy cooperative** societies will be processed, packed and marketed.

Dileep Sanghani elected as IFFCO chairman

The board of directors of the Indian Farmers Fertiliser Cooperative **(IFFCO)** has unanimously elected **Dileep Sanghani** as the **17th Chairman** of the Cooperative. He succeeds **Balvinder Singh Nakai**, who **passed away** earlier on **October 11, 2021**. Prior to this, Sanghani was serving as **vice-chairman of IFFCO since 2019**. Sanghani is a senior co-operator from Gujarat and the chairman of the Gujarat State Cooperative Marketing Federation Ltd. (GUJCOMASOL), a position he has held since 2017.

After getting elected, Sanghani said the IFFCO was committed to farmers and cooperatives and will continue to work for the farmers on the lines of Prime Minister Narendra Modi's vision of **'Sahkar se Samridhi'.**

Artificial Intelligence based Mobile App to detect crop diseases

Department of Research & Development of **Chandigarh University** has developed an **AI based Mobile App** which will **detect crop diseases** at an early stage of farming cycle. This will help the farmers to make arrangements before the spread of disease in the healthy crops.

Scientist of SEED, NCSTC Division, Department of Science and Technology, New Delhi, **Dr. Rashmi Singh** launched the **Mobile App** along with Dean Research, Chandigarh University **Prof. Sanjeet Singh**.

The diseases like cut worms, potato tuber moth are common in potatoes. Early and Late Blight in Tomatoes severely damage the crop. To overcome from these and many other diseases, this detecting application can be used to identify and detect the illness in these crops in order to increase agricultural production.

Mobile Honey Processing Van

Khadi and Village Industries Commission **(KVIC) Chairman**, **Vinai Kumar Saxena** has launched the **country's first Mobile Honey Processing Van** at **Village Sirora in Ghaziabad**. The Mobile Van has been designed in-house by KVIC at its Multi-disciplinary Training Centre, Panjokehra, at a cost of **Rs. 15 lakh.** This mobile honey processing unit can process up to **300 kg.** of **honey in 8 hours**.

The van is also equipped with a **testing laboratory** that would instantly examine the quality of honey.

Honey Mission which aims at training beekeepers, distributing Bee Boxes to farmers and helping rural, educated as well as unemployed youth in line with Prime Minister's dream of **"Sweet Kranti" (Sweet Revolution)** though honey production.

DAY-NRLM celebrates Agri Nutri Garden Week

(DAY-NRLM) has observed **'Agri Nutri Garden Week'** from **10th to 17th January, 2022** through awareness campaign and encouraging establishment of **'Agri Nutri Gardens'** in the rural households.

In line with Prime Minister's vision of enhancing strength of Rural Economy and call of **Atma Nirbhar Bharat,** Rural India is showing the way with establishment of over **78 lakh Agri Nutri Gardens** towards ensuring Food and Nutritional Security in Rural India. A total of **76,664 'Agri Nutri Gardens'** were established in this week against the target of 7500.

APEDA Flagged Off First Shipment of Marayoor Jaggery

On the **13th of January 2022**, the Agricultural and Processed Food Products Export Development Authority (APEDA) facilitated the virtual flagging off of the first shipment of GI tagged **"Marayoor Jaggery"** from **Marayoor, Idukki, Kerala** to **Dubai, UAE**.

Dr. M. Angamuthu IAS, **Chairman, APEDA** flagged off the first consignment of Marayoor Jaggery to Dubai. He mentioned promoting Marayoor jaggery in all parts of the world as being a unique GI product that is **chemical-free**. This initiative to promote GI-tagged products from India is ultimately paving the way to achieve PM's target of 400 billion USD of merchandise export by 2021-22.

TNAU Releases New Rice Variety for Sodic Soil Condition

The **Tamil Nadu Agricultural University (TNAU)** has launched a novel **rice variety** appropriate for **sodic soil** conditions developed by the **Anbil Dharmalingam** Agricultural College and Research Institute (ADACRI) in **Navalur Kuttapattu in Tiruchi**. The new short duration variety **TRY 5**, was determined to be superior then **TRY 2,** the college's existing early duration variety appropriate for salt damaged soil.

The college had also brought out **TRY 3** and **TRY 4**, which were medium duration varieties.

Cover Story

BUDGET 2022 FOR AGRICULTURE

In the run-up to India@100, the **Union Budget 2022** has put out a charter for agriculture that is forward-looking but takes a broad-brush approach on serious issues related to sustainability of farming and boosting farmers' income. The Finance Minister did not speak about doubling farmers' income in particular, or anything specific to agricultural markets, or support prices after the repeal of the farm laws.

The announcement has come after months-long farmers' agitation demanding guaranteed MSP for farm produce ended with the government repealing three controversial farm reform laws brought in 2020.

The overall allocation increased by a meagre **4.4 per cent** for the year, even as important schemes for crop insurance and minimum support price (MSP) saw a drastic slashing of funds. The total projected expenditure for 2022-23 is **Rs. 39.45 lakh crore**. Of this, about **3.1 per cent** or **Rs 1.24 lakh crore** is the share of the Department of Agriculture and Farmers' Welfare. Out of this share, three schemes – PM Kisan, Rs 68,000 crore; interest subvention on short term credit, Rs 19,500 crore; and crop insurance, Rs 15,500 crore – take away Rs 1,03,000 crore. The two other major schemes are Rashtriya Krishi Vikas Yojana (RKVY) and Krishi Unnati Yojana (KUY).

Highlights of Budget- 2022 for Agricultural Sector

The Finance Minister announced that **Indian Railways** will develop new products and efficient logistics services for small farmers and Small and Medium Enterprises.

The FM said that the Centre will pay **₹2.37 lakh crore** towards the procurement of wheat and paddy under MSP operations.

Kisan Drones

“Kisan Drones” will be promoted to help farmers to assess crops, digitize, land records as well as spray insecticides and nutrients.

Centre will promote chemical-free natural farming, public-private partnerships for the delivery of digital and high-tech services to farmers across the country. The FM asserted that the Centre will provide a comprehensive package, along with the state governments for farmers to adopt suitable varieties of fruits and vegetables, and to use appropriate production and harvesting techniques.

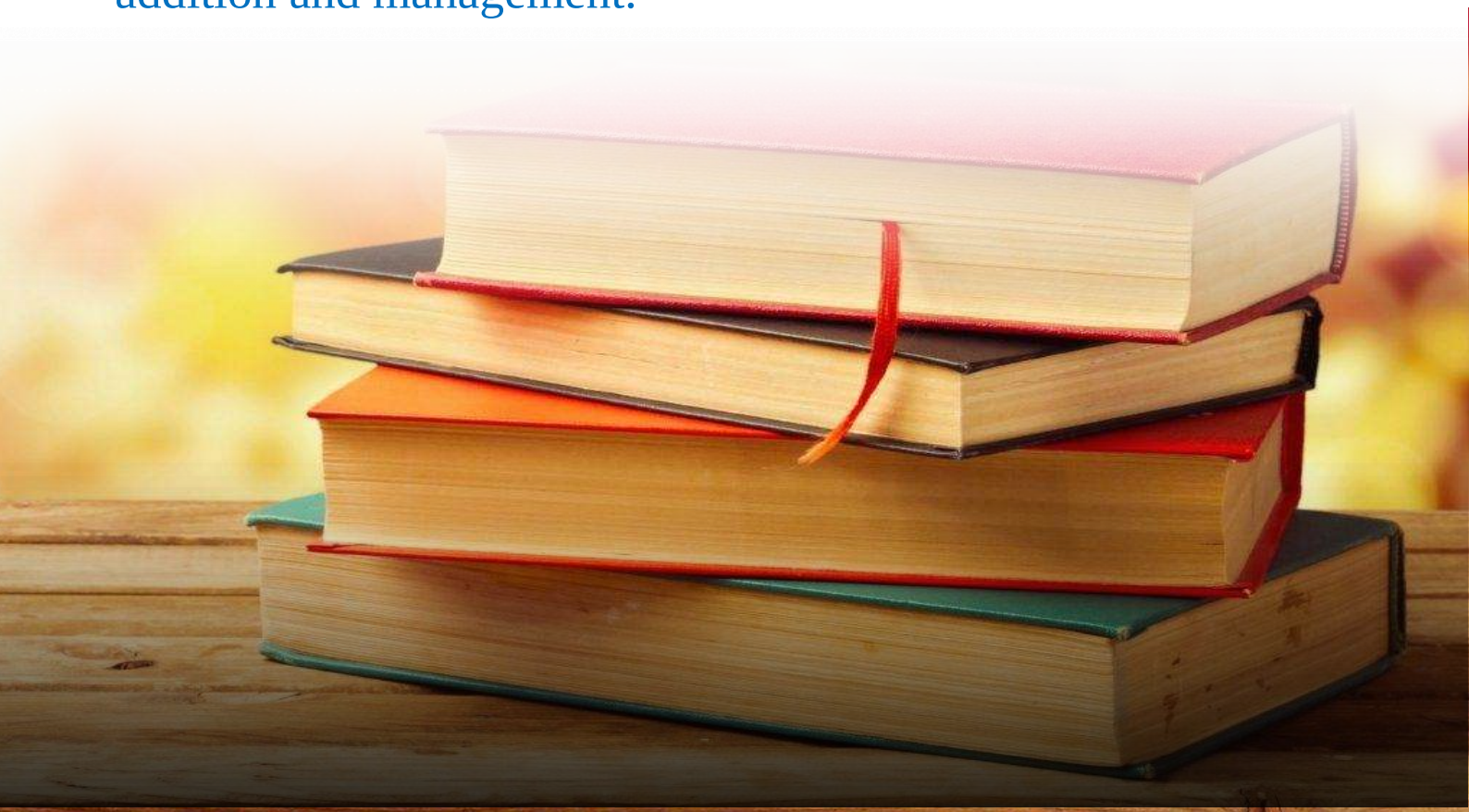
Finance Minister announced that a fund with blended capital, raised under the co-investment model, will be facilitated through NABARD. This will finance startups for agriculture and rural enterprise, relevant for farm produce value chain. The activities for these startups will include, inter alia, support for FPOs, machinery for farmers on a rental basis at farm level, and technology including IT-based support.

To reduce dependence on the import of **oilseeds,** a rationalized and comprehensive scheme to increase domestic production of oilseeds will be implemented.

To provide extra income to farmers and job opportunities to locals and help avoid stubble burning in agriculture fields, **5-7%** of biomass pellets will be co-fired in thermal power plants resulting in **CO_2** savings of **38 MMT** annually.

As 2023 has been announced as the **"International Year of Millets"**, therefore, the Centre will support post-harvest value addition, enhance domestic consumption of millets, as well as branding of millet products nationally and internationally.

States will be encouraged to **revise syllabus** of agricultural universities to meet the needs of natural zero budget and organic farming, modern-day agriculture, value addition and management.



The FM also said the government will bring in policies and required legislative changes to promote **agroforestry** and **private forestry**. In addition, financial support will be provided to farmers belonging to **Scheduled Castes** and **Scheduled Tribes** who want to take up agroforestry.

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DRONE TECHNOLOGY IN AGRICULTURE

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"Drone technology in agriculture will always only be improvement and development not be the drowning."

In recent days, the technology is growing steadily in all the sectors and it is also useful for the country's development. In our agriculture there are various technologies that is useful for crop protection and production, product marketing etc., Likewise drones are becoming a very useful technology for agriculture.

INTRODUCTION

Drones are the unmanned vehicle that can be operated by man or by autonomous system. Drones are like the mini-helicopters without the operators. The usage of drones is wide in range. Some of the usage are photography, weather forecasting, agriculture, area monitoring and military purposes. In agriculture, the major usage of drones is for application of pesticides and fertilizers. Drones are also known as **Unmanned Aerial Vehicle (UAV**).

THINGS TO KNOW ABOUT DRONES

For the proper flying, the drone must have an **energy source** either battery or fuel. Drone needs a **good controller** to navigate and to control the operations done. The controller uses the remote control which connects the drone by radio waves like Wi-Fi. Drone contains the basic things like electronic speed controller, flight controller, antenna, receiver, GPS module for location, camera, sensors, accelerometer to measure speed and altimeter to measure height. Based on the necessary or usage, the drone features will be changed. Now days, the drones are able to carry a man with weight of about 500 pounds. So, the size of the drones may vary from small to big which depends on our usage. The usage of drones can be of personal or commercial.

DRONES IN AGRICULTURE

In agriculture drones are mainly used for **fertilizer and pesticide application.** It can be applied either in liquid or powder form. In some places, drones are used for **paddy seed sowing**. The cost for buying drones is highly expensive. So it is recommended for large farmers. Small farmers can also buy this but not solo form.

It can buy by group of 10 or 15 small farmers. The capacity of drones for spraying liquid fertilizers vary from 6 to 16 liters. The best one is 10liter capacity which will spray for 1 acre of land. Then, for powder fertilizer 15kg drone is best. Next we need a good knowledge about operations of drone. If we don't know means, no problem we can learn by training. Efficient operators will train us.

Before flying of drones, **the location should be marked correctly** in our mobile phone for the automatic spraying of drones. Or else, we need a manual remote control. The main thing is landing of drone should be in empty area without any obstacles. By this, we can avoid the breakage of the propellers (wings). Battery attached drones are best compared to fuel operated drones. Because there will be frequent problems will occur in fuel motor and its repair cost is also expensive.

ADVANTAGES

- Application of fertilizers will be equal to all the crops.
- Large areas of farm will be covered.
- Time will be saved.
- Labor wages will be reduced.
- Fertilizer costs will be reduced.

DISADVANTAGES

- Cost of buying drones will be expensive.
- Good knowledge about drones is necessary.
- Marginal/Small farmers can't afford it.

DJI COMPANY'S UNMANNED VEHICLE

DRONES IN UNION BUDGET 2022-23

The Finance Minister Mrs. Nirmala Seetha Raman in the Union Budget proposal had mentioned that the usage of **'KISAN DRONES'** for land measurement, fertilizers & pesticides spraying, seed sowing will be encouraged. It means that the Drone technology in agriculture will be increased in few years. Youngsters and Business men can initiate a **start-up** for drones to improve its usage and to create awareness about drones among people and farmers. Our government is providing loans for start-up companies through NABARD and Banks. So we want to utilize it in efficient manner and make the nation proud.

CONCLUSION

The use of technology in agriculture will always only be improvement and development not be the drowning. So, let's use the drone only for the development of farming and farmer's economic status and make the agriculture as the best occupation and business in our country.

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AGRI BUSINESS INCUBATORS TRANSFORMING INDIAN AGRICULTURE

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Agri Business Incubators (ABI) are the organizations or centres established either solely by public organization or private organization or both Public Private Partnership mode that seeks to give form and substance that is structure and credibility to start-ups or emerging ventures to innovative ideas of individuals in agriculture and allied disciplines that have high growth potential to become competitive agribusinesses by serving, adding value or linking to farm producers to transform them into agripreneurs.

Stages of Incubation Process:

I. Pre Incubation Process:

Selection Process & Criteria for Inclusion of Client the ABI Programme:

The client that traditionally apply to ABIs come from a diverse background from fresh graduates to companies within a year of formation. Hence, the selection criteria needs to be open, inclusive yet focused in its outlook of creating a sustainable knowledge economy. This applies equally for community driven incubators that perform their service for free or a low charge as well as commercial incubators that normally take a cut in the equity of the client they incubate as a fee for their services. The broader framework that is normally followed is:

1. Submission of Applications by Client

The applications by the prospective client are normally in the format of an information gathering form created by the incubator. All the usual information (such as the name and members of the company), a business plan, registration & financial documents (when applicable), letters of recommendations and any other due diligence information are required of the applying candidates.

2. Pre-screening application review

Compliance and backgrounds checks are conducted by the incubator before forwarding them to the Selection Panel that will choose the client. This includes basic financial, academic and statutory checks along with validating recommendation letters to ensure authenticity of application. Most incubators also use this stage to verify the working minimum viable product (MVP) that some incubators require to be submitted as a part of the application, in order to gauge the feasibility of the product as well as the skill set of the team.

3. Reviews of Applications by Selection Panel

Most ABIs have a Panel of Experts who has the final call in selecting the client that is taken into the incubator. This Panel normally has experienced members of the industry, academicians and fellow entrepreneurs who have experience in both venture funding as well research capitalization. The membership is normally split between internal members of the incubator as well as external industry experts. The guidelines given to this panel in making their decisions are normally unique to each ABI but include focus area, research output requirements, available resources at the ABI as well short and long term goals of the ABI, etc. The Selection Panel usually selects a short list of applications, leaving the final selection to the interview stage.

4. Interview with Expert Panel

After short listing candidates on this process, the Panels in most ABIs also conduct interviews with members of the client groups to gauge potential and compatibility within the programme of the ABI. They long discuss the long term feasibility of the project, terms under which the client will exist under the incubator as well as their responsibility of the different members of the client team when under incubation, etc. This is usually

the ideal situation for both the parties to arrive at a common ground on compatibility as well as expectations from each other, making it the most crucial stage of the entire selection process.

5. Pre-Approval Intimation

The selected candidates are then informed about their duties, perks and obligations in order to establish a clear relationship between both the parties as well as given them a fair chance to plan their integration. This also lets the candidates compare offers and prepare for negotiations regarding their next stage, including financial commitments, equity distribution as well as incubation goal requirements.

6. Negotiation of Terms of Incubation

Most ABIs create broad frameworks for contracts between their client and themselves, yet have unique clauses that are the by-product of negotiations between the ABI and the client. This allows them to cater to interests of all stakeholders on a case to case basis. These terms attempt to keep the best interest of both the parties in mind while allowing for the client to have an active say on the terms (financial, legal and business oriented) that will govern them. This freedom makes sure the client plays an active role in the success of the venture and in turn helps the long term reputation of the incubator.

7. Execution of Agreement

This part includes the procedures that help the client settle into the incubator, meet the faculty and administrative staff, among other initial introductions. This allows the client to not only get acquainted with the functioning of the incubator but also start the process of accelerated development within the timeline required by their respective contracts.

II. Incubation Process:

Services provided by Incubators

Every incubator provides two distinct kinds of aid to its client. The first kind are physical, location based resources such as office space, communication facilities, conference rooms, library access, etc. These physical resources let client concentrate on the process of creating and promoting their product without having to worry about the physical upkeep of their company, leading to increased output

The second but just as important resources are the business oriented aids such as fund raising, venture capitalist scouting, legal services, and marketing support among various other kinds of help. This is an especially unique advantage of industry focused incubators as they know of key aspects in the industry that operate under, allowing their client direct access to both mentorship and funding that would otherwise be unavailable to them outside of the incubator. Both of these services are invaluable in letting a company get through the first few steps of its existence by not only ensuring maximum concentration on product development by the client but also ensuring that they have adequate mentorship for any problems that they may face on the way. It also serves as an excellent networking opportunity for any startup, where the people they meet at events organized by their incubator can lead to long lasting relationships that are invaluable to their company.

The Procedure of Incubation:

Operating Procedure:

The relationship between the incubators and the client is governed by their terms of association, which also defines the operating procedure between them. The terms of condition are traditionally open ended, with certain minimum working hours, product appraisal deadlines and limitations on conduct being the major chunk of the terms governing the client of the incubator. These lay down the schedule of incubation (usually 18 to 24 months subject to renewal), limits on resources and time, rights and obligations of both the parties as well other operating criteria unique to each ABI.

Most incubators provide resources to their client and then follow a hands off approach, allowing the client themselves to approach the incubator for any help it may need. This works quite efficiently as once they are informed of the resources and aid available to them, they can pick and choose from the ones they require, letting them exercise freedom in the process of development of their product without any imposed work schedule or standards.

Education & Learning:

However, all incubators also have some process of both education as well as review. For education, they require their client to attend special classes arranged for them in by calling down industry experts as well as network with various venture capitalists at organized gatherings. Incubators do so to not only mandate a learning curve for all incubator client, which in turn makes them create a better product/service, but

also to bolster the image of the incubator itself in the industry.

Appraisal & Review of Client:

As for the process of review, all incubators mandate at least a semi-annual review of the work carried out by the incubator client. This review is carried out by a committee of mixed staff, selection committee members as well as industry experts. The committee gauges the progress of the company against its objectives, as decided in the incubation contract. Product reviews, industry testimonials as well as live demos are used to determine this, apart from raw financial data such as product sales, etc. This lets both the client as well as the incubator keep a track of how the mutual goal of developing the company is progressing and what can be done better to improve it. The expert committee also evaluates the quality and impact of the business assistance provided by the incubator itself and suggests improvements so that the incubator can serve its client better.

Apart from this process of review, there are also frequent industry related components that serve the dual purpose of helping client acclimatize to the operations within the industry as well as allowing the incubator to get external opinions on the clients via these interactions.

III. Post Incubation Process:

Graduating from an Incubator:

The process of finishing incubation is traditionally known as 'graduating' and most incubators have differing criteria for gauging when a client can graduate from an incubator and what that entails from both the incubator as well as the client. Some of these criteria include self-sustenance in terms of revenue stream, selling the venture to a larger company, expiry of the period specified in the terms of agreement, etc. These conditions are also known to be multifaceted to ensure that the client is adequately charged for the services it avails at the incubator. For example, if a company is acquired straight out of the incubator then it is quite common for the client to encash certain amount of equity for the incubator. However, if the client is going mainstream by themselves, terms of deferred encashment of equity or even free services are common to allow the company to survive their initial years as an independent entity.

Uses of agri-business incubators:

1. To give form, substance, structure and shape to new idea and transforming it into a business venture.
2. Assisting the farmers, agripreneurs to practice agriculture on commercial lines.
3. Creating demand driven self-employment in agriculture and allied sectors.
4. Linking up of technology, business and market.
5. Promoting start-ups in agriculture. Research studies have shown that survival rate of start-ups through ABIs are 30-70%.
6. Initiation of technology led enterprises.
7. Facilitate speedy commercializ-ation of results of research outputs.

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HUNGRY IN INDIA: FOOD FOR ALL

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State of Hunger in India

India, with a population over 1.3 billion, has seen tremendous growth in the past two decades. Gross Domestic Product has increased 4.5 times and per capita consumption has increased 3 times. Similarly, food grain production has increased almost two times. However, despite phenomenal industrial and economic growth and while India produces sufficient food to feed its population, according to Food and Agriculture Organization of the United Nations (FAO) estimate the state of food security and nutrition in the World, 2020 report, 189.2 million people, that is 14% of the population, are undernourished in India. The problem of Hunger is complex, and different terms are used to describe its various forms.

Hunger is usually understood to refer to the distress associated with a lack of sufficient calories.

Undernutrition goes beyond calories and signifies deficiencies in any or all of the following: energy, protein, and/or essential vitamins and minerals. Undernutrition is the result of inadequate intake of food in terms of a quantity or quality, Poor utilization of nutrients due to infection or other illnesses, or a combination of these factors. These in turn, are caused by a range of factors, including household food insecurity, inadequate maternal health or childcare practices; or inadequate access to health services, safe water and sanitation.

Malnutrition refers more broadly to both under-nutrition (problems caused by deficiencies) and over nutrition (problems caused by unbalanced diet, such as consuming too many calories in relation to requirement with or without low intake of micronutrient rich foods).

Computation of Gross Hunger Index (GHI)

Gross Hunger Index scores are calculated using a three–step process that draws on available data from various sources to capture the multidimensional nature of hunger. First, for each country, values are determined for three dimension– inadequate food supplies, child undernutrition and child mortality rate with indicators of under-nourishment for the first dimension, waiting and something for the second dimension and under 5 mortality rate for the third dimension, as indicated below:

1. **Undernourishment:** The share of the population that is undernourished (PUN).
2. **Child Wasting:** The share of children under the age of five who are wasted (CWA).
3. **Child Stunting:** The share of children under the age of five who are stunted (CST).
4. **Child Mortality:** The mortality rate of children under the age of five (CM).

The Government of India is strongly committed to achieving the 2030 Sustainable Development Goals (SDGs). The current nutrition situation in India justify is high level national commitment with strong policy initiatives based on evidence–informed intervention towards combating all forms of malnutrition in the country. Ambitious targets having set of POSHAN Abhiyaan to reduce stunting (2%), underweight (2%), and anemia (3%), among young children, women and adolescent girls and reduce low birth weight (2%) per annum. Also the National Health Mission (NHM) includes programmatic components such as health systems strengthening, Reproductive– Maternal–Neonatal–Child and Adolescent Health and prevention and treatment of communicable and non–communicable diseases.

SDG India Index and Dashboard 2019–20

The NIT Ayog has brought out SDG India Index and Dashboard 2019–20 which measure the progress achieved and distance to be covered by the states/UTs in their journey towards meeting the targets, using the SDG India Index, covering 16 out of 17 SDGs. Two of the most important SDGs (Sustainable Development Goals) having a bearing on poverty, hunger and nutrition are:

SDG 1: No Poverty
SDF2: Zero Hunger

Food and Nutrition Security

The implementation of a revamped Public Distribution System

under the National Food Security Act (NFSA), 2013 is a paradigm shift in the approach towards the issue of food security at the household level, from welfare to a rights–based approach. Under the "Antyodaya Anna Yojana" (AAY), the poorest from amongst the Below Poverty Line families are entitled to 35 kg of food grains per month at more subsidized rates. The NFSA adopts a life cycle approach making special provision for ensuring food security of pregnant women, lactating mothers, and children from 6 months to 14 years of age. Under the Integrated Child Development Services, 70.37 million children in the age range of 6 months to 6 years, and 17.8 million pregnant women and lactating mothers are provided access to nutritious food as on March 31, 2019. Another initiative aimed at achieving better nutrition standard for school going children in the Mid–day meal scheme, which provide nutritious cooked Mid–day meal calorie range of 450–700 to over 120 million children at primary and upper primary levels.

Multidimensional poverty index

The concept of global poverty estimation was initiated in the 1970s. The global strategists led research to present the international poverty line on the national poverty line of very poor developing countries. Of all the countries that have taken up Multidimensional Poverty Index (MPI) to measure their overall poverty statistics, India has been the biggest gainer of them all. This can be concurred by the fact that India, all over middle–income country, head recording the fastest reduction in poverty (according to MPI) as reported in September 2019.

The concept of global poverty estimation was initiated in the 1970s. The global strategists led research to present the international poverty line on the national poverty lines very poor developing countries. They also used the purchasing power parity exchange rate (PPPs)–rather than nominal ones–to convert the line into the US dollar and to in standardise the poverty line across all the countries. The World Bank is the pivotal source for information on global poverty estimation methods. In 1990, a person was poor if he had an income less than Dollar 1 USD a day. It was revised to $1.25 per day per person in 2005 and approximately 1.6 billion people lived under this mark. It was again changed $1.90 per day per person in 2015, a nominal increase of 52% in the benchmark (Ortiz–Ospina, 2013).

To understand the umpteen importance of MPI, it is imperative to focus on the motivation that led to a major overhaul and evolution of poverty calculation to MPI. Three such motivations have been normative arguments, empirical evidence and policy perspective (Alkire, Foster, Seth, Santos, Roche and Balloon, January 2015). As per the normative, the argument stands that the poverty measures have to match up to the multidimensional nature of poverty itself. It is of tremendous importance the ethical calculation is carried out in order to "improve the fit between the measure and the phenomena it is supposed to approximate".Furthermore, Amartiya Sen 2000 has also established that while better human lives are dimension in different ways, the need to have an overarching framework for accommodating diverse deprivation it has never been greater. Moreover, he also states that while impoverished live result frequently from negligible incomes, the result and poor living is not just an outcome of inadequate incomes. IFA minimal recent life of freedom can be the major area of interest regarding people uplifted from poverty, then it is also needs to be understood that mere focus on money or any one particular means to achieve the end (decent free life) to study the area of interest will be a myopic exercise. Therefore, the need to study and uplift "impoverished lives"; not just "depleted wallets."

Work of Amartya Sen (Sen A., 2005, pp.275-296) asserted that, poverty should be defined as a condition that deprives people of the freedom to choose and prohibits dam from functioning effectively in society. It is this lack of facilities and opportunities for individual that prevents them from developing their full potential and capabilities. This kind of poverty analysis shift from a "means" (income) to an "ends" (freedom to pursue a fulfilling life). The capability the deprivation approach considers intrinsically important depreciations (health, education) and not just low income. There are other influences on capability deprivation apart from low–income and the relationship between low income and low capability varies between communities and individuals. Hence, it is important to be cognizant over the multi–faceted nature of poverty.

The Rangarajan Committee (Committee R., 2014) established a new poverty threshold for rural areas at rupees 972 per month rupees 32 per day. For urban areas, it was fixed at rupees 1407 per month or rupees 47 per day. Under this methodology, the population below the poverty line in 2011 2012 was 363 million (29.5 percent of the population).

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MARKETING OF AGRICULTURAL PRODUCTS BY ELECTRONIC MARKETS

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Marketing is a method of communicating between a company and its clients in order to sell them products or services. Until goods are in the hands of buyers, they are not complete products. The management process by which goods and services flow from concept to consumer is known as marketing. Marketing is more about creating a demand for a product and meeting the customer's wants than it is about persuading them to pay for it. Philip Kotler, as we all know, is the father of marketing, Dr. Philip Kotler describes marketing as "the science and art of researching, generating, and delivering value to satisfy the wants of a target market at a profit." Marketing detects unsatisfied wants and desires. It defines, measures, and quantifies the size of the recognized market as well as the profit potential. It determines which segments the organization is most suited to serve and then designs and promotes the relevant products and services." Thus, marketing encompasses all efforts related in the production of location, time, possession, and awareness utilities, among other things.

About marketing *vs* selling

It is a typical mistake for people to say they are going to marketing when they are actually going to the market to buy goods or services. Simply said, it is buying from consumers and selling from vendors. Marketing encompasses more than just selling. Now consider how selling differs from marketing:

Marketing: It focuses on consumer needs and it is a philosophy of business, in marketing customer comes first, then product.

Selling: It focuses on seller's needs and it is a routine day to day physical process, in selling product comes first, then customers.

Importance of Agricultural Marketing

Agricultural marketing is critical not only for promoting output and consumption, but also for quickening the rate of economic growth. Its dynamic functions play a critical role in encouraging economic growth.

- The marketing system employs millions of people in a variety of operations, including packaging, transportation, storage, and processing.
- Marketing operations increase the nation's gross national product and net national product by adding value to the product.

The marketing system is critical to the success of development programmes aimed at improving the lives of the entire population.

What are Agricultural products?

India is mostly a farming country. You will surely comprehend the meaning or definition of agricultural products if you are familiar with the definition of agriculture as well as the history of agriculture. As a result, agricultural products can be described as anything that comes from farming. Agro goods, agro produce, or agro products are all terms used to describe agricultural products. All commodities derived from plants, animals, microorganisms, and their by-products as a result of agricultural activities are considered agricultural products. Plant and animal products are products obtained from plants and animals. Agricultural products include crops, animals (such as chicken and poultry products), dairy and dairy products, fisheries and fishery products, forestry and forestry products, and so on.

Benefits of Agricultural products

Raw materials: Agriculture produces raw resources that are required in the manufacturing process. Sisal, cotton, bamboo, and other natural fibres are examples.

Trading commodity: In the financial markets, commodities such as wheat, corn, and tea are employed as trading commodities.

International Trade: International trade is based on agricultural goods that are traded among countries.

Foreign Exchange: Agricultural countries acquire foreign cash through the export of agricultural products.

Economic development: Agriculture and its products have contributed to economic growth and development in the majority of countries and areas.

What is Electronic Market?

The ability to bring consumers and sellers together in a virtual arena is one of the advantages

of the internet. As a result, electronic markets emerge. These online markets, also known as commerce web sites, allow buyers and sellers to meet and deal with one another. E-Markets are another name for these electronic markets, which are also known as online markets or e-hubs. They might also provide extra services like logistics or payment. Other activities, such as sponsoring online debates, giving research on customer demand, industry forecasts, and more, may be supported by these markets. E-markets provide sellers with numerous options for determining the optimal price for their items and lowering transaction costs. Participants in e-Markets can choose from a variety of market mechanisms, and the market's flexibility can be tailored to fit any industry's whole supply chain. Because of the efficiency gained by tightening and automating the relationships between suppliers and buyers of services and products, electronic markets provide a perfect environment for economic exchange. E-Markets encourage openness and are the closest thing to a totally efficient trading system that has yet to be devised. The more providers in an electronic market a smart buyer has, the more buying options he has and the more benefits he can get. The search for the best value proposition aids sellers in avoiding middlemen and making the most of the equipment they no longer require, as well as any other items they are willing to sell.

Benefits of Electronic Market

(a) The Internet provides "24/7" service to its consumers 24 hours a day, seven days a week. As a result, you may create and maintain relationships with customers all over the world, and your customers can shop or order products at any time.

(b) There is no expense to disseminating your message on the internet. Many social networking networks, such as Facebook, LinkedIn, and Google+, allow you to freely market and advertise your business.

(c) Using email, you may easily and quickly update your registered customers or subscribers.

(d) Your website's visitors or potential consumers can acquire up-to-date information on each visit.

(e) If you're running a deal, your customers can begin purchasing at reduced pricing as soon as they receive their email.

(f) If a company's business is sensitive to information, such as a legal firm, newspaper, or online magazine, without the need of a courier, that corporation can also distribute its products straight to clients.

Ways to sell agricultural products online

(a) Farmers are given an interface via which they can sell their products and interact with purchasers within a certain radius.

(b) Simple mobile interface with SMS for uploading product details and responding through phone and SMS Anyone can use the interface to buy the product/vegetable – first, go to the stock that appears on the Android app.

(c) Farmers can get a higher price for their products with no added marketing or transportation costs, but they can charge more if they distribute the things themselves.

(d) This programme also makes a civilian selection for the farmer's needs and to make it simple.

(e) A farmer can use this programme to find out the best price for his goods and avoid being duped by marketers.

(f) This application simplifies the farmers' requirements. Farmers may acquire detailed information about removing illicit marketing and inflation by using this programme.

(g) It aids in the correct storage and management of data and information.

(h) The system's well-defined interfaces make it simple to navigate through the many details.

Achievement of Electronic market

1. e-NAM (National Agriculture Market)

The e-NAM market is a 'virtual' one. It was a ground-breaking agricultural marketing effort that

increased farmers' internet access to a wider range of marketplaces and purchasers. This internet platform has proven to be a significant step forward in India's agriculture market restructuring. It is part of the Government of India's 'Doubling Farmers' Income by 2022' initiative, which aims to improve price realization and reduce intermediation costs by establishing a 'One Nation One Market.' On April 14, 2016, Honorable Prime Minister Sri Narendra Modi unveiled the electronic National Agricultural Marketing System under the Agriculture and Farmers Welfare Department, with the help of a lead agency, the Small Farmer's Agribusiness Consortium (SFAC). The e-NAM was launched in 21 pilot mandis across eight states, with twenty-four commodities being traded in pilot mode.

2. Collaboration of YONO SBI and ICAR-NCRSS for online trading

The ICAR-National Center for Research on Seed Spices has made a significant decision for spice crop farmers. Coriander, cumin, fennel, fenugreek, ajwain, kalonji, and other seeds may now be ordered online from the convenience of their own homes. The ICAR-National Center for Research on Seed Spices in Ajmar, Rajasthan, and YONO SBI have teamed together to create an online market for improved Seed Spices varieties. Farmers across the country can now use the YONO SBI Application to shop for seed varieties suitable for their climate zone, as well as other value-added items, from the ICAR-NRCSS Seed portal.

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PLANT HEALTH CLINICS

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Plant clinics are gathering places where local plant health extension officers, sometimes known as plant doctors, assist farmers who are dealing with pests and illnesses. They can detect any problem and offer management advice for any crop. It's a one-of-a-kind paradigm that, in addition to diagnostic and advising services, plays a critical role in knowledge transmission for plant complete health.

Plant health clinics (PHCs) are responsible for providing continuous healthcare to crops, fruits, and vegetables grown in rural and urban regions to reduce pest infestation losses. Though technology transfer may not always fall under the purview of PHC, information sharing and receiving feedback from stakeholders is a typical occurrence. Today, a plant health clinic can be thought of as a one-of-a-kind platform that serves as both a physician diagnosing plant ailments and prescribing treatments, as well as a teacher educating growers on various aspects of crop husbandry and pest management in the pursuit of sustainable agriculture and horticulture. Transferring technology /knowledge to stakeholders is a difficult but not impossible task. PHC is critical in distributing information on numerous areas of crop husbandry, including crop nutrition and the selection of varieties that are not only high yielders but also tolerant of a variety of edaphic and environmental conditions. PHC specifically trains growers in-field diagnosis of pests and diseases and suggests appropriate remedial measures, IPM, safe pesticide use, pesticide resistance management, and how to raise healthy crops using good agricultural practices, thereby arming growers with the most up-to-date information on sustainable agriculture innovation.

Plant clinics provide training on how to cultivate healthy crops using excellent agricultural methods, in addition to diagnostic and advising services. While people have easy access to clinics, the printed literature offered by PHC goes a long way in broadening urbanites' knowledge, and any confusion may be resolved over the phone, over SMS, or via e-mail.

Role of PHC

PHC plays a wider role, unlike human clinics by playing multiple roles by passing on knowledge in various fields. These include:

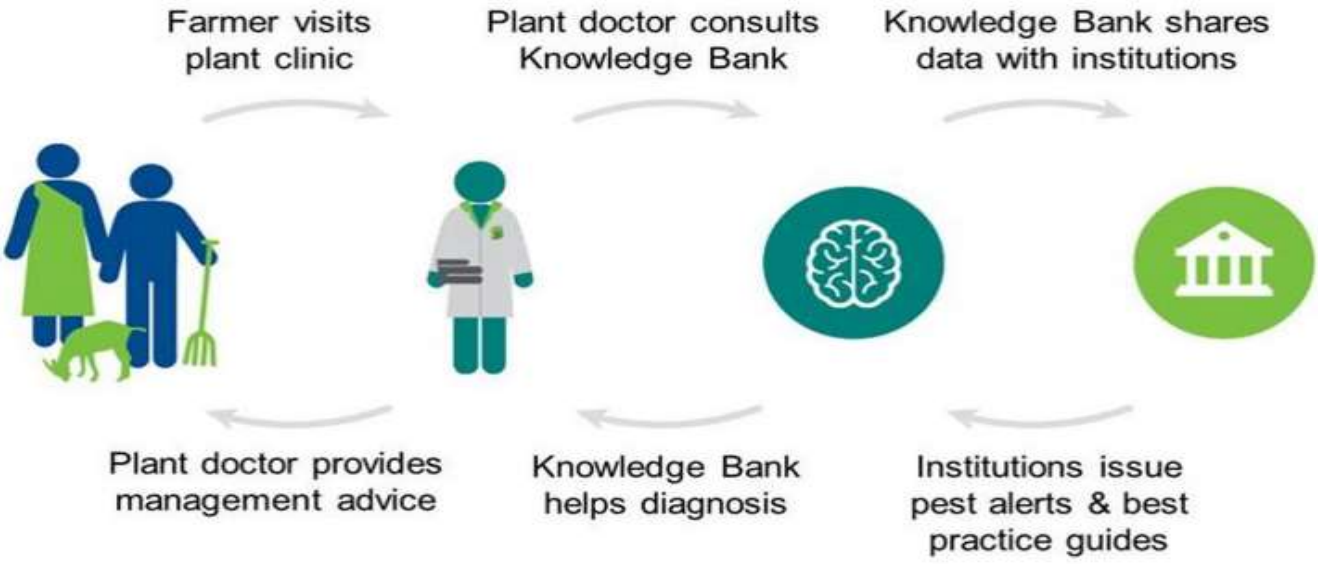
- Diagnosing plant ailments and providing remedies and empower the growers on various aspects of crop husbandry and pest management towards sustainable agriculture/horticulture.
- Training on field identification of pests, IPM, Safe use of pesticides, organizing plant health camp, communicating with print and electronic devices.
- In the event of an epiphytotic outbreak of pests and diseases mobile clinic plays an important role by rendering advice to the community to fight against the outbreak so that the area is saved before the village gets engulfed. The online clinic's role is limited yet it acts as an important forum for the dissemination of knowledge through the internet.

Recognizing the importance of plant clinics, the Department of Agriculture and Cooperation of the Government of India has launched the National Horticulture Mission, which has created 128 plant health clinics in the public and private sectors. To strengthen plant healthcare in the rural and urban sectors, the government should not have a narrow vision for PHC; rather, it should strive to see PHC expand and grow in the same way that human and cattle clinics do, to raise healthy plants that provide healthy grains, fruits, and vegetables.

Facilities and Infrastructure required for Plant health clinic

The clinics should have better physical infrastructure and diagnostic facilities with well-qualified and experienced pathologists, edapholo-gists, entomologists, and agronomists under one roof. The clinics need to provide services free of cost on plant health and ailments and innovations to achieve higher productivity. The role of a diagnostician is not only diagnosing the problem through visual/ microscopic examination or serodiagnostic technique but to provide the need-based mitigatory prescription with greater reliance on an integrated holistic approach that is environment-friendly, with the least impact on biodiversity, and is also easily affordable. It is also important to organize plant health camps, monitor pest scenarios, issue pest alerts maintain a vigil on pest incursion, and empower farmers with the knowledge to tackle pests. During an epiphytotic outbreak 'clinic on wheels' must help the farmers in rendering on-the-spot advice to arrest flaring-up of the problem. After all, communication with growers needs to be invigorated through print and electronic devices, toll-free telephony, e-mails, and SMSs.

How do PHC works?



Basic laboratory requirements:

Sl. No.	Basic equipment	Purpose
1	pH meter	For measuring pH of media and soil
2	Autoclave	For sterilization of culture media
3	Microwave oven	Sample preparation and heating
4	Refrigerator with stabilizer	Storage of samples, culture, and chemicals like enzymes and samples
5	BOD incubator	Maintaining Culture
6	Laminar flow	Culture in sterilized conditions
7	Computer, printer, scanner, UPS, software	Data storage and utilization For sending SMS alerts to farmers
8	Seed tester	For assessment of seed quality and diseases
9	Water distillation unit	For getting pure water
10	Binocular Microscope	For the microscopic study of pathogens.
11	Water purifier	For purification of water
12	Camera	For the recording of disease symptoms.

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ROLE OF HORTICULTURE IN ENTREPRENEURSHIP DEVELOPMENT

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Horticulture is a fast growing agricultural field that deals with farming and processing of plants, fruits, vegetables, flowers, aromatic and medicinal plants. Today people are getting attracted to the horticultural sector because of the government's specialization in this sector for its important contribution to the economy such as food production, employment generation and industrial input supply. Liberalization, privatization and globalization of world trade has created more job opportunities for teens all over the country.

Scope of Horticulture in India

India has a variety of climatic conditions that can be utilized for the cultivation of various horticultural plants. Climates vary from tropical, subtropical and temperate regions. Therefore, gardening has a wide scope for the following reasons:

- To take advantage of the great variability in agro-climatic conditions.
- Improving the economic situation of farmers.
- Creating job opportunities for workers and people.
- To protect the environment.
- To meet the needs of fruit, vegetables, flowers and spice drinks for the population growth and nutritional needs.
- Meet the requirements of the manufacturing industries.
- Meet the demand of export and import of horticultural products.
- Promote organic vegetable gardening produced in greenhouses or outdoors.
- Organic vegan production (as opposed to vegans = no meat consumption) excludes all animals.
- Crop production inputs (e.g. manure, blood meal or horn powder).

Hot spots for horticulture crops in India:

Horticulture has become a shining hot spot in Indian farming through consecutive years of severe drought and record productions. Better access to irrigation and increased consumer demand have pushed small farmers to grow more crops fruits and vegetables. The production of horticultural crops exceeded the production of food grains Fourth year in a row in 2016-2017: 295 million tons. The states which tops in fruit production are Andhra Pradesh, Maharashtra, Uttar Pradesh. With the increased Food and vegetable production, there will be more food processing units, and thus our economy will grow more.

Horticultural crops play a vital role in the Indian economy by providing employment opportunities, supplying raw materials for various food industries and increasing agricultural profitability due to the increase in production and export revenues of foreign currency.

- It will help promote smart food production and improve food security (Smart protein).
- A good source of nutrients, vitamins, minerals, flavor, aroma and dietary fiber, etc.
- It contains compounds and medicines that are beneficial to health.
- There is a local and international demand and it is a good source of foreign exchange.

Entrepreneurial opportunities in the horticultural sectors:

Horticulture is a broad field that includes a good variety of crops. Increasing opportunities arose to develop entrepreneurship in the horticultural sector especially for fruits, vegetables, flowers and other plants.

A) Urban farming

Urban farming can be classified into a large number of types based on area of farming, type of product produced, multi-modal sand used in cultivation. The following are the common types of urban farming.

1. Kitchen Gardening

Growing aromatic herbs, vegetables in and around a household space for everyday use in the kitchen. It is a very small scale production of vegetables which are used for household purposes and there is no surplus for sale. It's about meeting the daily needs of a small family and being less dependent on the market availability.

2. Rooftop gardening

Growing vegetables and herbs on the roof of the house or a single apartment or a group of families to meet the daily needs of the family or the community. The approach here is to use the empty space available on the roof top to reduce dependence on markets.

3. Vertical farming

Growing crops in vertically stacked layers. The main advantage of vertical farming techniques is to increase crop yields per unit area. Vertical farming can be followed in high-rise apartments, old abandoned buildings as well as on the walls. The approach here is a hit minimum space available for vegetable production.

4. Greenhouse gardening

Large vacant lots may be in and around the area greenhouse cover for high value-added crop production. It may be run by individuals, community or business owners and known for producing high-value crops under environmental control conditions with a greater amount of production than cultivation in the open field. The products also get better prices in the markets.

B) Industries associated with agriculture

1) Fresh turn out stalls

Fruit and vegetable surface unit is created in season but the market needs products all year round. Consumer income and demand are increased over the course of the years which forces the retailers or their representatives to select outlets in developing regions of the country. Supermarkets are growing very fast in developing countries over the past decade. To ensure the highest quality, the produce is collected directly from the farmers through diverse centers. Some of the turnout handlings in India: ITC Choupal, Recently, Heritage's Fresh, Spencer's Retail, Reliance Fresh's Ranger Farms, Big Bazaar, Big Basket and Metro.

2) Turf grass Operations:

The Turf grass operations Program is designed to train personnel for entry-level positions in home lawn care, turf grass farms, and golf yard attendants, lawn and ground workers for park areas as well as the public and private institutions. In addition, it provides opportunities to people who are already employed in a gardener business to acquire the necessary knowledge and skills in their fields.

- Landscape Technician (Creates and Maintains Landscapes).
- Golf Course Engineer (Golf Course Design).
- Golf Course Supervisor (Supervise construction and maintenance of golf course).

C) Tissue culture

Demand for and Supply of Tissue Cultured Plants has been increased for agricultural products, forestry, farms and horticultural crops, demand for high quality and high yield, disease-free plant material has increased dramatically over the past 20 years. Plant tissue culture has become a vital biotechnology and a commercially viable tool for elite breeding of high-quality, disease-free, high-yielding plant species through in-vitro methods by year roundly.

State departments of agriculture and horticulture promote tissue culture through the Agri-export Zones Expansion Program. Currently, only 6 to 7% of them are with Transplanted Tissue cultured Plants (TCP), more plants are expected to convert to TCP in the next 3-5 years. More than registered seed companies need millions of haploid plants of different species grown in their breeding program.

D) Scope of floriculture

This sector has created a lot of business opportunities due to the high returns per unit, space, increased job opportunities and a growing market with increased financial gains. As a result the international market is growing @ 8-10% per annum with a demand range of Rs 90,000 crores per annum and the domestic market is at 20-25%. Therefore, the horticultural business activity in India has no limits.

Shifts in Horticulture: The future

Opportunities in the horticultural industry are abundant; but in order to succeed, one must possess technical and personal skills. People who work in gardening must master a number of technical skills, including plant maintenance, mechanics, and business. Interpersonal skills are a person's abilities to establish fruitful relationships with others. Jobs and careers in gardening are similar to employees or employers in landscape horticulture, floriculture, olive growing and agronomics, pomology, turf grass gardening and other public areas.

The sector is gaining importance due to its nutritional value which is considered more modern, scientific and technological oriented and combined due to its large export potential in the trade of many perishable horticultural products. There are tons of business opportunities in agriculture that must be properly exploited to boost the Indian economy. Horticulture opens up a world of possibilities for students who chose to pursue training in this field.

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ECONOMIC ASPECTS OF ZERO BUDGET NATURAL FARMING SYSTEM IN INDIA

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The word budget refers to credit and expenses thus the phrase 'Zero budget' means without using any credit and without spending any money on purchased input. Natural farming means farming with nature and without chemicals. "Zero budget natural farming (ZBNF) or holistic agriculture is a method of agriculture that counters the commercial expenditure and things for the growth of plant are present around the root.

HISTORY

ZBNF is a unique chemical-free method that relies on agro-ecology. It was originally promoted by noted agriculturist SUBHASH PALEKAR, who developed it in the mid-1990s. ZBNF promotes the application of jeevamrutha- a mixture of fresh cow-dung, urine of aged cows, Jaggre,y pulse flour, water and soil -on farmland.

PALAKER'S VISION

- This model eliminates the cost of fertilizers, pesticides, and seeds and greatly reduces the incentive to borrow, one of chief causes for farmer suicides in the country. Hence its evocative title ZBNF.
- He believes in a method of cultivation which make use of already existing nutrients in the soil such as phosphate, potash, zinc and calcium in absorption from to the plants.
- In the zero budget natural farming nothing has to be purchased from the outside all thing required from growth of plants are available around the root zone of the plants.
- 98-98.5% nutrients are taken from air, water and soil energy. Remaining 1.5% nutrients taken from soil are also available free of cost as it taken from the prosperous soil which is enriched with these nutrients.

WHY WE DON'T NEED ANY FERTILIZER, PESTICIDES AND HERBICIDE IN ZBNF?

- Bhumi Annapurna: soil is rich with all nutrients for plant to grow.
- Plant do not compete for the food with weeds. They consist and live in symbiosis.
- Natural pest controls in the form of complementary and asthras will help.

SPECIFIC FEATURES OF ZBNF

- Zero budget natural farming requires only 10% water and 10% electricity than what is required under chemical and organic farming. ZBNF may improve the potential of crops to adopt to and be produced for evolving climatic conditions.
- It is, basically a natural farming technique that uses biological pesticides instead of chemical-based fertilizer. Farmers use earthworms cow dung, urine, plants, human excreta and such biological fertilizer for crop protection. It reduces farmers' investment. It also protect the soil from degradation.
- The ZBNF methods also promotes soil aeration, minimal watering, inter-cropping, bunds and top soil mulching, and discourages intensive irrigation and deep ploughing. Since farmers are not required to buy any input, the cost of production in ZBNF is reportedly zero.

FOUR PILLARS OF ZERO BUDGET NATURAL FARMING

- Jivamrita/jeevamrutha.
- Bijamrita/beejamrutha.
- Acchadana – mulching.
- Whapasa – moisture.

GOVERNMENT INITIATIVE TO SUPPORT ZBNF

Government of India has been promoting organic farming in the country through the dedicated schemes of Paramparagat Krishi Vikash Yojna (PKVY) since 2015-16 and also through Rashtriya Krishi Vikas Yojana (RKVY). The revised guidelines of PKVY scheme during the year 2018, various organic farming medels like natural farming, Rishi farming, Vedic.

Farming, Cow Farming, Homa Farming, Zero Budget Farming (ZBNF) etc. have been included wherein flexibility is given to states to adopt any model of organic Farming including ZBNF depending on farmer's choice.

Under the RKVY scheme, organic farming/natural farming project component are considered by the respective States level Sanctioning committee (SLSC) according to their priority/choice.

ZBNF V/S ORGANIC FARMING

S.N.	Zero Budget Natural Farming (ZBNF)	Organic Farming
1.	No external fertilizers are used in ZBNF.	Organic fertilizers such as compost, cow dung, and vermi-compost are used in organic farming.
2.	There is no tilling and no mixing. It requires natural ecosystems.	It requires basic agro methods like tilling, ploughing, mixing, etc.
3.	It is low-cost farming due to the local biodiversity	It is expensive due to the need for bulk manures.

ADVANTAGES OF ZERO BUDGET NATURAL FARMING

- Zero budget natural farming reduces the initial cost of farmers.
- Farmer's income automatically increases.
- The soil ecosystem improves.
- Cow dung adds soil value. It is full of nutrients value and available locally.
- Bacteria of cow dung decompose the organic matter in soil and make soil for the plants.
- It requires less electricity and water.
- ZBNF improves the productivity of the soil.
- It decreases the disease attack risk on the crop.

DISADVANTAGES OF ZERO BUDGET NATURAL FARMING

- This farming method used in some parts of India.
- The type of farming being debated, and there is not much scientific research under evaluation.
- This farming technique used in negligible areas.

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PACKAGING:

A HELPFUL TECHNIQUE FOR HORTICULTURAL PRODUCTS

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Fresh horticultural produce packaging is an important step in the long and complicated journey from grower to consumer. Handling, transporting, and marketing fresh produce is made easier by the use of bags, crates, hampers, baskets, cartons, and palletized containers. Proper product packaging can reduce not only bruising and cursing, but also improve produce marketing by reducing moisture loss, preventing contamination of the product with spoilage organisms, reducing pilferage, and maintaining a sanitary environment during marketing. Because of the lack of packaging, a large portion of horticultural produce is wasted. Bad weather, physical, chemical, and microbiological deterioration are the causes of this loss. Progress in food packaging will be critical in the coming years, owing to the creation of new consumer patterns and the world's population growth, which is expected to reach 15 billion by 2025. The shelf life of fresh product is determined by the product's properties such as water availability, spoilage mechanism, sensitivity to oxygen, light, carbon dioxide, and moisture. Processed foods in general are highly susceptible to the vagaries of climate and are predisposed to various physiochemical changes such as caking, hardening, drying, colour and flavour loss, rancidity, and so on. Aside from that, they are susceptible to microbiological spoilage and can become infected during storage and distribution.

WHAT IS PACKAGING

The science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use is known as packaging. The process of designing, evaluating, and producing packages is also referred to as packaging.

WHY DO WE REQUIRE PACKAGING?

Assume that there are no packaging materials or technology available. How are we going to transport horticultural produce such as apples, mangos, and so on to distant markets? So how do we weigh or count the fruits that are being transported or marketed? This would be extremely difficult. Without packaging, the commodity would have suffered significant physical, chemical, and microbiological losses. Handling, managing, transporting, and marketing the produce as loose and unpacked would have been extremely difficult. As a result, packaging for both fresh and processed commodities was required to contain, unitize, and protect the produce.

FUNCTIONS OF PACKAGING MATERIAL

1. Containment

The package protects the product and prevents leakage, pilferage, and other losses.

2. Protection and preservation

The package protects the produce from mechanical damage and adverse environmental conditions while it is being handled, stored, or marketed, thereby preserving its quality.

3. Convenience

Packaging assembles the produce into convenient handling unit.

4. Communication and marketing

Package facilitates promotion of sale of the produce through displaying vital information on label.

THE CHARACTERISTICS OF A GOOD PACKAGING MATERIAL

1. It should not be toxic or reactive with the product.
2. Eco-friendly.
3. Low cost, easy availability, and light weight
4. Allow for the restricted movement of air and moisture.
5. Should be strong enough to withstand damage during transportation.
6. The commodity should be protected from microbiological damage and chemical changes.
7. The package's closure should be heat sealable.
8. They must be environmentally friendly and biodegradable.

TYPE OF PACKAGING MATERIALS

There are mainly three types:

A. TRADITIONAL PACKAGING MATERIALS

1. Wooden boxes

Previously, these boxes were used for long-distance transportation of fruits (such as mango, apple, pear, stone fruit, etc.) and vegetables

(tomato), but they have become obsolete due to a variety of disadvantages, including environmental issues, fruit injury, and so on.

2. Sacks

Jute, cotton, and woven synthetic materials may be used to make natural and plastic sacks (polypropylene, polyethylene). Plastic sacks or mesh bags are now the most popular options due to their low cost, higher strength, and hygienic properties in wet conditions and rains.

B. MODERN PACKAGING MATERIALS

1. Plastic bags

For packaging, plastic bags made of LDPE (low density polyethylene), PVC (poly vinyl chloride), and PP (poly propylene) cellulose acetate films are used. Film bags are transparent, allowing for easy inspection of the contents, and can accommodate high-quality graphics. Plastic films come in a variety of thicknesses and grades and can be used to regulate the atmospheric gases inside the pouch. The film materials required to keep the proper mix of oxygen, carbon dioxide, and water vapour inside the bags.

2. Shrink films and Stretch films

The films are used for both individual and group packaging of fresh and processed products. When cooled after passing through hot air, these films have the ability to shrink and hold the product in place.

3. Plastic punnets

These are strong, clear, light-weight containers made of PET (Polyethylene Terephthalate). They have ventilation holes to keep the products fresh. Strawberry, kiwi fruit, and grapes are commonly packed in punnets.

4. Tetrapacks

These are the packages that are commonly used to pack various types of products. Fruit juice, vegetable oils, milk, and so on. These packages are constructed with 6-7 layers of materials.

i. Polyethylene: Sealing layer
ii. Polyethylene: Adhesion layer
iii. Aluminum foil: Gas and light barrier, aroma retention.
iv. Polyethylene: Adhesion layer
v. Paper: Stability, toughness, and printing
vi. Polyethylene: The package's outermost layer is water/moisture proof.

5. Foam sleeve

A type of polyethylene foam plastic tubular film is available in a variety of colours, diameters, and lengths. It is slipper over the individual fruits and fits tightly to reduce movement and moisture loss. It cushions the fresh produce and protects it from abrasion and scratches during transportation.

6. Corrugate Fiber Board boxes (CFB boxes)

Corrugated fibre board boxes are lightweight, easy to handle, recyclable, and suitable for printing, among other things. Wax or plastic coating can also be used to make these water resistant. Corrugated fibre board's strength and serviceability have improved in recent years. CFB boxes are now available in 2, 5, and 10 kg filling capacities. The majority of corrugated fibre board boxes are made from three or more layers of paper that are kept in place during the manufacturing process. To allow for ventilation, holes are drilled into the box's top and side edges.

C. ADVANCED PACKAGING TECHNIQUES

1. Modified atmosphere packaging (MAP)

The atmosphere surrounding the produce is altered in this technique from that of normal atmosphere. A modified atmosphere for horticultural produce can be created passively (via product respiration passive MAP) or by replacing air in the package with a gas mixture (active MAP). Modified atmosphere packaging refers to the packaging of a commodity in such a way that a modified atmosphere, i.e. a decrease in O_2 levels and an increase in CO_2 levels, is generated inside the package. The product is exposed to normal atmospheric gases in a modified atmosphere package (oxygen, nitrogen, carbon dioxide and water vapor).

Examples of MAP in fresh commodities include capsicum, cucumber, and cabbage.

Chips, Pepsi, and other processed commodities are examples of MAP.

2. Vacuum packaging

When the total pressure inside the package falls below that of the outside environment as a result of more or less evacuation of the internal gases, a vacuum environment is created. The modification of the packaging atmosphere from normal (21 percent oxygen and 78 percent nitrogen) is widely used as an effective modern packaging technology that significantly extends shelf life and improves the quality level of most food products. This is commonly used in the commercial packaging of mushrooms, pomegranates, fresh cut papaya, carrots, and other produce. □

ALTERNATE WETTING AND DRYING IN RICE WITH IoT – AN INNOVATIVE WATER SAVING TECHNOLOGY

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Water is an essential input to agriculture in nearly all its aspects having a profound effect on the eventual yield. Agricultural inputs like seeds and fertilizers will fail to achieve their full potential if plants are not optimally watered. India has 18% of world population, having 4 per cent of world's fresh water, out of which 80 per cent is used in agriculture. Of this, 80 per cent water is consumed by just three crops- rice, wheat and sugarcane. Farmers in India are using 25 times the amount of water than that is needed to produce paddy. Improper irrigation methods and conventional flooding irrigation practice are the stated reasons for the high wastage of a scarce resource. The traditional practice of puddled transplanted rice cultivation with continuous flooding demands higher water consumption, high labour and energy intensive, leading to higher production costs. It also contributes 1.5% of global methane emissions and various nitrogen losses (percolation, volatilisation and denitrification) that reduce the Nitrogen Use Efficiency. As 4 billion people around the globe are currently affecting by the increasing threat of water scarcity, there is a need to replace the normal transplanted rice with sustainable crop establishment methods like direct seeded rice and mechanized system of rice intensification to achieve stable and increased rice yields with less irrigation water. Integration of the above sustainable crop cultivation practices with a potential water saving technology called alternate wetting and drying improves Nitrogen use efficiency and water productivity by reducing weed growth, which was a significant problem in Direct Seeded Rice and System of Rice Intensification. The integration of an intelligent water-saving irrigation system called IoT (Internet of things) based water measuring sensors with different crop establishment methods under Alternate Wetting and Drying helps to monitor the water levels in the field. IoT is the web-based irrigation control system or programmed software connected to the mobile phone to remotely turn on the pumps when the water level in the field reaches a critical level. Using this technology, one can save the water and money on electricity or diesel for their pumps, reducing the various nitrogen losses and Green House Gas emissions from the rice fields.

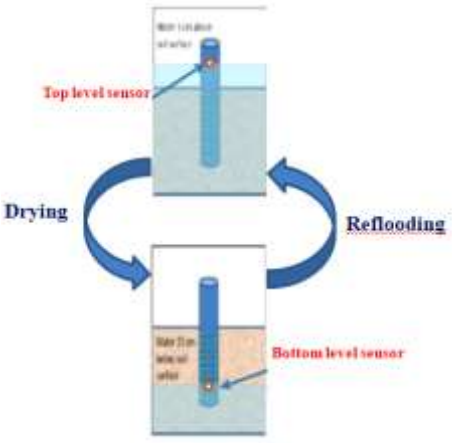
WHAT IS AWD IN RICE

Alternate Wetting and Drying (AWD) is a water-saving technology that farmers can apply to reduce their irrigation water consumption in rice fields without decreasing its yield. In AWD, irrigation water is applied a few days after the disappearance of the ponded water. Hence, the field gets alternately flooded and non-flooded. The number of days of non-flooded soil between irrigations can vary from 1 to more than 10 days depending on the number of factors such as soil type, weather, and crop growth stage.

WHAT IS IoT?

"IoT based smart irrigation system" is for to create an IoT base automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the moisture content and sufficient water level and pass data through IoT platform. It overcome labour intensive work and also controls water management system. The Internet of Things (IoT) is the inter-networking of "physical devices" also referred to as "connected devices" and "smart devices". Sometimes referred to as the Internet of Everything (IoE) and Machine to Machine (M2M) communicating. IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine (M2M) communications and covers a variety of protocols, domains, and applications.

IoT BASED AWD IRRIGATION IN RICE



In IoT based AWD two type of sensors were used i.e., bottom level and top level sensors. When water level reaches 5cm above ground level, top sensor will detect it and when water level reaches 5cm below the ground level, top sensor will detect it. These sensors will send the data to the mobile phones through IoT gateway and IoT cloud. The farmer will receive the information about the water level in the field in the form of a text message with which he can switch on or off the motor. By using this technology, progressive US rice farmers have saved $35/acre for water and up to $15/acre for nitrogen, and are able to save 50% or more water, reduced methane emissions by 50% and nitrogen use by 25%. Yield enhanced and 8% quality improvement. Saving of 50% water enabling the farmer to grow paddy during summer.

ADVANTAGES OF IoT

a. Water Conservation: Soil moisture sensors allow for water use only when and where needed.

b. Real-Time Data give Farmers can visualize water levels and soil moisture in real time and remotely to accelerate decision making process.

c. Lowered Operation Costs: Automating processes in irrigation can reduce resource consumption, human error and overall cost.

d. Efficient and Saves Time The machine-to-machine interaction provides better efficiency, hence; accurate results can be obtained fast. This results in saving valuable time. Instead of repeating the same tasks every day, it enables people to do other creative jobs.

e. Increase in productivity.

f. Reduce soil erosion and nutrient leaching.

IoT BASED SMART IRRIGAT-ION SYSTEM

CHALLENGES

a. Complexity: The IoT is a diverse and complex network. Any failure or bugs in the software or hardware will have serious consequences

b. Privacy/Security: The risk of losing privacy Ex: There is a chance that the software can be hacked and your personal information misused.

c. Lesser Employment of Menial Staff or unskilled workers: The unskilled workers and helpers may end up losing their jobs in the effect of automation of daily activities.

d. Equipment is costlier.

e. Awareness of Indian farmer for this technology.

CONCLUSION

Automation of irrigation with IoT based sensors is the need of the hour to reduce the water consumption by the local farmers in flodded rice**.** This area of research needs to be explored for specific results in local areas of the country.

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KISAN CREDIT CARD – FINANCIAL INNOVATION IN INDIAN AGRICULTURAL CREDIT MARKET

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The Kisan Credit Card (KCC) scheme is a turning point in the history of rural credit in India. Based on the recommendations of R.V. Gupta committee, National Bank for Agriculture and Rural Development (NABARD) introduced Kisan credit card (KCC) scheme in August 1998 to meet out various credit requirements of Agriculture sector by giving financial assistance to farmers for multiple purposes through a single window. Co-operative banks were the first to launch the KCC scheme, in the country followed by RRBs and commercial banks. The Kisan Credit Card scheme was brought about with the aim of simplifying the procedure for farmers in getting adequate and timely credit. This would help farmers in the purchases of various agriculture inputs such as seeds, fertilizers, pesticides etc. The KCC also covers post-harvest expenses, consumption requirem-ents, and investment in credit requirements for agricultural and allied activities. Minimum loan limit of KCC is 5000/- and there is no upper limit.

Farm credit is a strategic input in agriculture sector. Provision of sufficient and timely disbursement of credit to the farming community plays an important role in faster and sustainable growth of agriculture and allied activities in rural development. The kisan credit card aims at providing timely and adequate credit to the farmers in a cost effective and flexible manner. In addition to credit for crop production, the policy also minimizes the role of money lenders in the flow of agricultural credit.

OBJECTIVES

Kisan credit card aims at providing adequate and timely credit support from the banking system to the farmers for their cultivation and other needs as indicated below:

1. To meet the short-term credit requirement for cultivation of crops including fodder crops.
2. Post-harvest expenses.
3. Produce marketing loan.
4. Consumption requirement of farmer household.
5. Working capital for maintenance of farm assets and activities allied to agriculture like dairy, poultry, fishery, piggery, sericulture etc.
6. Investment credit requirement for agriculture and allied activities like purchase of farm equipment's/machinery like pump sets, drip irrigation equipment's, sprayer, tractor etc.

ELIGIBILITY CRITERIA

1. All farmers- individual/ joint borrowers who are owner cultivators.
2. Tenant farmers, oral lessees and Share croppers.
3. Self Help Groups or Joint Liability Groups of farmers including tenant farmers or Share croppers.
4. Recorded/registered Share croppers and tenant farmers who are cultivating crops for a period not less than five years in order to meet the production credit need are also eligible.
5. The individual tenant farmers/ Share croppers cultivating crops on oral lease basis who are resident of the village at least for a period of three years continuously and cultivating lands for a reasonably long period but not less than three years could also be issued KCC with a farm credit limit up to 10000 in general cases.
6. The age of the KCC holder should be 18 years and above but not exceeding 70 years.

DOCUMENTS REQUIRED

1. Application form
2. Two passport sized photographs
3. ID proof like driving licence Aadhar card, Voter identity card, Passport (any one of these).

4. Documents stating land holding details dually certified by the revenue authorities/ online land records.

KISAN CREDIT CARD APPLICATION PROCEDURE

1. Visit the official site of any bank of your choice and visit the Kisan Credit Card Section.
2. Download the application form and print it out.
3. Fill out the application form.
4. Visit the nearest branch of the bank and submit the application long with the documents asked.
5. The loan officer will provide the details necessary to the applicant.
6. Upon the sanction of the loan amount, the KCC will be dispatched.

Alternatively, the applicants can also take help from the bank to apply for the KCC. The banks have specially designated personnel for helping the applicants fill out the form and provide the guidance in complying with the other requirements.

RATE OF INTEREST

Sr. No	Parameter	Interest Rate
1	Limit up to 3 lacs	7.00% p.a. (fixed), subjected to government of India providing interest subventions. One-year MCLR +Strategic premium
2	Limit above 3 lacs to 25 lacs	One-year MCLR +Strategic premium + 1.25%
3	Limit above 25 lacs	One-year MCLR +Strategic premium + 2.00%

BENEFITS AND ELIGIBILITY CRITERIA FOR THE KCC SCHEME

1. Farmers will meet their financial requirements along with any expenses incurred during the post-harvest season.
2. The farmers eligible for the KCC scheme will issued a savings account with affordable interest rates
3. The KCC scheme will facilitate a hassle-free disbursement procedure and a flexibility in repayment of loan.
4. No collateral will be required for loans that amount up to Rs. 1.6 lacs.
5. Limit to be fixed on the basis of operational land holding, cropping pattern and scale of finance.
6. The Card has a validity of 5 years post which it will be subject to an annual review. In case of a good credit score, the card limit would be further extended to include rising costs, incidental expenses or change in cropping pattern etc.
7. Rescheduling of loans and conversions will be permitted in case of any damage to crops due to an unforeseen event like natural calamity etc.

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BIOFORTIFICATION OF FRUITS AND VEGETABLES

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The process of adding nutritional value to a crop is known as bio-fortification. It refers to agricultural nutrient enrichment to combat the negative economic and health effects of vitamin and mineral deficiencies in humans. Many dietary guidelines for human health and disease prevention have emphasized dietary patterns centered on increasing fresh fruit and vegetable consumption while reducing simple carbohydrates, salt and saturated and transfat consumption (Wang *et al*., 2016). People require many minerals that must be incorporated in their diet in order to sustain excellent health. All important minerals are found in food, which is mostly plant-based, thus it's important to eat a healthy, balanced diet on a regular basis to get the right mix of minerals (Gharibzahedi *et al*., 2017). Food enrichment with health-related chemicals and mineral elements, on the other hand, might be regarded a technique to combat malnutrition or meet a specific nutritional demand. In the case of non-processed foods, such as vegetables, the only way to boost nutrient content is to use enhanced genotypes or particular agronomical procedures in the pre harvest period (Kyriacou *et al.*, 2018). The strong demand in mineral enrichment of fresh consuming vegetables and fruits has sparked a flurry of research focused on the development of appropriate application techniques.

Need of Biofortification

Vitamin A deficiency (VAD) is a major public health concern in developing countries, especially among children and women of reproductive age, with an estimated 600,000 fatalities per year among children under the age of five. According to data provided to the World Health Organization (WHO) by the Government of India, 62 per cent of all preschool-age children have VAD. Deficiencies in iron (Fe), zinc (Zn), and selenium (Se) are critical public health concerns as well as significant soil limits to crop productivity, especially in developing nations.

Methods of Biofortification

A. Agronomic Biofortification

Fertilizers are used to boost the micronutrient content of edible components. The mobility of mineral elements in the soil and in the plant is proportional to the degree of agronomic biofortification success (White *et al*., 2003). Zinc (foliar applications of $ZnSO_4$), Iodine (soil application of iodide or iodate), and Selenium are the most acceptable micronutrients for agronomic bio fortification (as selenate). Inorganic Se fertilizers resulted in a more than 10-fold rise in Se concentrations. Due to the conversion of Fe^{+3}, which is unavailable to plant roots, Fe ($FeSO_4$) has a poor mobility in soil. Synthetic metal chelators (e.g. EDTA- Fe- and Zn-chelates, which proved successful in boosting mineral concentration in edible vegetable and fruit tissues) were used to circumvent the phytoavailability bottleneck (Shuman *et al.*, 1998). Foliar application of micronutrients (Fe, Zn, Cu, etc.) in plants is a quick and easy form of fertilizer application. Mycorrhizal interactions have been observed to increase Fe, Se, Zn, and Cu contents in crop plants in several investigations. Micronutrients such as Zn, Cu, and Fe are better absorbed and used by AM-fungi.

B. B. Conventional plant breeding

The following are the steps in biofortification by traditional plant breeding:

1. Identify target populations.
2. Set nutrient target levels.
3. Screen germplasm and genes.
4. Breed biofortified crops.
5. Evaluate the performance of new crop kinds.
6. Assess nutrient absorption and effect
7. Measure nutrient retention in crops/food.
8. Develop strategies to disseminate seeds.
9. Promote marketing & consumption of biofortified food.

10. Improve nutritional status of target populations.

C. Genetic engineering

When there is insufficient variation among genotypes for the desired character/trait within a species, or when the crop is not suitable for conventional plant breeding (due to lack of sexuality; *e.g*. banana), genetic engineering is a viable option for increasing the concentration and bioavailability of micro nutrients in edible crop tissues. One of the major issues is the so-called 'gene flow' environmental issue, which refers to the risk of foreign genes being transferred to non-target species. Redistributing micronutrients between tissues, boosting the efficiency of biochemical pathways in edible tissues, and even reconstructing selected pathways are all possible targets for transgenes. Some of the strategies entailed removing 'antinutrients.' Golden rice, for example, was one of the first biofortified crops, with the edible section of the grain modified to create beta-carotene or provitamin A. Other crops, such as maize, orange cauliflower, tomato, yellow potatoes, and golden canola, are being treated in the same way (Susana *et al*., 2015).

Targeted crops

Several conventional and transgenic varieties of banana, cassava, beans, potato, orange sweet potato (OSP), cowpea, pumpkin, and other horticultural crops have been released as a result of biofortification efforts.

Table 1: List of biofortified varieties

Crop	Developed Variety	Nutrient	Leading institutions	Targeted country	Release year
Cauliflower	Pusa Betakesari	Beta carotene	ICAR-IARI, New Delhi	India	2015
Sweet Potato	BHU Sona	Beta carotene	ICAR-CTCRI, Thiruvananthapuram	India	2017
	BHU Krishna	Anthocyanin	ICAR-CTCRI, Thriuvananthapuram	India	2017
Cowpea	Pant Lobia -1	Iron, Zinc	G.B.P.U.A.T., Pantnagar	India	2008
	Pant Lobia -2	Iron, Zinc	G.B.P.U.A.T., Pantnagar	India	2010
Pomegranate	Solapur Lal	Iron, Zinc and Vitamin C	ICAR-NRC on pomegranate	India	2017
Banana /Plantain	_	Provitamin A carotenoid	IITA	Nigeria, Ivory Coast	2019
Bean	_	Iron, Zinc	Embrapa	Brazil	2008
Cassava	_	Provitamin A carotenoid	CIAT	Nigeria, Brazil	2017
Irish Potato	_	Iron	CIP	Rwanda, Ethiopia	-
Pumpkin	_	Provitamin A carotenoid	Embrapa	Brazil	2015

IITA: **International Institute of Tropical Agriculture,** CIAT: **International Center for Tropical Agriculture**
CIP: **International Potato Center**

Fig.1 BHU Sona

Fig.2 BHU Krishna

Fig. 3 Solapur Lal

Fig.4 Pusa BetaKesari

Conclusion

Biofortified crops, whether created through traditional breeding techniques or sophisticated biotechnological instruments, are not a cure for malnutrition. Global nutrition's ultimate goal is to provide a sufficient and diverse diet for the world's population. Biofortified crops, on the other hand, can supplement existing micronutrient interventions and have a substantial influence on the lives and health of millions of people, particularly those in need.

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BENEFITS OF MORINGA IN HUMAN DIET

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There are only some plants that have multiple edible parts. Moringa is one amongst them, hence it's called a "Miracle Tree" or "Wonder Tree". The Moringa tree is also referred to as horseradish, ben, and canafistola, scientific name Moringa oleifera. It's most known for its fruit/seed pod, the drumstick, a typical vegetable in Indian cooking. However, this plant's leaves, seeds, flowers, bark, and roots are edible and are used for traditional Ayurveda and Siddha herbal medicines. The Moringa tree is beneficial as food and medicine, but the leaves are extremely nutritious and beneficial with more healing properties. The easiest consuming them is as a dietary supplement, one can avail various health benefits of Moringa within the type of oil, leaf powder, or extract.

MORINGA IS A SUPERFOOD

Because the name suggests, Superfood is a food with many nutritious values. No wonder Moringa may be a superfood of superfoods because it is the most nutrient-dense, antioxidant-laden, therapeutic food on this planet. The many nutrients found in this tree bring it to the highest of the superfoods list. The leaves, fruit, sap, oil, roots, bark, seeds, pod, and flowers of the tree have medicinal properties. Adding this superfood to your daily diet could be a good investment.

COMPLETE PROTEIN

Moringa is high in protein and contains a powerful 8 of the 9 essential amino acids. It's been observed in various studies that plant proteins tend to be healthier than animal proteins as they are low in calories and high in fibers.

Vitamins	Quantity/ 100g
Vitamin A	4 µg
Thiamine (B_1)	0.0530 mg
Riboflavin (B_2)	0.074 mg
Niacin (B_3)	0.620 mg
Pantothenic acid (B_5)	0.794 mg
Vitamin (B_6)	0.120 mg
Folate (B_9)	44 µg
Vitamin C	141.0 mg

WAYS TO CONSUME MORINGA

The leaves and flowers in their fresh form are consumed as food, they will be consumed directly or added to smoothies, soups, and salads. Moringa oil extracted from its seed is sometimes not recommended for internal consumption. It is used for topical (external) applications. The oil is rich in vitamins and antioxidants, and is suggested as a wonderful skin cleanser, moisturizer, wound healer, and has anti-aging effects. It is also used for healthy hair and hair treatments.

BENEFITS OF MORINGA DROPS

It has been reported during a few studies that Moringa contains a staggering 92 nutrients and 46 natural antioxidants with a variety of anti-inflammatory compounds. Researchers found that the leaves, which are rich in polyphenols, flavonoids, flavonoids, glucosinolates, and alkaloids, have numerous health benefits.

Conclusion

Moringa oleifera is a prominent source of nutrients and antioxidants. Like other vegetables such as spinach

and fenugreek, Moringa leaves are not as popular everywhere the globe, but currently, it is used as substitutes in soups, lentils, and other preparations in the geographic area. Still, there is a knowledge gap within the potential uses of Moringa as a food supplement and food fortification. Moringa has enormous potential uses but is extremely little explored. It is often utilized to form foods that would be a step towards curbing malnutrition. The published literature gives the overall scenario of the chemical constituents, nutritional content, potential uses, and pharmacological activities of the plant. The identification, isolation, and standardization of plant extracts could also be considered for detailed studies which may be useful for the further development of promising food products with health benefits and nutrients to cure different lifestyle-related diseases similar to malnutrition.

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MEDICINAL PROPERTIES OF THE GOLDEN SPICE CURCUMIN

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Turmeric is also called as '**Golden Spice of India'**. World turmeric production is about 78 percent. India is the largest producer of turmeric and also the biggest consumer and exporter of turmeric. This spice is widely used in middle-east and Asian countries including China, Bangladesh and South East Asia. It is mainly cultivated in China, Bangladesh, Burma (Myanmar), Taiwan, Sri Lanka, Nigeria, Australia, Jamaica West Indies, Peru and other Caribbean and Latin American countries. Turmeric (*Curcuma longa*) is widely used in Ayurveda, Unani and Siddha medicine as a home remedy for many diseases. Turmeric has been used for thousands of years and has become an integral part of a food and traditional medicine. Pharmaceutical companies are understanding the composition of turmeric and making various products out of it. Curcuminoids are polyphenols that give yellow color to turmeric. Traditional medicinal uses of turmeric are for cough, diabetes, wound healing.

ANTI-OXIDANT ACTIVITY

The aqueous extract of turmeric shows anti-oxidant activity greater than vitamin E. TRAP and FRAP assays are used to determine anti-oxidant activity. Oxidative stress is a result of an imbalance between oxidants and defensive mechanisms which results in the pathogenesis of many human diseases. Turmeric increases the activity of certain endogenous enzymes such as SOD (Superoxide dismutase), GSH (Glutathione), catalase by scavenging different forms of free radicals like ROS (reactive oxygen species) and RNS (reactive nitrogen species). It also inhibits lipoxygenase/ cyclooxygenase, xanthine hydrogenase/ oxidase which are ROS generating enzymes. Phenolic functional groups are responsible for anti-oxidant activity of turmeric. It enhances lipid peroxidation inhibitory activity and potentiates the radical scavenging activity.

RHEUMATOID ARTHRITIS

It is a condition associated with an ongoing chronic inflammation process characterized by hyperplasia of the synovial fibroblasts. Systemic review and meta-analysis have shown that turmeric extracts can reduce pain and inflammation related symptoms through down regulation of tumor necrosis factor (TNF), COX2 and other inflammatory cytokines. As per the pilot clinical study, curcuminoid preparation was found to be safe, effective and with lesser side effects compared to diclofenac sodium and a few other NSAIDs.

ANTI-DIABETIC ACTIVITY

Turmeric extract shows its anti-diabetic activity by reducing oxidative stress by quenching reactive oxygen species (ROS) and thus prevents oxidative damage. Curcumin inhibits superoxide production and vascular protein kinase C which is the cause of diabetes. It also lowers lipid peroxidation by maintaining the activity of anti-oxidant enzymes. In type II diabetes mellitus, the study shows that turmeric reduces the level of blood sugar and glycosylated hemoglobin level in alloxan-induced diabetic rat model. Curcumin increases glucose metabolism, insulin sensitivity and decreases glycation end products.

WOUND HEALING ACTIVITY

The topical application of curcumin extract on wounds on diabetic rats has shown an increase in cellular proliferation and collagen synthesis at the wound site. Its mechanism involves the improved activity of nitric oxide synthase along with increased levels of beta transforming growth factor. Turmeric contains proteins, fats, vitamins which plays role in wound healing as well as regeneration by an early synthesis of collagen fibers. It also causes tissue remodeling, fibroblast proliferation, granulation, collagen deposition. Turmeric formulation applied at the wound site causes an increased in DNA, hexosamine, protein, hydroxyproline content.

ANTI-BACTERIAL ACTIVITY

Different extracts of turmeric showed anti-bacterial activity against different bacteria, parasites and pathogenic fungi. Bacterial apoptosis is caused by the formation of reactive

oxygen species and DNA damage. Growth of certain bacteria like Staphylococcus, Lactobacillus is suppressed curcumin oil fraction. *In vivo* study shows that curcumin has a poor activity for complete eradication of H. pyroli.

ANTI-INFLAMMATORY ACTIVITY

Acute and chronic inflammation gives rise to many pathological conditions. Turmeric acts as an anti-inflammatory agent by different pathways. It causes suppression of NF (nuclear factor) κB activation through downregulation of cyclooxygenase-2, xanthine oxidase and inducible nitric oxide synthase and upregulation of PPAR-ϒ. It also reduces pro-inflammatory cytokines like interleukin-1β, interleukin-4, interleukin-6, interleukin-8, Interleukin-12 and inhibits the activity of lipoxygenase, cyclooxygenase, nitric oxide synthase. In this way, it inhibits inflammatory cell proliferation, metastasis, and angiogenesis and improves inflammatory and immune responses.

ANTI-VENOM ACTIVITY

Ar-tumerone acts as an anti-venom agent and is isolated from turmeric. It has proteolytic and hemorrhagic activity against the venom enzyme by acting as an enzymatic inhibitor. Turmeric also acts against toxins of Indian cobra. Turmerin is a protein which inhibits enzymatic activity and neutralizes edema and myotoxicity of phospholipase A2 of the cobra. Beta-sitosterol shows a70% neutralization potential of cobra venom.

CARDIOPROTECTIVE EFFECTS

Turmeric is effective against many cardiovascular diseases including myocardial infarction, arrhythmia, cardiomyopathy, myocardial ischemia as studied in both *in vivo* and *in vitro* animal models. It decreases levels of triglycerides, LDL (low-density lipoproteins), VLDL (very low-density lipoproteins) and thus decreasing lipid peroxidation. Turmeric decreases cholesterol level by decreasing its uptake by the intestine and thereby increasing the conversation of cholesterol into bile by the liver. It potentiates prostacyclin synthesis and inhibits thromboxane synthesis by inhibition of platelet aggregation.

ANTI-CANCER ACTIVITY

Turmeric acts as a chemoprotective agent through various signaling cascades. Turmeric effects are studied on different signaling pathways including Ras signaling, β-catenin signaling pathways, transcription pathways such as NF-κB and AP-1 families and STAT family transcription factors. Turmeric has been shown to suppress transformation, tumor initiation, tumor promotion, angiogenesis, proliferation, and metastasis. It also acts through the downregulation of transcription factors, inflammatory cytokines, protein kinase, growth factor and other oncogenic molecules. Glutathione levels in cancer cells are lower than normal cell so it increases sensitivity to curcumin and its uptake in cancer cells is high. According to the recent work curcumin decreases the glucose uptake and lactate production in cancer cells through down regulation of pyruvate kinase M2 (PKM2). Turmeric and its derivatives have the ability to act against different types of carcinomas. It acts against different cancers like oral cancer, lung cancer, multiple myeloma, prostate cancer, pancreatic cancer, breast cancer, head and neck squamous cell carcinoma, colorectal cancer. Turmeric has the limitation of poor water solubility and poor bioavailability so it can be converted into different nano formulations and effectively used as an anti-cancer agent.

HEPATOPROTECTIVE ACTIVITY

Turmeric shows a hepatoprotective effect due to the augmentation of antioxidant activity and reducing the proinflammatory cytokines formation (anti-inflammatory activity). In animal studies, turmeric has been found to protect the animal liver from various hepatotoxic substances like Thallium, beryllium, iron, thioacetamide, tetrachrobenzoquinone, ethanol, paraquat, aflatoxin B1, streptozotocin, acetaminophen, alcohol, lindane, CCl4(carbon tetrachloride), diethyl nitrosamine and heavy metals. In the mice model, CCl4-induced liver toxicity reduced by pre-treatment with curcumin normalized serum aminotransferase activities, decreased levels of malondialdehyde and the hepatic histo-architecture.

ANTI-FUNGAL ACTIVITY

Different extracts of turmeric show anti-fungal activity against different fungi such as *Aspergillus flavus, Fusarium verticillioides, Curvulariapallescens, Colletotrichum falcatum, Aspergillus niger, Aspergillus terreus, Fusarium oxysporum, Fusarium moniliforme, Fusarium graminearum, Cryptococcus neoformans, Candida albicans, Rhizoctonia solani, Phytophthora infestans, Erysiphe graminis, R. solani, Puccinia recondita, Botrytis cinerea, Fusarium solani, Helminthosporiumoryzae, Trichophyton rubrum, T. mentagrophytes, Epidermophyton floccosum and Microsporumgypseum*. In case of *candida albicans*, turmeric shows an inhibitory effect by preventing its adhesion to a buccal epithelial cell.

Turmeric causes down regulation of enzyme desaturase. So, there is reduction of ergosterol of fungal cell and the generation of ROS results in cell death. Another mechanism may be by a reduction in proteinase secretion and alteration of membrane-associated properties of ATPase activity.

ANTI-ULCER ACTIVITY

A study in rats has shown that turmeric can be used for a gastric and duodenal antiulcer activity. Turmeric taken as an adjuvant with other anti-ulcer drugs helps to achieve remission of ulcers. Its ethanolic extract inhibits gastric acid, gastric juice secretion and ulcer formation. Pre-treatment with turmeric extract reduces the intensity of ulcer formation. It is safer and cost-effective.

CONCLUSION

Turmeric has been used for thousands of years worldwide. It is a major part of Ayurveda, Siddha medicine, Unani and traditional Chinese medicine. India consumes nearly 80% of turmeric. Most people use turmeric in food and consume it on daily basis. It has been studied in numerous clinical trials that turmeric is used for various human diseases and conditions. In this review, we have seen that turmeric has powerful biological properties. As turmeric is cost-effective and safer than many other drugs so it can be widely used for many pathological conditions and can act as a novel drug. Turmeric has a broad spectrum of action so it is used for the long term and on daily basis. Turmeric and its analogues attack multiple targets, so its effectiveness increases. Hence, many years of research justify turmeric as "The golden spice".

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SPINE GOURD: A NUTRITIOUS CUCURBIT

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Figure 1: Fruits of *Momordicadioica*

Spine gourd, more commonly known as Kakrol, is botanically named *Momordica dioica* Roxb. It is an important member of the Cucurbitaceae family. In nature, it is dioecious and perennial, although its vines are annual. It is commonly planted in Orissa, Maharashtra, Bihar, and West Bengal, and is steadily gaining favor as a commercial vegetable crop due to its rich taste and high nutritional content. It's high in phytoconstituents.

Momordica dioica phytoco-nstituents include traces of alkaloids, steroids, triterpenoids, flavonoids, glycosides, saponins, ursolic acid triterpenes, dark brown semi-drying oil, saturated fatty acids, ascorbic acids, vitamin A, thiamin, riboflavin, niacin, protein carbohydrates, lectins, ascorbic acids, carotenes, bitter principles, Olea Momordicin, an alkaloid found in the seed, and Momordicafoetida, an alkaloid found in the root. Cucurbitacins and cucurbitane glycosides are glycosidic structures found in the spiny gourd.

NUTRITIVE VALUE (PER 100 g OF EDIBLE PORTION):

Constituents	Quantity
Moisture	84.1
Protein	3.1g
Carbohydrates	7.7g
Fibre	2.97g
Ash	1.1g
Iron	4.6g
Calcium	33mg
Phosphorus	42mg
Carotene	2700IU
Thiamine	45.2mg
Riboflavin	176.1g
Niacin	0.59mg
Ascorbic acid	275.1mg

BOTANY:

It's a dioecious climber with a glabrous stem. Broadly oval, whole leaves with deep 3–5 lobed margins. Flowers are yellow, and the fruits are ovoid or ellipsoidal, 2.5–6.3 cm long, with a small beak thickly covered in soft spines. Seeds are somewhat compressed and irregularly corrugated, measuring 6.0-7.0 mm in length.

CLIMATE AND SOIL:

- It's a warm-weather crop. High humidity and a temperature of 25–30°C are essential for vine development to be productive. It may be grown well in areas with an average rainfall of 150–250 cm. Plants of the spine gourd are dormant throughout the winter months.
- Because it is a resilient crop, it may be cultivated in a variety of soil types. However, sandy soil rich in organic matter and with adequate drainage is preferred.
- The pH of the soil should be between 6 and 7. Before planting, the land should be ploughed three to four times and then harrowed to eliminate the bits of perennial weeds.

THERAPEUTIC USES:

Spine gourd is a less exploited cucurbitaceous crop though it is very high in nutritional and medicinal properties. Various scientific researches on the medicinal and nutritional benefits of spine gourds reveal that these vegetables have antiox- idant, analgesic, nephroprotective, neurop-rotective, antiallergic, antiulcer, anti- cancer, antimicrobial, antidiabe-tic, antimalarial, anti-inflammatory, hepatoprotective and antihepatotoxic properties. Spine gourds are considered to have diuretic, laxative, antivenomous, antihypertensive, anti-asthmatic, antipyretic, an- tileprosy, and antidepressant properties as well.

In Ayurvedic system of medicines, juice of fresh spine gourd fruits is recommended as a remedy for treating hypertension and

diabetes. Spine gourd vegetable prepa- ration is also considered as a healthy food for diabetics.

1. ANTI-OXIDANT:

It is a substance that inhibits oxidation, especially one used to counteract the deterioration of stored food products.

- Compounds derived from natural sources are capable of providing protection against free radicals.
- The alcoholic extract inhibited the formation of oxygen derived free radicals (ODFR) *in vitro* with 4000 µg/mL ascorbic system.

2. ANTI-DIABETIC:

In alloxan-induced diabetes in albino Wister strain rats, researchers investigated antidiabetic effects by utilizing ethanolic, aqueous, chloroform, and ethyl acetate as solvents. Sharma and Arya also discovered that ethyl acetate and ethanol extracts containing steroids included triterpenoids, which had possible involvement in alloxan-induced diabetic rats and type-2 diabetes in general.

3. PREVENTS HYPERTENSION AND SUPPORTS HEART HEALTH:

People with high blood pressure should drink fresh spine gourd fruit juice. Due to its strong antioxidant activity, it promotes blood circulation and helps avoid atherosclerosis. It has anti-lipid peroxidative capabilities, which means it protects and repairs artery walls.

4. PREVENTS SEASONAL INFECTIONS:

Monsoon time is considered as an ideal time for common viral infections in the form of fever, cold and cough. Mother Nature has given enough power to spiny gourd to prevent such infections. So don't hesitate to eat it.

5. PROTECTS LIVER:

Spine gourd is high in antioxidants and flavonoids, which help fight free radicals. It possesses anti-lipid peroxidative capabilities, which means it inhibits fat oxidation and, consequently, fatty liver in the first place. Those with fatty liver disease or liver damage should avoid it at all costs.

6. PREVENTS AND CURES RESPIRATORY DISORDERS:

When the powder or infusion of spine gourd fruit is placed in the nostrils, it causes errhine (mucus discharge). In Ayurveda, it is used to treat asthma, bronchitis, and obstructed sinuses.

7. BRAIN FUNCTION:

Fruit of the plant possesses neuro-protective properties and supports the brain function via the CNS (Central Nervous System). In Ayurveda, it is used to treat mental disorders.

8. SUPPORTS DIGESTIVE SYSTEM:

The vegetable has a cooling effect and is simple to digest. Pulp and seeds contain a lot of soluble fiber and have laxative effects. They are beneficial to the digestive system and are used for conditions such as stomach ulcers, piles, and constipation. It's also used to treat biliousness or the overproduction of bile juice.

9. REMOVE KIDNEY STONES:

If you are suffering from kidney stones, Spiny Gourd might help you get rid of them. To clear kidney and bladder stones, mix 10 grams of powdered Spiny Gourd in one glass of milk or water and consume it once a day.

10. USEFUL FOR PREGNANT WOMEN:

Many dangerous complications might emerge during pregnancy. Neural tube abnormalities are one of the issues. Fresh green Spiny Gourd pods are high in folate (Vitamin B_9), an important nutrient for cell development and reproduction. Because Spiny Gourd includes around 72 mcg/100 g of folate, expectant moms who eat fresh green pods of Spiny Gourd throughout their pregnancy have a lower risk of neural tube abnormalities.

11.ANTIMALARIAL:

Aqueous leaf extract of *Coccinia grandis* decreases the SGPT, SGOT, ALP, total protein, blood urea nitrogen concentration. Hydrophilic moiety of *Coccinia grandis* extract is responsible for antimalarial activity. The extract significantly reduces the *Plasmodium berghei* parasite strength in mice in some studies.

12.ANTIPYRETIC:

Studies evaluated that *Coccinia grandis* for antipyretic activity at the doses of 100 and 200 mg/kg of extract in yeast-induced fever. The extract showed antipyretic activity by influencing the prostaglandin biosynthesis. Prostaglandin is considered as a regulator of body temperature.

13. ANTIFUNGAL:

Studies found antifungal activity of the *Coccinia grandis* leaves extract against the *Candida albicans* II, *Candida tropicalis*, *Aspergillus Niger*, *Saccharomyces cerevisiae*, *Candida tropicalis* II, *Cryptococcus neoformans* and *Candida albicans* ATCC. Aqueous extract is more sensitive for both strains of *Candida albicans* and Ethanolic extract is more sensitive for *Aspergillus Niger* and both strains of *Candida albicans*.

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WHICH CAME FIRST: BEES OR FLOWERS ?

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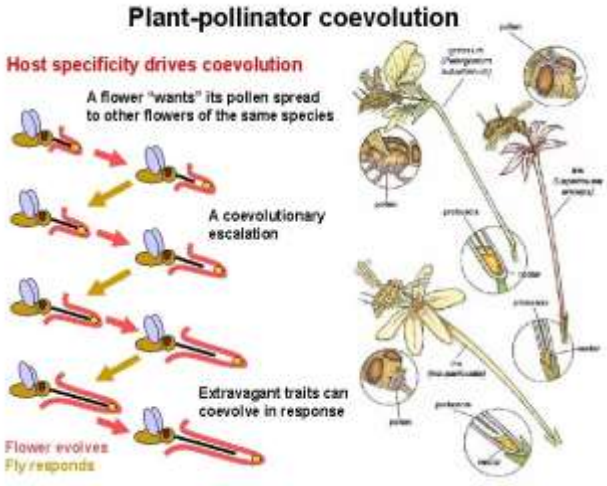
Bees are great for our garden as they are attracted to bright flowers in need of nectars to feed. When they do this their bodies collect pollen from one plant to other, which aids in pollination. This helps plants to produce their progeny fruits, vegetables and seeds. So, the question is which came first, bees or flowers?

WIND POLLINATION

Charles Darwin called flowers as "an abominable mystery". Flowers were relatively late bloomers in evolution history. Over 140 million year, Earth landscape looked completely different from now, where the Earth without flowers. At that time plants were limited by ferns, conifers, and cycads. Now these plants are used as landscape for Jurassic park. These plants concur world by reproduction through spore and wind pollination. Meanwhile, there were plenty of insects that recognize today present along with them; but not bees. Plants are rooted to grounds, despite rooted, different type of plants have evolve different strategies for exchanging sex cells with far off partners. Non flowering plants like conifers rely mostly on the wind to deliver pollen, but it is inefficient, because it may or may not get pollination.

CO-EVOLUTION OF FLOWERS WITH BEES

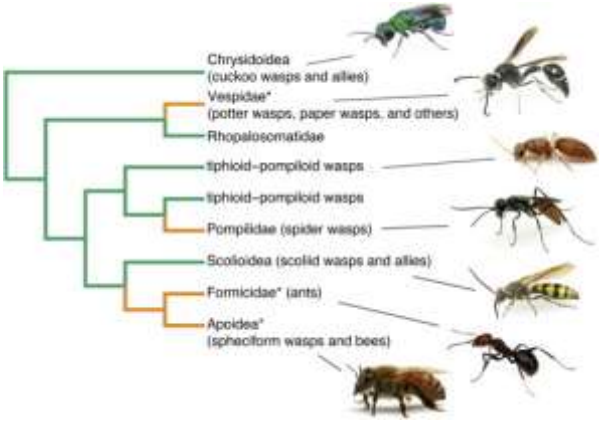
In order to increase the chance of fertilization, angiosperms have recruited their own special delivery system called insects. In former time nectar was not main reason for insects to visit plants. The early pollinators came to eat genetic material called pollen, to get nutrition. They drop few crumbs along the way, thus flowers get pollinated and this relationship called as mutualism. Plants pollinated by insects had advantage over wind pollination. This started co-evolution of flower with insects. The main task for flowers is to attract pollinators, First white flower, and then bright coloured flowers, then weird shaped flowers and intoxicating scent flowers were evolved for attracting insects. To deal with competition some started to produce sweet sugary nectar, a starting point of interaction between insect and flower.



CARNIVORE'S WASP TO HONEY BEE EVOLUTION

Many modern bees were live alone at early time. DNA and anatomy studies showed that honey bees were evolved from solitary, carnivorous wasp. These wasps stock their nests with insect corpses. If that insect had recently visited a flower, its corpse might be dusted with a little bit of pollen. Over time, some wasp replaced their dead insect diet with more and more protein rich pollen. Days go on and the bees are nothing but vegetarian wasp.

Evolution of bees from wasp



Some of which unknowingly become adapted to help plant to reproduce. So plants were making flowers and insects pollinating these flowers and replaced the wind pollination. Bees with their special adaption, flowering plants completely dominate the world.

CONCLUSION

Today flowering plants make up biggest single group in plant kingdom. When comes to pollination, nothing is better than bee. They have unique UV vision that sense flower patterns that cannot seen with our eyes. Besides, honey bee collect huge baskets of pollen and have special long tongue to slurp up nectar present in plants.

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HONEY BEE:
A TRUE FRIEND AND IDEAL INSECT FOR HORTICULTURE

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India is the world's second-largest producer of fruit (88.9 mt) and vegetable (162.89 mt), after China. Cross pollination occurs in the majority of horticulture crops. At least 30% of the world's plants benefit from cross-pollination. 90% of our wild flora and crops will be able to flourish. It's true. Approximately one-third of all plants or plants are thought to be Humans use items that are either directly or indirectly harmful to the environment. Pollination by bees is required.

In India, there are 50 million people. Thousands of hectares of land are bee-dependent. The importance of bees as pollinators has been recognized for many years, yet this information is regrettably underappreciated and misunderstood. Flowers have a short life span in most crops, making pollination difficult.

The blooms will fall and no seeds, berries, or fruit will grow if such a crop is not pollinated at that period. To pollinate a cross-pollinated crop, there must be a sufficient number of bees in the field. This is particularly essential in crops where a single bloom may only be pollinated for a certain period of time, or where nectar production or bee visits are limited to days when the temperature is at a given level. In such a crop, pollination must occur within three or four days in some years. When the ground temperature is over 15^0C, the blooms emit several unique smelling compounds that attract bees. When the weather gets colder, only a few bees seem to be interested in the blossoms. The entire harvest might fail if the farmer does not give honeybees or other pollinators for pollination. In a single minute, a honeybee may visit 18-20 flowers. The absence of bees for pollination might result in crop losses of up to 75% for the farmer. When a single coffee blossom blooms, it is only open for three to four days. If the bloom is not pollinated by a bee or another.

Tab.1- HONEYBEE COLONY IN HORTICULT-URAL CROPS:

Crops	Bee colonies per hectare
Apple	4
Alfalfa	8
Apricot	2
Asparagus	4
Avocado	5
Bean (Lima)	9
Blackberry	7
Blueberry	8
Cabbage	5
Carrot seed	8
Citrus	2

Table 2. The role of honeybees in the pollination of stone fruits

Fruit	Variety	Condition	Fruit set (percent)	Yield/tree (kg)
Apricot	Trevatt	Open	19	99
		Enclosed	11	67
Cherry	Moss Early	Open	36	35
		Enclosed	2	2
Peach	Golden Queen	Open	26	216
		Enclosed	22	155
Peach	Crawford	Open	28	47
		Enclosed	10	18
Plum	Satsuma	Open	6	38
		Enclosed	2	15

POLLINATION'S ROLE IN INCREASING THE QUALITY AND YIELD OF HORTICULTURE CROPS

Bee pollination not only results in more fruits, berries, or seeds, but it may also improve the quality of the food, and efficient

flower pollination may help protect crops from pests. The growth of all seeds in a fruit results in a higher weight owing to proper pollination.

An apple, for example, can only produce all of its seeds if it has been thoroughly fertilized and pollinated by many bees. An apple bloom has the potential to produce 10 seeds. The fruit does not develop a side where the seeds do not develop if all of the seeds do not develop. As a result, the apple has a bad form and is light in weight. Similarly, for strawberries to properly mature, 21 visits from bees are required. A single strawberry might have between 400 and 500 seeds on its surface. Pollination by a sufficient number of bees can help safeguard the crop from significant insect infestations.

POLLINATION BY BEES HAS A NUMBER OF ADVANTAGES:

Honey bees are the most effective pollinators of a wide range of agricultural, horticultural, forestry, feed, and wild plants. Cross pollination by bees results in somatic, reproductive, and adaptive heterosis in plant offspring.

- Stimulate germination of pollen on stigma,
- Increase viability of seeds, embryos and plants,
- More nutritive and aromatic fruits,
- Stimulate faster growth of plants,
- Increases number and sizes of seeds and yieldof crops,
- Increases nectar production in the nectaries,
- Increases fruit set and reduces fruit drop,
- Enhances resistance to diseases and other adverse climatic conditions,
- Increases the oil content in oil seed crop.

CONCLUSION

Pollination plays a critical part in falling horticulture output, which can be linked to a number of causes. Improved agricultural technology, such as the use of high-quality seed, high-yielding cultivars, and sound agronomic practices like timely irrigation and fertilizer application, are all beneficial, but without pollination, neither fruit nor seed will form. Pollinator shortage is the primary cause of insufficient pollination and output.

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SPHERIC MICROBES:
A BOON TO MITIGATE DROUGHT STRESS IN PLANTS

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Drought is a havoc to the farming community. It poses severe challenges to germination, growth and can affect the production and yield. Successive years of monsoon failures and associated drought have led to crop failure and have necessitated the need for scientific intervention in farming. Green-house gas emission and elevated temperature due to the climate change have even aggravated the situation to a worser condition. To add on, the anthropogenic interventions by the use of chemicals have disturbed the whole rhythm of the nature and the effects are visible as an open book. Though agronomic, breeding and biotechnological interventions are on its way to make revolutions in climate smart agriculture, the unseen microbes are silently playing their role in tackling the drought by the plants. The microbes present in rhizosphere (root region), phyllosphere (leaf), caulosphere (stem), spermoshere (seed), carposphere (fruit) and anthosphere (flower) play big role in growth of plants through solubilizing nutrients, mobilizing nutrients, releasing growth hormones, producing antimicrobial compounds, producing signalling compounds and many more. With the exploitation of wide array of microbes that express these functions, the methylotrophic bacterium commonly referred as Pink Pigmented Facultative Methylotroph (PPFM) and potassium solubilizing microbes are promising in the context of drought management in plants.

PINK PIGMENTED FACULTATIVE METHYLOTROPH

Methylotrophic bacteria are ubiquitous in nature and are a substantial part of the microflora of the surfaces of young leaves. These bacteria are capable of utilizing C1 compounds such as formate, formaldehyde, methanol and methylamine as well as a wide range of multi-carbon growth substrates such as C_2, C_3 and C_4 compounds as carbon source. The genus *Methylobacterium* is composed of pink pigmented facultative methylotroph (PPFM) and non-pigmented facultative methylotroph (NPFM) bacteria which are capable of growing on C1 compounds such as formate, formaldehyde, methanol and methylamine as well as on a wide range of multi-carbon substrates. PPFM is a phyllosphere (leaf surface) borne microbe and survives with the methanol which is emitted as a by-product during cell wall metabolism taking place during opening of stomata.

HOW PPFMs ARE HELPFUL TO PLANTS IN TACKLING DROUGHT ?

PPFMs produce plant growth regulators like auxin, cytokinin and Vit B_{12}. These compounds fuel the germination and root growth and result in cell elongation. Elongation results in deeper roots and helps the plants to draw water from deeper surface. The osmo-protectants like sugars and alcohols exudated by PPFMs keep the plants away from desiccation and high temperature, thus helping the plant to stay greener. PPFMs cause an increment in the production of proline, which usually accumulates during the stress condition. Proline enhances water uptake and maintain the water status of the plants. PPFM protect the soluble protein, RUBISCO from degradation and help to maintain the photosynthetic efficiency even in drought condition. During drought, plants produce more of ethylene, leading to yellowing and senescence. But PPFMs synthesise the enzyme ACC deaminase that would prevent the formation of ethylene during drought, there by delay senescence in plants and help to overcome drought.

PPFM APPLICATION TO CROPS

This bio-fertilizer can be applied as foliar spray, 1% volume (*i.e.*, 10 ml of bio-fertilizer in 1 L of water) of liquid PPFM during morning and evening at an interval of 15 days between subsequent spray or as seed treatment by soaking the seeds in 1% solution for 5-10 minutes. Tamil Nadu Agricultural University is one of the pioneering

institutes in PPFM research and PPFM bio-fertilizer is available.

POTASSIUM SOLUBILIZING BACTERIA (KSB)

Potassium is an essential mineral element for plant growth and stress tolerance as it regulates stomatal closure and cell turgor. Potassium has a crucial role in preventing the drought induced leaf senescence. It can increase the plant dry mass, leaf area and water retention in plant tissues under drought stressed conditions. This essential element is present in a complexed form in the nature, which is made available to the plants by the metabolism of potassium solubilizing bacteria, through production of organic acids.

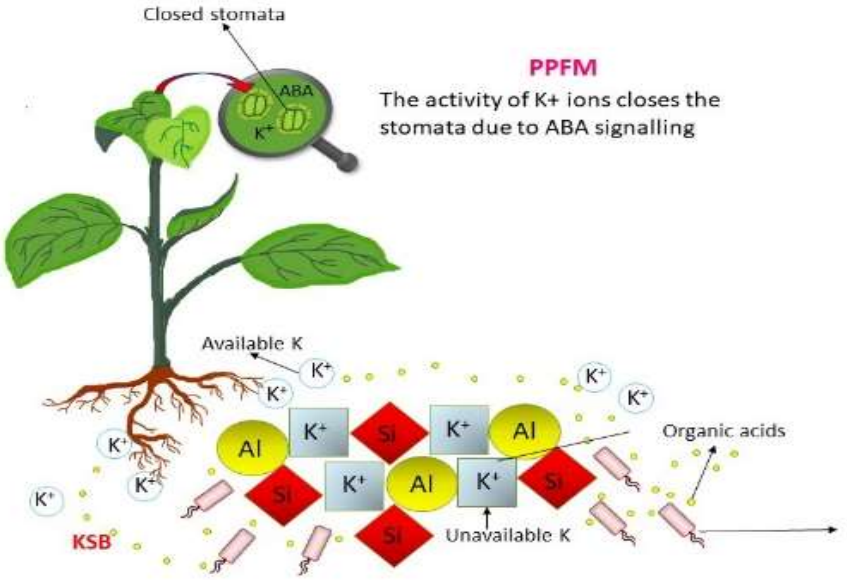
ROLE OF POTASSIUM SOLUBILIZING BACTERIA IN DROUGHT TOLERANCE

During the drought stress, the plant accumulates abscisic acid, a stress hormone. It assembles potassium ions to maintain the turgor pressure and leads to stomatal closure thus reducing the water loss and wilting, respiration, energy loss. Application of potassium solubilizing bacteria in soil, releases potassium from the complex potassium minerals like mica, apatite and elevates the potassium uptake by the plants resulting in drought tolerance. Potassium solubilizing bacteria are promising in building a sustainable greener earth as it reduces the hazards of chemicals and maintains the equilibrium of the nature.

KSB APPLICATION TO CROPS (as prophylactic measure)

1. Seed treatment

Two hundred gram of the KSB inoculant (carriers like lignite



based) is mixed with 200 ml of rice gruel to make a slurry. The seeds required for an acre can mixed in the slurry to have a uniform coating and is to be shade dried for 30 minutes. The shade dried seeds should be sown within 24 hours. Two hundred gram is sufficient to treat upto 10 kg of seeds. For liquid formulation, 200ml of the liquid inoculant is mixed with 20 litres rice gruel and the seeds are soaked overnight before sowing.

2. Seedling root dip

This method is used for transplanted crops. Four hundred gram of the KSB inoculant is mixed with 40 litres of water. The root portion of the seedlings required for an acre is dipped in the mixture for 5 to 10 minutes and is transplanted. For liquid formulation, the roots of seedlings, required for planting one acre are to be dipped in 200 ml of liquid bio-fertilizers mixed in 10 litres of water for 20 minutes just before transplanting.

3. Main field application

Two kilogram of the KSB inoculant is mixed with 20 kg of dried, powdered farm yard manure and broadcasted in one hectare of main field just before transplanting. For liquid, 250 ml of liquid KSB is mixed with one litre of water and thoroughly mixed with 10 kg farm yard manure and used for broad casting one acre of land.

PPFM AND KSB ARE RECOMMENDDED FOR?

Both are recommended for all agricultural and horticultural crops. For better results seed treatment, seedling dip and main field application are recommended. During severe drought PPFM can be sprayed at 15 days interval.

CONCLUSION

PPFMs and Potassium Solubilizing Bacteria are novel strategies which are effective and user friendly to manage drought. In an agricultural world of unpredictable climate, exploration and use of such beneficial microbes could be a checkmate to stress environment and a boon for sustaining agriculture. PPFM and Potash Solubilizing formulations are available with institutes of TNAU. Lets' turn to organics for a better tomorrow and evergreen sustainable agriculture.

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JEEVAMRUTHAM – A BOON FOR SOIL MICROBES (LIQUID GOLD)

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Jeevamrutham comprises of two words – Jeeva and Amrutham. Both are derived from Sanskrit. The word "Jeeva" means a living being and "Amrutham" means the elixir (medicine) upto extending life. It is a microbial culture, mainly prepared from cow dung and cow urine, generally used in organic farming in order to meet the nutritional requirement of crops. The freshly prepared Jeevamrutham was acidic in nature with a pH of 5.63. The EC (Electrical Conductivity) of Jeevamrutham was 0.23 dSm^{-1} and the calcium content was (66.4 ppm).

TYPES OF JEEVAMRUTHAM

1. The liquid state of Jeevamrutham

Preparation: The dung and urine of cow, hybrid cow, were considered by using 1kg dung, 1 litre urine, 200 g jaggery, 200g flour and 100 g soil from the same field, mix them in a big tank properly and keep the tank in shade and cover it with jute bag and it should be breathable and leave it. The mixtures were kept for incubation under shade for 5 days and stirred vigorously for 10–15 minutes three times a day with a wooden stick. The average minimum and maximum temperatures during the study period were 13.4 and 31.1ºC, respectively. The final volumes of the mixtures were made to 20 litres with water in plastic containers.

2. The semi-solid state of Jeevamrutham

Preparation: Mix 100kg Desi cow dung, 5 litre urine, 1kg jaggery, 1kg pulse, one handful of soil from the same land with a small amount of water. Make small balls out of the mixture. Keep these balls in full sunlight to dry them. Now, these dried balls can be kept near the mouth of a dripper or near the sprinkler. When the water falls on the semi-solid Jeevamrutham, the microbes get activated again.

3. Dry Jeevamrutham (*Ghana jeevamrutham*)

Preparation: Spread 200kg of cow dung on ground uniformly in the form of layer and add 20 litres of liquid jeevamrutham on it and mix it. Now, make a heap of treated cow dung and cover it using jute bag for 48 hours allow it for fermentation then spread on the floor, dry in the sunlight. After drying is completed, store it in jute bags in the room. Air should be flowing. Ghana jeevamrutham can be stored for 6 months.

ADVANTAGES OF JEEVAMRUT:

1. Acts as an agent to increase the microbial count & beneficial bacteria in the soil.
2. Improves pH of the soil.
3. Jeevamrut can be made within 4-5 days so it can be used effectively and frequently.
4. Suitable for all crops and increases the yield.
5. Reduces costs of chemical fertilizers.
6. Earthworm count increases in the soil. Earthworm helps to keep soil quality porous which has a higher water holding capacity.
7. Improves aeration, bring up minerals from deep in the field.

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FARMING TECHNIQUES FOR SEQUESTERING CARBON IN SOIL AND ITS IMPACTS ON CROP PRODUCTION

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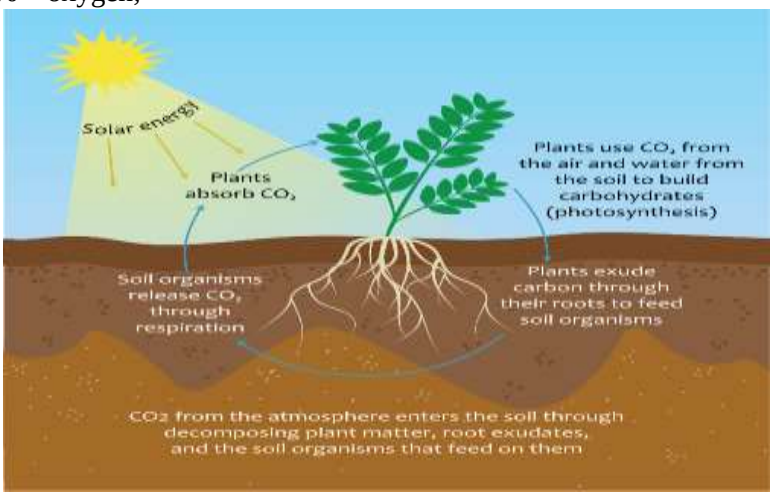
The earth's atmosphere (dry air) consists of 78.09% nitrogen, 20.95% oxygen, 0.03% carbon dioxide, and small amounts of other gases by volume. Carbon is found in all living organisms and is the major building block for life on earth. Carbon in the form of carbon dioxide, carbonates, organic compounds etc. is cycled between various reservoirs, atmosphere, oceans, land and marine biota. According to Grace (2001), carbon exchange is facilitated by the natural processes of photosynthesis (plant uptake of carbon dioxide), respiration (the release of energy and carbon dioxide), dissolution and carbonate precipitation. Climate change is becoming an alarming issue today due to increasing amount of green-house gases (GHGs) in the atmosphere. It could be controlled by mitigating GHGs especially carbon dioxide, by sequestering carbon into soil and vegetative cover. The major GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The concentration of CO_2, CH_4 and N_2O in the atmosphere since industrial revolution increased by 30%, 145%, and 15%, respectively due to human activities (IPCC, 2007). CO_2 is a unique GHG which traps long length wave radiation reflected from the earth's surface and probably the only one that has a major role in plant physiology. CO_2 causes 7.5% of the total global warming. Soil, vegetation and the ocean are considered potential sinks of carbon dioxide because of the large quantities of carbon dioxide currently sequestered in these pools and their capacities to continue taking up carbon dioxide. Photosynthesizing vegetation takes up carbon dioxide and sequesters it as biomass carbon in the terrestrial carbon pool. Carbon dioxide enters the soil carbon pool when dead biomass decomposes through roots. Although oceans store most of the earth's carbon, soils contain approximately 75% of the carbon pool on land i.e. three times more than the amount stored in living plants and animals. Therefore, soils play a major role in maintaining a balanced global carbon cycle.



As reported by Sundermeier *et al.* (2005), soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately reemitted. This transfer or "sequestering" of carbon helps off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity. Soil carbon sequester-ation can be accomplished by management systems that add high amounts of biomass to the soil, cause minimal soil disturbance, conserve soil and water, improve soil structure, and enhance soil fauna activity.

Management techniques for carbon sequestration in soils are Conservation agriculture, Minimum/ zero tillage, Cover crops, Crop residue and Organic agriculture.

Conservation Agriculture

Conservation agriculture has a proven potential of converting many soils from source of carbon to sinks of atmosphere Carbon by sequestering it into soil (FAO/CTIC, 2008; Lal *et al.*, 1998). Conservation agriculture improves agriculture by reducing erosion, increasing water infiltration, improving soil surface

aggregates, reducing compaction through promotion of biological tillage, increasing surface soil organic matter and carbon content and moderating soil temperatures (Hobbs, 2007).

Minimum/zero tillage

Minimum or zero tillage the main purpose of tillage is to provide favourable soil environment for plant growth. It is one of the major factors responsible for reducing carbon stocks in soil. Soil organic matter is oxidized when it is exposed to the air by tillage, resulting in a reduction in organic matter (OM) content, unless additional OM is returned to the soil as residues, compost, or other means. Tillage disrupts the pores left by roots and microbial activity. The effect of this on below ground biology is not well known. The bare surface exposed after tillage is prone to breakdown of soil aggregates as the energy from raindrops is dissipated. This results in clogging of soil pores, reduced infiltration of water and increased runoff, leading to soil erosion. When the surface dries, it crusts and forms a barrier to plant emergence (Hobbs, 2007).

Crop Residue

As reported by Sundermeier *et al.* (2005), transferring carbon dioxide from the atmosphere into the soil can also possible through mixing crop residues. This transfer or "sequestering" of carbon helps off-set emissions from fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity. Soil carbon sequestration can be accomplished by management systems that add high amounts of biomass to the soil, cause minimum soil disturbance, conserve soil and water, improve soil structure, and enhance soil fauna activity.

Cover crops

Cover crop is the use of crops such as legumes and small grains for protection and soil improvement between periods of regular crop production. Cover crops improve carbon sequestration by enhancing soil structure and adding organic matter to the soil. Wang *et al*. (2010) in their studies on six winter and summer cover crops each grown in two soils, gravelly loam soil (GL), and fine sandy soil (FS), in phytotrons at three temperatures reported that among winter cover crops, the highest and the lowest amounts of C accumulated were 0.597 kg/ m^2 by *Vicia faba* L. and 0.149 kg/ m^2 by white clover (*Trifolium repens*) respectively in the FS soil. Among summer cover crops, sunhemp (*Crotalaria juncea* L.) accumulated the highest quantity of C (0.481 kg/ m^2), while that by castor bean (*Ricinus communis*) was 0.102 kg/m^2 at 30° C in the GL soil. Following a whole cycle of winter and summer cover crops grown, the mean SOC increased by 13.8 and 39.1% in the GL and FS soils, respectively as compared to the respective soils.

Organic Agriculture

According to the Codex Alimentarius Commission (2001), organic agriculture is the holistic production management system that avoids use of synthetic fertilizers, pesticides and genetically modified organisms, minimizes pollution of air, soil and water and optimizes the health and productivity of interdependent communities of plants, animals and people. The application of FYM has long been treated as a valuable source of organic matter to enhance soil fertility. Li *et al*. (1994) observed that manure application yielded the largest amount of C sequestered over a range of soils and climatic conditions. The rate of sequestration was the highest in clay soil. Gregorich *et al.* (1998) also observed that manure soils had large quantities of soluble C with a slower turnover rate than in control or fertilized plots.

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CARBON SEQUESTRATION: TACKLING GLOBAL WARMING

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As we know, the concentration of greenhouse gases is increasing day by day due to various anthropogenic activities like cutting of trees, burning of fossil fuels, transportation etc. Industry, transportation and domestic use emits nearly 10 Gt C to the environment annually. There is need to reverse the faster rate of emission of greenhouse gases. Carbon sequestration is the very effective method to stabilize the emission of greenhouse gases like sequestration of atmospheric CO_2 as organic carbon in the biosphere.

WHAT IS CARBON SEQUESTRATION ?

The term carbon sequestration is used to describe both natural and deliberate process by which either carbon is removed from the atmosphere or diverted the emission of carbon from sources and used by plants for photosynthesis and also involved in geologic formations. Actually, diverted carbon is stored in terrestrial environments like vegetation, soils etc. and can also be stored in oceans.

INTRODUCTION

The climate variability is the evidence of increasing greenhouse gases i.e.; it shows the presence of greenhouse gases more than optimum level causing the increase in temperature of earth. CO_2 is the main component of the greenhouse gases and there is a need to removal of CO_2 or diversion of CO_2 emission from sources. Main cause of increase in level of CO_2 is the burnings of carbonaceous fuels and also emitted from agriculture and livestock. Now-a-days, there is biggest challenge is the development of nation with maintaining the health of environment because many industrial processes, using of fossil fuels, thermal power generation, transport etc are responsible for increasing the level of CO_2 more than optimum level.

Capture and storage technologies are used to stabilize the concentration of CO_2 by capturing the CO_2 gas from viable surface. Carbon capture and sequestration is a type of physical process which involve the capturing and storing of CO_2. CCS technology is used to reduce the CO_2 emission and maintain the temperature of earth. CCS technology has various steps to reduce CO_2 emission from sources:

Firstly, CO_2 will be captured and separated from other gases and then purified, compressed using some technique and transferred to the sequestration site.

There are several methods for sequestration of atmospheric CO_2.

1. ABIOTIC SEQUESTRATION

In abiotic sequestration, physical and chemical reactions are involved and there is no participation of living organisms. The abiotic carbon sequestration in oceanic and geological structure is most effective method for capturing CO_2.

▪ Oceanic Injection

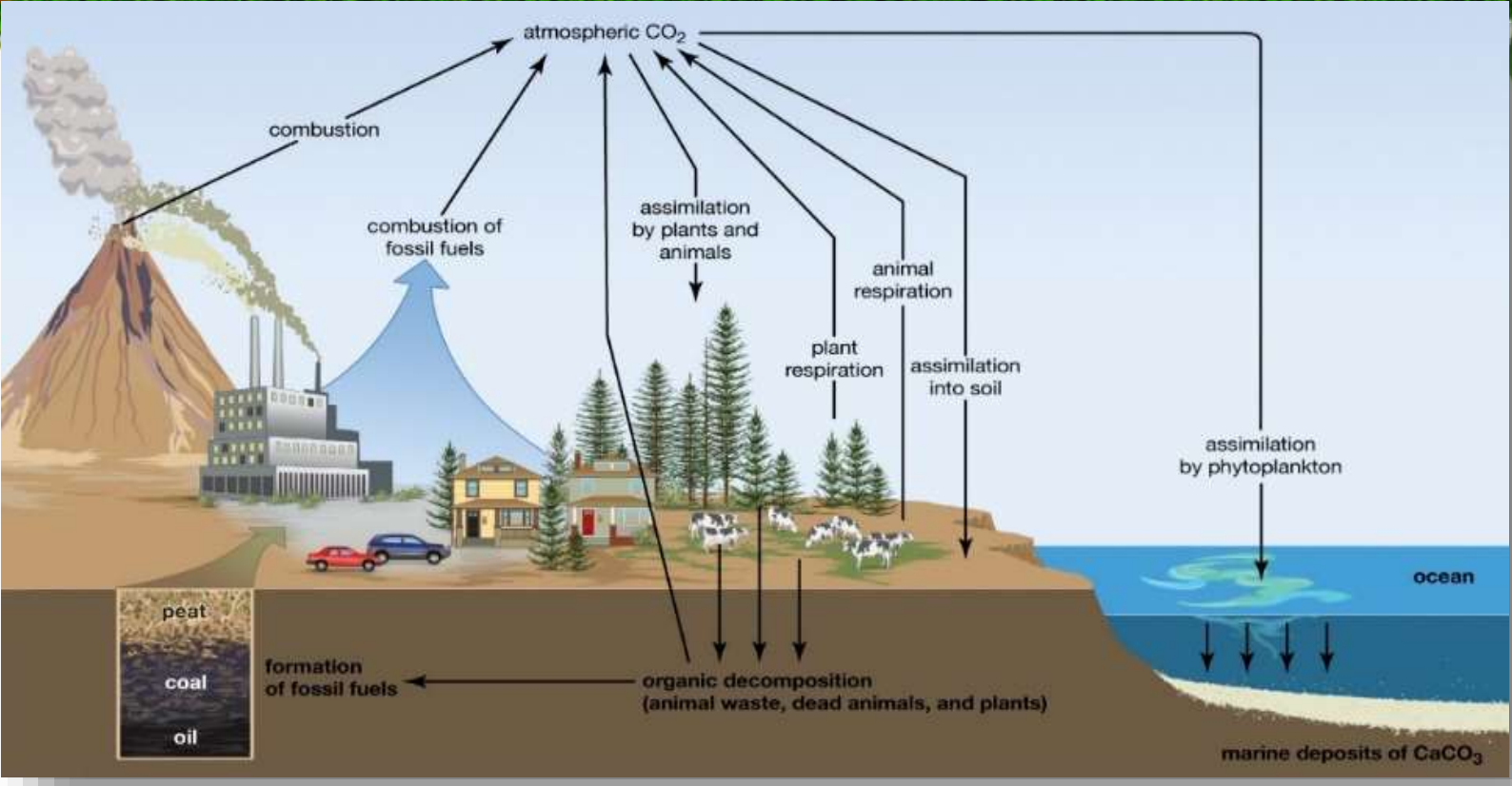
Injection of CO_2 stream in the ocean is considered very earlier (i.e., about 3 decades) by engineers and in the late 1970s injection of CO_2 stream have done in the ocean. To minimize the outgassing, the CO_2 must be injected at great depth.

▪ Geologic Carbon Sequestration

It is a type of Carbon Sequestration in which CO_2 is stored from industries i.e., CO_2 is stored as a liquid and liquefaction of CO_2 is done under heavy pressure and then this CO_2 stream is injected into porous rock for the formation in geologic basins. The storing CO_2 can also be used in oil enhanced recovery. In oil enhanced recovery the liquid CO_2 is injected into the oil-bearing site for reducing the viscosity of oil and flow more easily into the oil well.

▪ Scrubbing and mineral carbonation

It is also a type of abiotic carbon sequestration which involve the transformation of industrial CO_2 into $CaCO_3$ or $MgCO_3$ or may be into another mineral carbonate. It involves two steps- scrubbing and mineral carbonation. Scrubbing is the process of chemical absorption of CO_2 using an amine or carbonate solvent for carbon capture and then CO_2 is purified by passing through an absorption column containing amine solvent. Pure CO_2 gas is reprecipitated by forming the mineral carbonate which is a stable rock in which CO_2 is sequestrated forever. Magnesite ($MgCO_3$), olivine



(Mg_2SiO_4) and serpentine [$Mg_3Si_2O_5(OH)_4$] are the product of aqueous mineral carbonation reactions.

2. BIOTIC SEQUESTRATION

Biotic Sequestration is a type of carbon sequestration in which plants and living organisms are involved in removing the CO_2 from atmosphere.

▪ Oceanic Sequestration

Oceanic Sequestration in which several biological processes lead to the carbon sequestration through photosynthesis i.e., phytoplankton is help in sequestration of carbon through photosynthesis and some of the particulate organic material formed by the phytoplankton help in sequestration of carbon.

▪ Terrestrial Sequestration

Terrestrial carbon sequestration is the process of absorbing CO_2 from atmosphere by trees, plants and crops through the process of photosynthesis. When plant dies the carbon containing stem, leaves become organic matter and it is used as organic manure, therefore, we can say this is also a type carbon sequestration. Terrestrial carbon sequestration is very beneficial in terms of reducing CO_2 level and maintain the healthy environment. It's also help in reducing soil erosion and maintain soil moisture content. Terrestrial ecosystems such as grazing lands, croplands and forest are referred to as carbon storage sink because of their ability to sequester CO_2.

CONCLUSION

Using fossil fuels, transport, thermal power plant etc are responsible for increasing the greenhouse gases content in atmosphere. Day by day global warming is increasing which create a major problem like melting of glaciers, risk of flood etc. To cope with these problems, we should aware about this. To control the global warming, carbon sequestration is the best way to maintain healthy environment. For this, we should plant more trees to sequester the carbon and stop deforestation. There are various methods to sequester the carbon, which includes abiotic and biotic carbon sequestration. These two methods are very effective in maintaining the optimum level of CO_2 concentration in the atmosphere.

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GREEN MANURING FOR BETTER SOIL HEALTH

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Mineralization and immobilization are the two main process which occurs regularly in soil. These process decides the availability or unavailability of nutrients to the plants in soil. Here mineralization is the conversion of nutrient or element from immobilized or unavailable form or organic form to available or inorganic form, and immobilization is the reverse process where available form of an element converts to unavailable form. The key factors which play crucial role in mineralization are the microorganism, which depends on different organic matters for their food and converts them to manures and results in release of various nutrients to the plants in available form. Therefore green manure crops acts as a food of micro-organisms. Here green manures are the crops grown for the purpose of restoring or increasing the organic matter content of the soil and their use in cropping system is called green manuring. In this process the crops are grown *in situ* or brought from outside and incorporated into the main field.

AN IDEAL GREEN MANURE CROP MUST HAVE THE FOLLOWING CHARACTERISTICS

1. It should be multipurpose in use.
2. It must be fast growing and of short duration.
3. Up to some extent the crop must be tolerant to shade, sunlight (long exposure), water stagnation, drought and adverse temperature.
4. It should have good vegetative growth.
5. The vegetative part should be much more flexible.
6. It must have water requirement as well as less nutrient demand.
7. It must be economic in relation to the crop production.
8. It must be resistant to pest and diseases comparatively.
9. The crop must be photo-insensitive.
10. It should have wider ecological adaptability.

TYPES OF GREEN MANURING SYSTEM AND CROPS

(A) *In situ* green manuring

Those crops which grown for the purpose of green manuring in which they freshly incorporated into the soils in the same field in which they grow is called as *in situ* green manuring.

The category is further divided into legumes and non-legumes based on family to which they belong

(a) Legumes- Crops which are belongs to leguminoceae, which apart from directly contributing or adding organic matter into the main field fix atmospheric nitrogen with the help of nodules found either in their root zone or in stem. The nodules forms in the roots as a result of infection caused by the bacteria which lives in a symbiotic association with the crop. The amount of nitrogen fixed is completely depends on type of legume and amount of dry matter produced in that season by the crop.
Eg. Dhaincha (*Sesbania bispinosa* (*aculeata*), sunhemp (*Crotolaria juncia*). Greengram (*Vigna radiata*), Clusterbean (*Cyamopsis tetragonaloba*).

(b) Non legumes- Crops which belongs to family other than leguminoceae, which grown for adding organic matter into the soil. They also adds different major nutrients into the soil but do not fix atmospheric nitrogen. But they helps to conserve nutrient in soil by reducing the leaching loss specially of nitrogen.
Eg. Sunflower (*Helianthus annus*), Oats (*Avena sativa*)

(B) Green leaf manuring- In green leaf manuring the leaves, twigs of plants , shrubs, trees are brought

from outside *viz* growing on bunds, boundaries, fallow land and incorporated into the main field.

It is also falls into legumes and non-legumes category.

(a) Legumes- Eg. Gliricidia (*Gliricidia sepium*), Pongamia (*Pongamia glabra*)

(b) **Non legumes-** Eg. Calotropis (*Calotropis gigantea*), Congress–grass (*Pathenium hysterophorus*)

THE INCORPORATED GREEN MANURE ORGANIC MATTER CONSIST OF THE FOLLOWING COMPOUNDS

Water soluble fraction- Such as carbohydrates, organic acids, soluble proteins, amino acids etc.

Insoluble fractions- Such as cellulose and hemicelluloses.

Resistatant fraction- Such as lignin.

NUTRIENT CONTENT OF SOME GREEN MANURE AND GREEN LEAF MANURE CROP

S. N.	Crop Name	Nutrient content (%) on air dry basis		
		N	P	K
1	Sunhemp	2.30	0.50	1.80
2	Dhaincha	3.50	0.60	1.20
3	Gliricidia	2.76	0.28	4.60
4	Pongamia	3.31	0.44	2.39
5	Parthenium	2.68	0.68	1.45
6	Calotropis	2.06	0.54	0.31

(Sources: https://agritech.tnau.ac.in/org_farm/orgfarm_green%20manure.html)

TIME OF INCORPORATION

Time of incorporation of green manure crop completely depends on the duration of crop growth period. But it should be always be done when plants attains a maximum succulent stage and are half of their potential height. In other words before the commencement of flowering, in vegetative stage only the crop must be incorporated. This is done to avoid the unnecessary dispersal of flower or seeds in the main field. Generally it varies from 40 days to 65 days after sowing of green manure crop.

METHOD OF INCORPORATION

Mode of incorporation of green manuring crops depends on the soil type, it varies from place to place. For the crop cutting and mixing we can use green manure trampler or rotavator if trampler is not available. After cutting we can also place the crops in furrows and cover it with the next furrow through leveller or trampler (if the crop grown by ridge and furrow method).

In green leaf manuring after spreading of leaves or twigs in main field, they need to be trampled by plough or human labour.

BENEFITS OF GREEN MANURING

1. It directly adds organic matter into the soil and improves the physical, chemical and biological properties of the soil.
2. Green manures act as a source of food for the microbial population and ultimately increases their plant population.
3. It increases the availability of nutrients to the plants.
4. It conserve and concentrate the nutrient pool in the soil surface.
5. It helps in improvement in sub surface of soil.
6. It reduces the soil degradation or soil loss.
7. It helps in reducing the infestation of weed flora in main field.
8. It also play role in amelioration of soil eg. *Sesbania rostrata* helps in reclamation of alkaline soils.
9. It increases the water holding capacity of the soil.
10. Overall it improves the yield of proceeding crop by 15-20%.

ASSOCIATED PROBLEMS

Biggest problem associated with the green manure crops is their use in cropping system skips the farmers from production of their commercial crops. The green manure crops with deep root also absorbs large amount of water from the soil for transpiration and which causes depletion in ground water table. The green manure crops must be tilled in soil at the proper stage otherwise they may cause heavy infestation of weed flora.

CONCLUSION

To restrict the continuously deteriorating soil health, holistic farming is the only solution left in the hand of the farmers, where they have to add on organic farming or manures along with the chemical farming or chemical fertilizers. Green manuring is one of the component of organic farming, which can help them to maintain the carbon nitrogen (20:1) ratio in a better way. The better carbon nitrogen ratio is major factor which directly affects the mineralization in soil. But green manuring must also be done in the lean periods when the lands remain fallow. In this way we can maintain the succeeding crop yield as well as we can improve the poor managed soil structure.

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FISH FEED MANUFACTURING AND IT'S IMPORTANT IN AQUACULTURE

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Fish is a vital source of both nutrition and income generation for numerous local people's livelihood in the whole world. Feed is one of the main inputs in the fish farming system. Feed formulation procedures involve nutritionally complete and economically sustainable feed. Feed accounts for almost 50% of the variable cost of fish production.

Introduction

In animal production systems, good nutrition is important to the economic production of a healthy, high-quality output. Nutrition is crucial in fish farming (aquaculture) since feed accounts for almost half of the variable production cost. In recent years, fish nutrition has evolved substantially with the implementation of novel, comprehensive commercialized feeds which enhance effective fish health and performance. The creation of novel species-specific feed formulas helps the aquaculture business grow to meet the growing demand for inexpensive, safe, high-quality fish and seafood products.

Conventional feed source

These are the feedstuffs that are commonly used in the preparation of fish feed. Their application is standardized and widely accepted. Many of these are inexpensive and widely available in huge numbers. They are mostly agricultural or industrial items. Wheat bran, groundnut cake, and rice bran are a few examples. Some are derived from animals (fish meal, blood meal, and shrimp meal), while others are derived from plants (maize, soya bean meal, cottonseed meal).

Feed formulation

Feed formulation procedures involve the combining and blending of feed materials (based on a formula) into a nutritionally complete and economically sustainable feed that can be utilized in the appropriate amount to give the desired level of production in fish cultivation.

Feed manufacturing process

The processing procedures, which include sourcing, mixing, pelleting, drying, and storing, are critical because they govern nutritional bioavailability, attractiveness, palatability, as well as longevity, all of which have a significant impact on fish performance. The types of fish feed, such as floating fish feed as well as sinking fish feed, are determined by the species of fish farming.

Source of raw ingredient

It involves the investment of high-quality ingredients at very cheap prices since the quality of the ingredients consistently determines the quality of the prosperity and cost of the ingredients.

Grinding of feed ingredients

Typically, a hammer mill is used for grinding fish feed ingredients. The coarseness or fineness of the constituent structure has a considerable impact on both the physical characteristics and nutritive value of the completed product. Grinding aids in the proper mixing of various materials enhances pellet quality, minimizes pellet breakage, and boosts fish feed acceptability and ingestion.

Weighing and mixing

Weighing must be precise to guarantee that the feed ingredients are in the right quantities as specified in the diet. To guarantee correct blending, the feed ingredients are physically blended after weighing. This is the most crucial and challenging stage of fish feed manufacturing since the feed manufacturer must ensure that the ingredients are combined properly.

Conditioning

Addition some amount of the water for moisturizing all ingredients before pelleting. It is beneficial for feed pelletizer to make high stability feed.

Pelleting of feed

This is accomplished through the use of a locally manufactured pelleting machine, which can be operated manually or electrically. It is made up of cylindrical dies of variable diameters that are used to pellet varying sizes of feed according to the age, size, and species of fish involved. The majority of fish feed manufactured is in the form of compressed pellets. The pelletized feed has many advantages, including less feed waste, more uniform feed intake, and the removal of growth inhibitors.

Drying of feed

Drying is done instantly after pelleting, to reduce moisture existing in the feed. Drying improves the stability of the feed for adequate storage.

Sprayer

Oil sprayer to the spray required amount of oil over the fish feed as well as proper oil mix with feed. After the oil mixture is in the feed further, go for cooling.

Cooler

Cooler required for just cooling of the feed and sieving before labeling and packaging. Sieving is also required to remove extra fine particles attached to the feed. It is helpful for feed quality and marked accessibility.

Labeling and packaging

Packaging is just required for selling feed with a specific weight of feed in one bag. After packaging the sealing of the bag. Labeling of the packet such as quantity, net weight, batch no., date of manufacture, self-life as well as storage environment of feed. The proximate composition is also shown in the bag such as crude protein, crude lipid, fiber, moisture, and ash.

Feed care and storage

Mold development and feed degradation are accelerated by high moisture levels. Avoid improper handling as well as breakage to the feed bags, which could shatter the pellets and produce fines (powder) that the fish will not ingest. Mice, rats, roaches, and other pests should be properly controlled in the feed storage facility since they consume and contaminate feed while also transmitting diseases.

Conclusion

Nutrition is crucial in fish farming (aquaculture) since feed accounts for almost half of the variable cost of production. Feed formulation is used in the appropriate amount to achieve the desired level of production in fish farming. Vitamins, proteins, and lipids are particularly heat-sensitive, and high storage temperatures can easily denature them.

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GOAT FARMING:

BEST SOURCE OF INCOME FOR RURAL FARMERS

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Farming and Animal husbandry are synonymous with each other. The livelihood of India mostly revolves around these two. In the event of less agriculture, the main means of livelihood of the people becomes animal husbandry. Farmers have been doing animal husbandry and its use since ancient times along with agriculture. The utility of animals is therefore also important. Because, they have been used in many major works related to agriculture. Organic manure made from their dung, boosts agricultural yield. The goat, popularly known as the cow of the poor, has always been recognized as a secure source of livelihood. Goat being a small animal, its maintenance cost is also minimal.

Goat, popularly known as poor's cow in rural areas, has always been recognized as a secure source of livelihood. Goat being a small animal, the cost of its maintenance is also less. Even during drought, it can be easily arranged for food. Women and children can easily do the work of its care and at the same time, if needed, their needs can also be fulfilled by selling it easily. These include cows, buffaloes and goats etc. Due to the drought in the last few years, it is a difficult task to make proper arrangements for fodder etc. for big animals, people are now giving priority to goat rearing.

HOW TO START GOAT FARMING

Goat farming is a profitable business. Due to good economic prospects, goat farming is gaining momentum as a commercial production for the last few years. It should be kept in mind that due to high demand of goat and its products and good price and good economic benefits, many progressive farmers, ex-employees and educated youth are starting this goat farming on commercial scale as an industry. Presently Goat Farming is a low investment due to its multi-functional utility. Business is done. At the same time, commercial goat farming is contributing a lot to the country's economy and nutrition.

TO BUILD A SUCCESSFUL GOAT FARMING FARM, YOU SHOULD KNOW THESE THINGS

1. Chose a right location

Finding the right place is the first point, goats are generally animals living in warm environment, so make sure that the place is well drained and the space is also good. Goats live in groups, so it is not necessary to divide the space separately for each one, all can live in one room.

How much space is needed for goat farming?

- An adult female goat requires 12 square feet of space.
- An adult male goat requires 15 square feet of space.
- There should be 8 square feet space for each goat.

2. Land requirements

If you use supplemental feed, then your work will go on in less land, if you graze, then you can get 1 acre of land for 10 goats.

3. Goat's Breed

You should choose the breed based on your needs, you have to see whether you want to produce milk or produce meat. You can also put a form with both types of breeds.

- **Goat breeds in India**

About 21 main goat breeds are found in India. The breeds of these goats are divided into three parts on the basis of production.

- **Milk Breeds**

This includes breeds like Jamunapari, Surti, Jakhrana, Barbari and Beetle etc.

4. Fertility Capacity

A goat comes to the stage of child breeding at the age of about one and a half years and breeds in 6-7 months. Usually a goat breeds 3 to 4 children at a time and their number increases by breeding twice in a year. Sell only after raising a child for one year

5. Food requirement

Goats need food of their choice. They do not eat dry or soiled grass. You

have enough of them Clean fresh hay must be ensured so that they do not starve. It is well known that goats are not carnivorous animals. They usually prefer to eat grass, plants, shrubs, weeds and herbs. Goats for proper growth. It also requires energy, vitamins, fiber and water.

6. Proper care and management

Always try to take proper care of your goats. Never feed them contaminated food or polluted water, Keep their house as clean as possible, clean their house regularly. Children at the time of breeding and Take extra care of the pregnant, keeping babies with their mothers for several weeks after birth. Do not mate with multiple male goats in a single day, artificial insemination is also a good method for your breeding. Vaccinate them on time to keep them free from all kinds of diseases and health problems. Keep a stock of some essential vaccines and medicines.

7. Vaccination

Many types of viral diseases like PPR, Goat Pox, foot and mouth diseases and bacterial diseases like Anthrax, Brucellosis etc. are very harmful to goats. Thus, to prevent these types of diseases. Proper vaccination is essential. Those who have not been vaccinated with PPR should be vaccinated in the fifth month of pregnancy, Babies who are vaccinated with PPE when they are 5 months old.

PRECAUTIONS DURING GOAT FARMING

Due to the area adjacent to the forest, there is a fear of wild animals, because the place where the goat lives, its smell comes and after smelling that smell, the wild animals start coming towards the village. Sometimes they even harm the pets.

- Keep small goat children away from dogs.
- Goat is one such animal, which causes more damage to crops. Therefore, special care has to be taken in case of crop in the field.

GOAT REARING PROBLEMS

Goat is the cow of the poor, yet there are many problems in its rearing. It is most difficult to take care of goat during the rainy season. Because the goat does not sit in a wet place and at the same time the disease is also very high in them. Goat's milk is nutritious, but no one wants to buy it because of the smell in it. Therefore no value can be found for it. The goat has to be taken daily for grazing. That's why a person has to always be there to look after him.

BENEFITS OF GOAT FARMING

Goat farming along with farming in drought affected area is a good business of low cost which can be done easily, it has broadly the following benefits-

- Cash money can be easily obtained by selling goats at the time of need.
- No technical knowledge is required for goat rearing.
- This business is expanding very fast. Therefore, this business is going to give more profit in less cost.
- The market for these is available locally only. Most of the businessmen come from the village and buy goats and goats and take them away.

However, every business has some risks. But, with proper care and good management, better production and high profit can be ensured. Goat Farming is recognized for its versatility and fast growing Low risk, profitable and very easy business to be carried out due to the rate.

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IMPORTANCE OF NUTRIENTS IN ANIMAL PRODUCTION AND HEALTH

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The efficiency of animal production depends on nutritional status of animal and management practices. Nutrition plays a pivotal role in animal production and health. It brings out the genetic potentiality of the animal. For example, even if a cow has a capacity of producing 25 litres of milk per day as per genetic makeup, the cow can not produce 25 litres of milk per day if it is underfed. It makes the animal production economical as the cost of feeding of animals accounts for 70-75% of total animal production cost. It minimises the competition between human and animal for food by introducing non-conventional feeds for animal feeding. It manipulates feed ingredients for effective utilization of nutrients.

Functions of Water

- Life can not be sustained without water.
- Animals may live for more days without food but die in fewer days if deprived of water.
- Functions of water as a major component in body metabolism.
- As a major factor in body temperature regulation.
- All the biochemical reactions that take place in an animal require water.
- Act as solvent for a wide variety of compounds. Due to this solvent action, it helps in the transport of dissolved nutrients in the system and helps in the excretion of end products of metabolism. Many compounds readily ionize in water. Salts within the body dissociate into ions, which have specific action in body tissues. It serves as a carrier of digestive juices, enzymes and hormo-nes.
- It is a medium for hydrolysis of nutrients in the system.
- It provides cell rigidity, fluidity and elasticity.
- It serves as lubrication fluid in the synovial cavities.
- It serves as a medium for transportation of semisolid digest in the gastrointestinal (GI) tract; medium for various solutions like blood, tissue fluids and cell secretions and excretory fluids such as urine and sweat.

Water Requirement

Water requirements for any class or species of animals depends on dietary and environmental factors.

Water consumption is related to:

- Heat production
- Energy consumption
- Body surface area in non-stressing situations.
- All environmental temperature that do not result in heat stress, there is a good linear relationship between dry matter consumption and water consumption.
- Non-heat stressed non-lactating cattle may drink 5-6% body weight per day.
- Water consumption may increase by 12% or more of body weight per day during heat stress.
- Animals will consume 2 to 5 kg of water for every 1 kg of dry feed consumed when they are not heat stressed.
- Birds require less than mammalian species.
- Young animals generally require more water than adult per unit of body weight.

Classification of minerals

In animal tissues and feeds, minerals are present in varying amounts and concentrations. The seven minerals / elements that are present in high concentration (>70 mg/kg live weight) are termed as major minerals. They are as follows: Calcium (Ca), Phosphorus (P), Magnesium (Mg), Sodium (Na), Potassium (K), Chlorine (Cl) and Sulphur (S). Trace elements or Micro minerals are those minerals that are pesent in low concentration (<70 mg/kg live weight) but are physiologically equally important.

Functions of Minerals

- The main structural components of bones and teeth are to give rigidity and strength eg. calcium and phosphorus
- Magnesium, fluorine, silicon in bones and teeth also contribute to the mechanical stability of the body.
- Small fractions of calcium, magnesium and phosphorus and most of the sodium, potassium and chloride in the body fluid and in the soft tissues acts as electrolytes.
- Electrolytes in body fluids like blood and cerebrospinal fluid helps to:
  - maintain acid – base balance and osmotic pressure.

- regulate membrane permeability.
- exert characteristic effect on the excitability of muscles and nerves.

- Salts in the saliva, gastric and intestinal juices and rumen fluid are appropriate medium for the action of enzymes and growth of microbes.
- Essential trace elements are integral part of or components of certain enzymes.
- Trace elements are also components of biologically important compounds such as
  - Iron in haemoglobin
  - Cobalt in vitamin B_{12}
  - Iodine in the hormone thyroxine
  - Trace elements also function as activators of enzymes.

Dietary Source of Minerals

- Concentrate feed and forages that they consume.
- Mineral supplements such as bone meal mineral mixture, common salt, calcite, shell grit etc.
- Drinking water – minor source
- Soil contamination of herbage source for grazing animals.

Vitamins

Vitamins are organic compounds required in tiny amounts for essential metabolic reactions in a living organism. Absence or deficiency of vitamins causes deficiency disorders. Vitamins may be classified based on their solubility as fat soluble vitamins and water soluble vitamins.

Fat-soluble vitamins include vitamin A, D, E and K. Water-soluble vitamins include vitamin B complex group and vitamin C. The B complex group of vitamins includes the following are Vitamin B1 (thiamin), Vitamin B_2 (Riboflavin), Vitamin B_3 (Niacin/ Nicotinamide/ Nicotinic acid), Vitamin B_6 (Pyridoxine), Panthothenic acid, Folic acid, Vitamin B_{12} (*Cyano cobalamine*), Biotin and Choline.

Functions of Vitamin

- Synthesis of glycoprotein to maintain integrity of epithelial cells
- In bone formation synthesis of mucopolysacharides
- Synthesis of the visual pigment Rhodopsin
- Retinol and retinoic acid (RA) are essential for embryonic development during fetal development.

Deficiency of Vitamins

- Mild vitamin A deficiency may result in changes in the conjunctiva (corner of the eye) called Bitot's spots.
- Severe or prolonged vitamin A deficiency causes a condition called xerophthalmia (dry eye)
- If vitamin A is deficient optic foramen is not formed properly.
- In poultry Vitamin A deficiency leads to high mortality rate.
- Vitamin A is commonly known as the anti-infective vitamin, because it is required for normal functioning of the immune system.
- Vitamin A is essential for normal bone formation as it is involved in the synthesis of mucopolysacharides needed for laying down of the bone matrix.
- Deficiency of vitamin A can lead to infertility or sterility in male
- A variety of deficiency symptoms in chicks and young turkeys have been reported, including poor growth, anaemia, poor bone development and poor egg hatchability.
- In pigs, biotin deficiency causes foot lesions, alopecia (hair loss) and a dry scaly skin.
- In growing pigs, both growth rate and food utilization is adversely affected.
- In poultry, biotin deficiency causes reduced growth, dermatitis, leg bone abnormalities, cracked feet, poor feathering and fatty liver and kidney syndrome (FLKS).
- Fatty liver and kidney syndrome, which mainly affects two-to five-week-old chicks, is characterized by a lethargic state with death frequently following within a few hours.

Dietary Source of Vitamins

- **Animal source:** Oils from livers of certain fish (Cod and Halibut), egg yolk, milk fat.
- **Plant source:** All green leaves are rich in provitamin A, beta-carotene.
- Conversion of carotene to vitamin A takes place in the intestinal mucosa.
- Folic acid is widely distributed in nature; green leafy materials, cereals and extracted oilseed meals are good sources of the vitamin.
- Folic acid is reasonably stable in food stored under dry conditions but it is readily degraded by moisture, particularly at high temperatures.
- Biotin is widely distributed in foods; liver, milk, yeast, oilseeds and vegetable are rich sources
- Green leafy materials, yeast, egg yolk and cereals are rich sources of choline.
- The main natural sources of the vitamin are foods of animal origin, liver being a particularly rich source.

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PHENOMIC APPROACHES FOR PLANT DISEASE DETECTION

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Plant phenomics approaches aim to measure traits such as growth, performance, and composition of plants using a suite of noninvasive technologies. The goal is to link phenotypic traits to the genetic information for particular genotypes, thus creating the bridge between the phenome and genome. Application of sensing technologies for detecting specific phenotypic reactions occurring during plant pathogen interaction offers new opportunities for elucidating the physiological mechanisms that link pathogen infection and disease symptoms in the host, and also provides a faster approach in the selection of genetic material that is resistant to specific pathogens or strains. Appropriate phenomics methods and tools may also allow Presymptomatic detection of disease-related changes in plants or to identify changes that are not visually apparent. This review focuses on the use of sensor-based phenomics tools in plant pathology such as those related to digital imaging, chlorophyll fluorescence imaging, spectral imaging, and thermal imaging. A brief introduction is provided for less used approaches like magnetic resonance, soft x-ray imaging, ultra sound, and detection of volatile compounds. We hope that this concise review will stimulate further development and use of tools for automatic, nondestructive, and high-throughput phenotyping of plant pathogen interaction.

Phenomics

Plant phenomics as science of studying how plants change physically over time especially in the growing season. How those physical characteristics are associated to their genetics, climate and their environment.

Plant phonemic approaches aims to measure

Growth, Performance, Composition

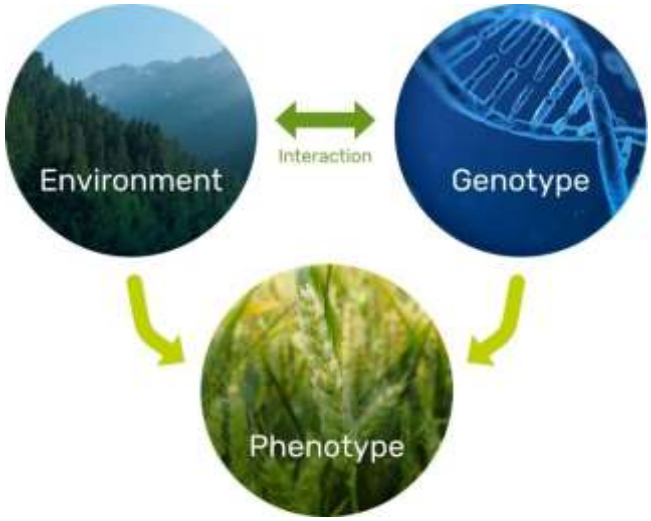


Image Acquisition

First step in image acquisition is to capture the leaves using mobile phone or digital camera. These stored images of the leaves from the database are load by specifying the path.

Image Pre-processing

Pre-processing improves the quality of the image by removing unsought distortions. Clipping the images based on the region of interest (ROI), image smoothing and contrast enhancement are done here.

Image Segmentation

Image segmentation is the method of dividing an image into different sub images. Here we use K-mean segmentation technique which uses hue estimation method for dividing and clustering the image. Since the green colour of the leaves is normal, we do not consider them. We select the cluster image showing the infected area for feature extraction. Figure 4, below shows the segmented images of the leaves.

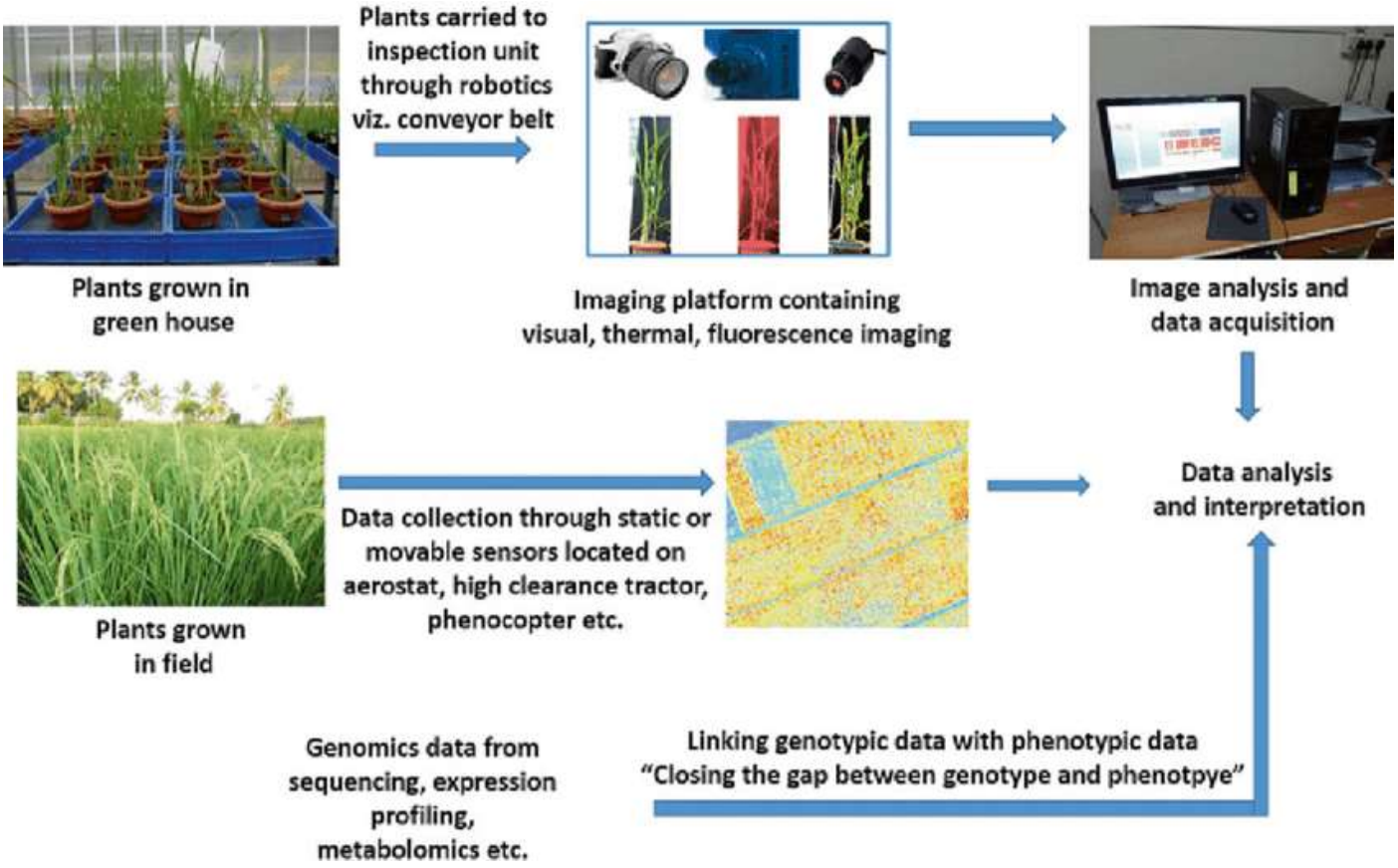
Phenomic buggy

- High resolution, non-destructive field phenotyping
- LIDAR technology- core principle.
- Measure- Crop height, spatial dimension and biomass in large areas

All in one phenomic buggy

Future directions

Characterization of different pathogen groups is necessary. The impact of mixed infections on the optical properties of plants has to be investigated. The interaction between such as nematodes has to be foliar



A schematic representation of phenomic approaches based plant disease detection

pathogens and soil borne pests evaluated. The interaction of biotic and abiotic stress has to be explored. The connection to other knowledge based methods will provide a holistic perspective on plant systems (e.g., weather based prediction models).

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Trichoderma: A POTENTIAL MICROBIAL ANTAGONIST

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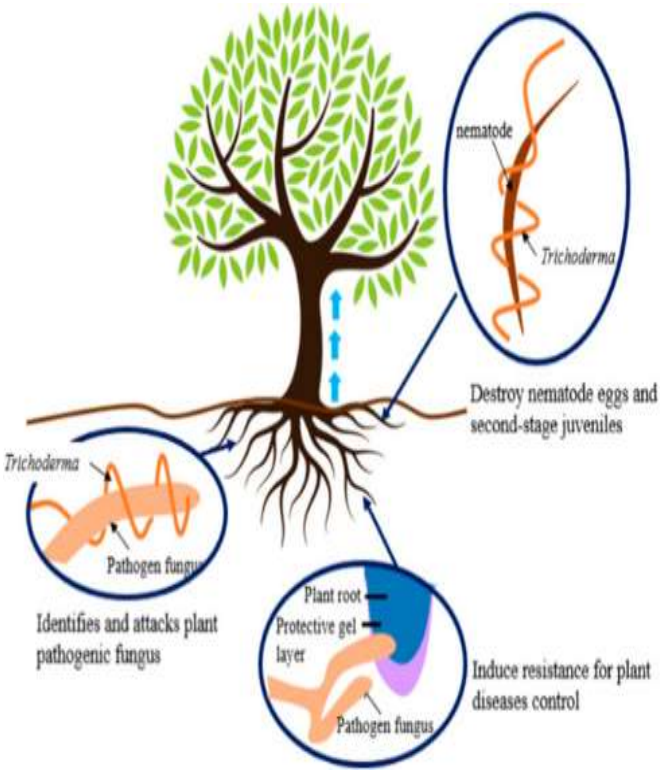
Trichoderma is the most important bio pesticide, with several success stories. In India, a variety of effective components based on various *Trichoderma* species have been commercialized. *Trichoderma* isolates are created utilizing a variety of organic and inorganic carriers, which are then fermented either solid or liquid. Seed treatment, seed bio-priming, seedling dip, soil application, and foliar spray are some of the applications. *Trichoderma* formulations with strain mixes function better than individual strains in the management of plant diseases. Due to the short shelf life of bio pesticide products, commercialization has been stopped. Many small and major entrepreneurs have entered the commercial manufacturing of bio control agents, resulting in the global introduction of a variety of bio control products.

Introduction

The different methods of biological control are highly significant for management of diseases as it has been reported that chemical managements are highly nonspecific in nature. *Trichoderma* was initially isolated from soil and decomposing organic materials in 1794. *Trichoderma* is being used to produce more than 60% effective bio-fungicides all over the world. In India, for example, some 250 *Trichoderma*-derived bio fungicides are used, however as compared to bio control, Indian farmers still rely on synthetic chemical fungicides to a greater amount. These fungi spread quickly, are invasive, filamentous, opportunistic, and avirulent, and they have a symbiotic connection with plants. They not only boost plant growth in pathogen-infected soils, but they also suppress pathogen growth through a variety of antagonistic methods.



Interactions

1. Interaction with plants

Fungi induce rapid plant development and production for exchanging sucrose from plants, as well as improved absorption of nutrients, modification of rhizosphere and enhanced resistance to both abiotic and biotic stresses. Attachment, penetration, and colonisation of *Trichoderma* within the plant roots are the first steps in establishing a symbiosis. Invasion of root is aided by the production of expansin-like proteins after successful attachment. They express endopolygalacturonase activity and have cellulose binding modules.

2. Interaction with pathogens

Mycoparasitism, competition, and antibiosis are three important biocontrol techniques developed by *Trichoderma* in direct combat with fungal diseases.

a. Mycoparasitism: One of the most relevant mechanisms of antagonism shown by *Trichoderma* spp. is mycoparasitism, which refers to the direct attack of one fungus species on another.

b. Competition: In comparison to other microorganisms of rhizosphere, *Trichoderma* has a better ability for mobilization and absorption of nutrients from the soil.

c. Antibiosis: This is the interaction and diffusion of low molecular weight chemicals into other cells, reducing the activity of other microorganisms.

3. Interaction with micro-organisms

Trichoderma interacts with a variety of microbes, primarily pathogenic fungi. Hyperparasitism, competition, and antibiosis are examples of these interactions. Various reports on the use of *Trichoderma* sp. to combat plant pathogenic bacteria such as *Rhizoctonia solani*, *Pythium ultimum* and *Botrytis cinerea*.

Direct control by *Trichoderma* sp.

Through parasitism and the synthesis of insecticidal secondary metabolites, antifeedant chemicals, and repelling metabolites, *Trichoderma* works directly as an entomopathogen. Furthermore, in the field, *T. longibrachiatum* can increase eggplant crop output by 56 percent by applying fungal spores to the leaves, causing up to 50% mortality of the lepidopteran eggplant/brinjal borer (*Leucinodes orbonalis*).

Indirect control of insects by *Trichoderma* sp.

By the stimulation of systemic plant defensive responses, the addiction of natural enemies or through the parasitic relationship of insect and symbiotic microorganisms, *Trichoderma* can behave indirectly as a plant mycoparasite. *Trichoderma* is capable of activation of plant defences against pests and pathogens through root colonization, both through local and systemic application, reactions mediated by the plant defence hormones jasmonic acid (JA) and salicylic acid (SA).

Roles of *Trichoderma* spp.

1. Impacts on Plant Morphology

Many studies show that applying *Trichoderma* spp. to the rhizosphere of plants improves plant morphological features as root-shoot length, biomass, height, number of leaves, tillers, branches, fruits and so on. T. *harzianum* treatment to roots of cucumber boosted biomass and lateral root growth.

2. Impacts on Plant Physiology

Photosynthesis, assimilation nutrient and absorption, gas exchange, water usage efficiency, stomatal conductance and other physiological processes in plants all have been shown to be positively regulated by *Trichoderma* spp.

3. Impacts on nutrient solubilization and absorption

Trichoderma-treated plants' roots showed increased ability to investigate the soil and enhanced mineral intake. Various strains of *Trichoderma* release acids such as coumaric, glucuronic, and citric acids, which aid in the discharge of phosphorus ions which appear to be inaccessible to plants in most soils.

Applications

1. Bioremediation: *T. harzianum* degrades a variety of harmful organic pollutants, including phenols, cyanides, and nitrates. Several studies have shown that *Trichoderma* spp. strains are involved in the detoxification of polycyclic aromatic hydrocarbons (PAHs).

2. Animal Feed: Lytic enzymes generated by *Trichoderma* spp., such as cellulases, hemicellulases, and pectinases, can be used in feeds to partially hydrolyze plant cell walls. This technique improves the feed's digestibility as well as its nutritional content.

3. Biofuels: the employment of fungi from the genus *Trichoderma* in the production of self-styled second-generation biofuels is now possible thanks to alternative energy sources.

4. Batta used *T. harzianum* Rifai's invert-emulsion formulation to fight apple blue mould infestation and prevent fruit degradation after harvest. *Trichoderma* spp. are well-known fungal crop/seed pathogen antagonists. *Colletotrichum truncat-um*, which causes brown blotch on cowpea, has been controlled by soaking seeds in *T. viride* spore suspension.

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RECENT SCENARIO OF TERMITE INFESTATION AND THEIR MANAGEMENT

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Termites are among the common insect pests belonging to the order Isoptera. Although these insects are often called "white ants", they are not ants, and are not closely related to ants. They are found abundantly and widely in tropical and sub-tropical regions of the world. About 3,106 species are currently described, with a few hundred more left to be described. Termites come in interaction with humankind because of their natural food source and habitat.

They pose serious threat to a wide range of agricultural crops, structures, especially wooden materials and prove themselves a major insect-pest to humankind. Loss due to termite attack not only confines itself into the internal. Termites constitute ten percent of the animal biomass in tropics and subtropical regions of the world and this figure rises up to 95% when only soil insects are included.

Different species of termite

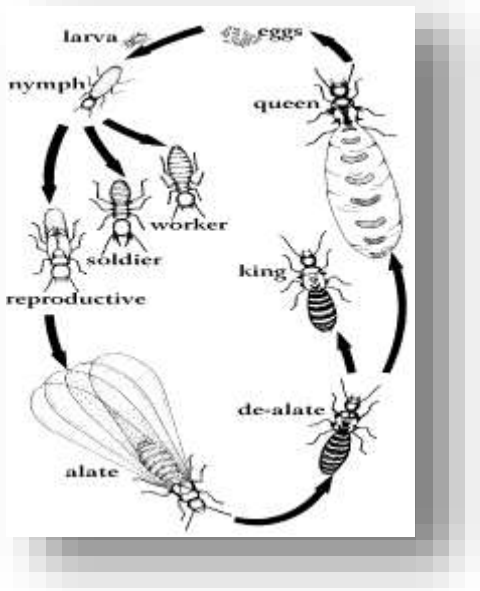
Termites are considered to be the most destructive insect pests in the world. Many buildings and structures are damaged by these pests each year resulting in huge financial losses.

There are 220 different species of termites in India that cause problems to properties:

- *Coptotermes gestroi*
- *Coptotermes heimi*
- *Heterotermes indicola*
- *Schedorhinotermes spp.*
- *Ondototermes spp.*
- *Psammotermes rajathanicus*
- *Macrotermes gilvus*
- *Microcerotermes spp.*
- *Nasutitermes sp.*

Caste of termite

The termite society, or colony, is a highly organized and integrated unit. There is a caste system with division of labour based on the colony members' structure, function, and behaviour. The major castes in the colony are the reproductive, soldier, and worker castes. Soldiers and workers are sterile and may be male or female. The functional reproductive are of two types, referred to as primary and secondary, or supplementary.



A new termite colony is established through the dispersal of winged adults (alates), which develop in a mature colony during specific seasons of the year. High atmospheric humidity, in combination with temperature, climatic, and seasonal parameters that vary by species, is usually related with alate emergence and flight. Some species may only emerge once a year, whereas others may have multiple flights in a row.

Reproductive

Possess compound eyes and are more or less brown due to their sclerotized cuticle. Developing reproductive have wing buds, wings or wing stumps. Reproductive can be further divided into:

- **Alates**, both sexes' juvenile winged reproductives. Approximately 100 to 1000 alates leave the colony for mating and colonizing flights on a regular basis. After mating, a pair chooses an appropriate location, such as a rotting scar on a tree, to start a new colony.
- **De-alates**, alates who shed their wings after the colonizing flight and transform into queens and kings in the process. Only a few eggs are deposited and raised by a female de-alate at first. As the colony expands in size, additional workers become available to assist the young queen in caring for the brood. The number of individuals in a pest species' colony has grown

to such proportions after three to five years.

- **Queen and king**, who are the colony's primary reproductive individuals. Once the queen has a large number of workers to assist her, her only job is to create a large number of kids. A huge queen can lay over 1000 eggs in a single day. A queen's life span can be as long as 50 years.
- **Neotenics-** As the queen's productivity declines, they help her lay eggs. One of the neotenics takes the queen's position when she dies or deteriorates. That is why the removal of a queen from her colony does not inevitably imply the colony's demise.
- **Workers:** are sterile, wingless and blind males and females. Their cuticle is un-pigmented and not hardened, therefore the animals are confined to a dark and moist environment. Workers build the nest and galleries, they fetch food, care for the brood and feed reproductives and soldiers. The worker's life span is one to two years.
- **Soldiers:** are, like workers sterile, wingless and blind males and females with an unpigmented, unsclerotized cuticle. Soldiers defend their colony from intruders by the use of powerful jaws and/or by ejecting a white sticky repellent from an opening on their head. Soldiers can't feed themselves, they have to be fed by workers. Usually the number of soldiers is much smaller than the number of workers. Soldiers can be **mandibulate** or **nasute**, depending on the species. Therefore soldiers can be used for the identification of termite species. The life span of the soldiers is one to two years.

Relationship with humans

As pests:

Owing to their wood-eating habits, many termite species can do significant damage to unprotected buildings and other wooden structures. Termites play an important role as decomposers of wood and vegetative material, and the conflict

with humans occurs where structures and landscapes containing structural wood components, cellulose derived structural materials and ornamental vegetation provide termites with a reliable source of food and moisture

In agriculture:

Termites can be major agricultural pests, particularly in East Africa and North Asia, where crop losses can be severe (3–100% in crop loss in Africa). Counterbalancing this is the greatly improved water infiltration where termite tunnels in the soil allow rainwater to soak in deeply, which helps reduce runoff and consequent soil erosion through bio-turbation. In South America, cultivated plants such as eucalyptus, upland rice and sugarcane can be severely damaged by termite infestations, with attacks on leaves, roots and woody tissue. Termites can also attack other plants, including cassava, coffee, cotton, fruit trees, maize, peanuts, soybeans and vegetables.

Termite attack on Maize field

Management of termite in field crops:

- Avoid using un-decomposed cow manure, and allow water to stagnate in the field by flooding irrigation.
- Plant residue cleaning, collection, and burning
- Using phenyl 1 percent in irrigation water to deter termites from the farm bed.
- Pentachlorophenol is used as a termite repellant.
- Termite control with the fungus Metarhizium anisopliae (trade name BioBlast).
- Before sowing seeds, treat them with chlorpyriphos 20EC @ 400ml in 5 litres of water per quintal of seeds, then dry them in a shed.
- During field irrigation, Chlorpyriphos 20 EC @ 2-3 litre was utilised.
- Seed treatment with Imidacloprid at 70 percent WS (Gaucho) and 48 percent FS.
- Termite fumigation using methyl bromide and chloropicrin is used to control termites.

Different technology used for termite control:

Barrier technology

- **Physical barrier:** In this technology the used of fine material particles *viz*. sand and crushed volcanic cinders were reported to have potential to work as barrier against subterranean termite *Reticulitermes hesperus*. Logan and his co-worker reported the particle size should be between 1.7 to 2.4 mm to act as effective barrier.
- **Chemical barrier:** chemical barrier can be broadly classified into two categories *viz*. repellant and non-repellant. Non-repellant chemical such as Cloranthranil-iprole, Imidacloprid, Chlorfenapyr and Fipronil etc. used against termite. Repellant chemical such as Chlorpyriphos, Bifenthrin, Permenthrin etc.

Bait technology:

Baiting is a promising technology of termite management in building construction. Baiting technique is almost proved against lower termites including *Reticulitermes* and *Coptotermes*. Bait toxicants were divided bait toxicants into three groups *viz.*

- The metabolic inhibitors,
- Biological control agents, and
- Insect growth regulators (IGRs)

Borate technology:

- Borate refers to the compounds containing boron and oxygen, usually naturally exists in the form of sodium and calcium borate. Indian has recommended use of borate compounds for wood preservation in the form of BCCA (Borate CCA) and ACZB (Ammonical Copper Zinc Borate).
- **Gel treatment:** gel is a newer formulation in insecticides, but in Indian context Gel formulations of termiticides.

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SPECIES AND VARIETAL DIVERSITY OF CITRUS

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Citrus is India's third most important fruit crop, with several species believed to have originated in the North East. Citrus fruits are rich in antioxidants and have neutraceutical characteristics, making them a popular daily diet choice.

Citrus inchangensis, C. latipes, C. macroptera, C. assamensis, C. aurantium, C. jambhiri, Citrus limonia, C. karna, C. pennivesiculata, and *C. maderaspatana* are among the various citrus species found in the country. Citrus and related genera have a wide range of variety due to their diverse Eco-geographical distribution and the occurrence of spontaneous mutations and natural hybridization. Citrus genetic resources in India have been thoroughly examined. Fruit genetic diversity is abundant in tropical and sub-tropical locations around the world, with over 500 citrus species estimated to exist in Southeast Asia alone. Genetic resources are the foundation of any crop development programme, and they are especially important for a diversified fruit like citrus. Study on genetic resources of Citrus in North Eastern India indicated the presence of 23 species, one subspecies and 68 varieties, thus accordingly this area assumes a special status as a treasure house of citrus germplasm. Citrus genetic resources, which include acids, oranges, pummelo, grapefruit, mandarins, wild and semi-wild species, and other related genera, are extremely valuable to the Indian fruit sector.

Lime and Lemon

Table 1: Different Species of citrus with their centre of origin and distribution

S. No.	Species	Common name	Probable Centre of Origin	Distribution
1.	*C. medica*	Citron	India	All over India
2.	*C. limon*	Lemon	Eastern Himalaya	All over country in homestead gardens
3.	*C. aurantifolia*	Sour Lime	India	Widely distributed in India
4.	*C. limmettoides*	Sweet Lime	India	North Western India
5.	*C. jhambhiri*	Rough Lemon	North – East India	-
6.	*C. karna*	Karna Khatta	India	N.E. And N.W. India
7.	*C. reticulata*	Mandarin	China	K.N., M.P., T.N., W.B
8.	*C. indica*	Indian wild orange	North – East India	All over India
9.	*C. maxima*	Pummelo	Malaysia	In home gardens

10.	*C. aurantium*	Sour orange	India	All over India
11.	*C. sinensis*	Sweet orange	Southern Indo China	A.P., M.H., Raj.
12.	*C. paradisiaca*	Grapefruit	West Indies	Limited cultivation
13.	*C. latipes*	Khasi Papeda	North East India	N.E. India
14.	*C. pseudolimon*	Galgal	India	-
15.	*C. assamensis*	Adajamir	North East India	N.E. India

Species Diversity

All edible citrus fruits belong to the *Eucitrus* subgenus, which is classified into five horticultural groups:

1. Acid group:

- **Acid lime**: *Citrus aurantifolia*- Highly polyembryonic species, highly susceptible to tristeza and bacterial canker.
- **Tahiti or Persian lime**: *Citrus latifolia* Triploid and monoembryonic.
- **Rangpur lime**: *C. limonia*- indicator of Exocortis, vigorous rootstock.
- **Lemon**: *Citrus limon* – Weakly polyembryonic species, leaf, flower bud and new flushes are pigmented.
- **Rough lemon**: *C. jambhiri* – Important rootstock, tolerant to tristeza, saline and calcareous soils.
- **Citron** : *C. medica* – also known as Persian Apple, monoembryonic species, indicator of Exocortis.
- **Sweet lime**: *Citrus limettoides* – highly polyembryonic, leaf lamina is cupped or rolled.

2. Orange group:

- **Sweet orange**: *Citrus sinensis*- highly polyembryonic species, tight skin with solid central core.
- **Sour orange**: *Citrus aurantium*- Cold hardy species, oil is used for perfumery known as oil as neroli.

3. Pummelo and grape fruit group:

- **Pummelo**: *C. grandis*- Monoembryonic species, leaf is pubescent, petioles are broadly winged.
- **Grape fruit**: *C. paradisi*- It is very similar to pummelo but the fruits are smaller than pummelo and thin peeled, fruits highly juicy, sweet with bitter after taste and have typical flavor. Leaves are smaller than pumello, polyembryonic.

4. Mandarin Group:

- *C. reticulata*- A highly polyembryonic species of Chinese origin. Petioles are with narrow or broad wings. Seeds are small, not noticeably flattened.
- *C. unshiu* (Satsuma mandarins)- A polyembryonic species of Japanese origin, cold hardy, fruits seedless with thin rind, colour orange at maturity. The fruits are very juicy with agreeable flavour.
- *Citrus deliciosa* (Willow-leaf mandarins)- Trees medium sized, drooping growth habit. Fruits strongly compressed and yellow to light on colour with distinctive flavour. It is an early variety.
- *Citrus nobilis* (King mandarin) - A polyembryonic species, native of Indo-China. Thought to be a natural tangor of ancient origin.

5. The fifth group consists of mainly hybrids of different citrus fruits with trifoliate orange (*Poncirus trifoliata*) which is primarily utilised as a rootstock.

- Citrange (*Poncirus trifoliata* × *C. sinensis*) var. Troyer, var. Carrizo
- Citrangor (Citrange × *C. sinensis*)
- Tangelo (Tangerine × grape fruit)
- Citrangequat (Citrange× kumquat)

Varietal Diversity

1. Mandarin

- Nagpur santra – Finest mandarin cultivar.
- Khasi mandarin – Grown in NE India
- Kinnow mandarin – *C. nobilis* × *C. deliciosa*, developed by H.B. Frost in 1915
- Mudkhed seedless- Bud sport of Nagpur mandarin
- Emperor – Australian cultivar
- Dancy – Grown in USA
- Laddu
- Sutwal – Introduction from Nepal
- Coorg mandarin– Commercial variety in S. India.

2. Sweet orange

- Mosambi- Most popular in MH.
- Satgudi- Extensively grown in AP.
- Pineapple – Mid season cultivar, pineapple scented.
- Hamlin – Introduced from Brazil.
- Washington Navel– Rudimentary type of fruit.
- Malta blood red– Most popular variety in Haryana, Punjab and Rajasthan.
- Valencia– Bears 2 crops in a year.
- Shamouti – Seedless variety from Israel.

3. Lemon

- Eureka – Italian cultivar
- Lisbon – Portuguese cultivar
- Pant lemon-1- Selection from kagzi kalan, trees are dwarf, heavy fruiting, tolerant to canker, scab and gummosis, self-incompatible cultivar.
- Baramasi
- Lucknow seedless

- Villa France – Belongs to Eureka group.
- Nepali oblong- Resistant to canker.

4. Sweet lime

- Mitha chikna
- Mithotra
- Sharbati

5. Acid lime

- Pusa Abhinav- New variety, clonal selection
- Pusa Udit- New variety, clonal selection
- Kagzi lime- Cluster bearing variety
- Vikram – Cluster bearing variety
- Pramalini- Canker resistant cultivar
- Chakradhar– Seedless and thornless cultivar
- Sai sharbati- Selection from kagzi lime
- Balaji
- Jai devi– Pleasant aroma and thin peel
- Rasraj– Interspecific hybrid between lime and lemon

6. Pummelo

- Chakotra
- Dawnfruit – Triploid seedless of acidless pummelo and tetraploid Ruby blood orange.
- Flemings Shardock– Pyriform fruit.

7. Grapefruit

- Duncan – white fleshed and yellow peel
- Star Ruby – induced mutant of Hudson grapefruit
- Hudson – natural mutant of Foster
- Foster – mutant of Walters
- Thompson – Seedless, bud sport of Marsh
- Flame- bud sport of Ruby Red
- Triumph

Conclusion

Citrus species and varieties are widely cultivated throughout the tropical and sub-tropical regions of the world. Several species are believed to be originated in North East India. Citrus species and varieties hold great economic significance for Indian fruit industry and therefore there is a need for proper documentation of different species and cultivars and Preservation of endangered and threatened species of citrus which are also valuable.

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IN VITRO AND FIELD EFFICACY OF NANOPARTICLES (PESTICIDES) AGAINST PLANT PATHOGENS AND RNAi-INDUCING MOLECULES

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Sustainable agriculture is needed. It may be understood to present a good approach of ecosystem for long run. Practices that can cause long-term damage to soil include excessive tilling of the soil which leads to erosion and irrigation without needed drainage. This will lead to salinization. This is to satisfy human being food, animal feed and fiber needs.

Long-term experiments are required to show the effect of different practices on soil properties which are essential to sustainability and to provide important data on this objective. In the United States, a federal agency, the development of nano-chemicals has appeared as promising agents for the plant growth and pest control. The fertilizers are required in plants growth. Nanomaterials act as fertilizers might have the properties such as crop improvement and with less eco-toxicity.

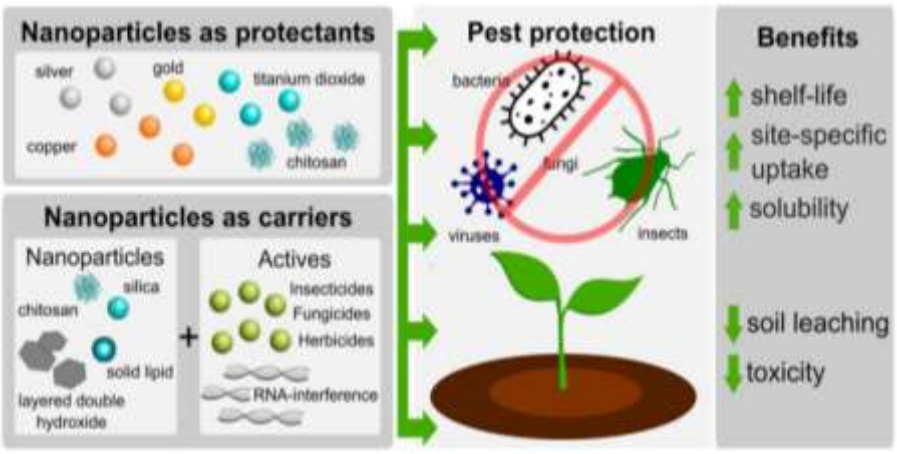
Plants can give an important way for their bioaccumulation into the food chain. The recent developments in agriculture cover the applications of NPs for more effective and safe use of chemicals for plants. The effects of different NPs on plant growth and phytotoxicity were reported by several workers including magnetite (Fe_3O_4) nanoparticles and plant growth, alumina, zinc, and zinc oxide on seed germination and root growth of five higher plant species; radish, rape, lettuce, corn, and cucumber, silver nanoparticles and seedling growth in wheat, sulfur nanoparticles on tomato, zinc oxide in mungbean, nanoparticles of AlO, CuO, FeO, MnO, NiO, and ZnO. Silver nanoparticles can stimulate wheat growth and yield. Soil applied 25 ppm SNPs had highly favorable growth promoting effects on wheat growth and yield.

Zinc has been considered as an essential micronutrient for metabolic activities in plants although it is required in trace amounts in plants. It was found that zinc has an important role in management of reactive oxygen species and protection of plant cells against oxidative stresses. Zinc has important functions in the synthesis of auxin or indoleacetic acid (IAA) from tryptophan as well as in biochemical reactions required for formation of chlorophyll and carbohydrates. The crop yield and quality of produce can be affected by deficiency of Zn. The development of insecticide resistance in pest insects has been an increasing problem for agriculture and public health.

Magnesium oxide (MgO) is important inorganic materials with many uses such as adsorbents, fire retardants, advanced ceramics, toxic waste remediation, and photo electronic materials. Therefore, various techniques and routes for synthesis of MgONPs have been reported. MgOH was synthesized by green methods using nontoxic neem leaves extract, *Citrus limon* leaves extract, *acacia* gum.

CONTROL OF PLANT PESTS

Fusarium wilt is a destructive disease of tomato and lettuce in several countries due to its severe production loss, prolonged survival of fungus in soil and generation of resistant races. The disease can be reduced to some extent with the use of resistant cultivars and chemicals. However, the occurrence and development of new pathogenic races is a continuing problem, and the use of chemicals is expensive and not



always effective. In recent years, the use of nanomaterials has been considered as an alternative solution to control plant pathogens. Synthesized nanoparticles of magnesium oxide (MgO) and tested the effect of different concentrations on the green peach aphid (GPA) under the greenhouse conditions. The synthesis of nanomaterials of copper oxide (CuO), zinc oxide (ZnO), magnesium hydroxide (MgOH) and magnesium oxide (MgO) has been carried out successfully by using aqueous extracts of *Punica granatum* peels, *Olea Europa-ea* leaves and *Chamaemelum nobile* flowers.

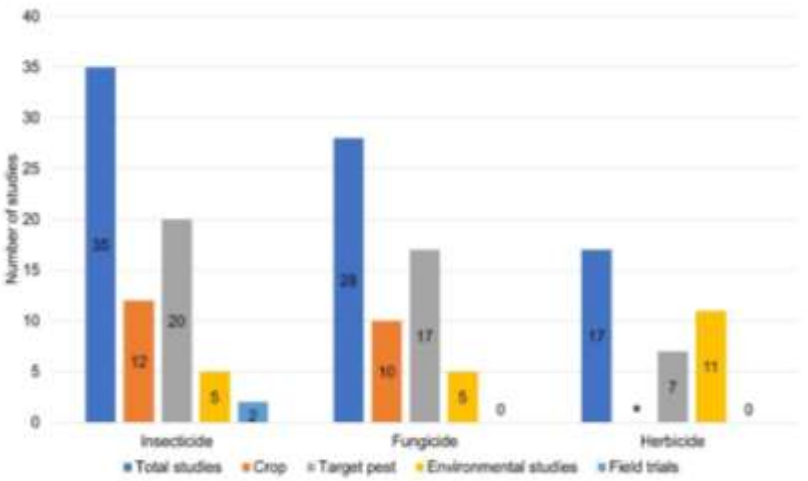


Figure 1. Nanomaterials as protectants or carriers to provide crop protection. This schematic shows different nanomaterials as either protectants or carriers for actives such as insecticides, fungicides, herbicides, or RNA-interference molecules, targeting a wide range of pests and pathogens. It also highlights the potential benefits of nanomaterial applications, such as improved shelf-life, target site-specific uptake, and increased solubility, while decreasing soil leaching and toxicity.

Nanoparticles as carriers for insecticides loading insecticides into nanoparticles first started in the early 2000s. Since then, conventional insecticides (27 studies) and bioactive compounds with insecticidal properties (13 studies) have been conducted with a range of nanoparticles (Table 1). These studies have explored eight different MoA and a range of essential oils (not included in Insecticide Resistance Action Committee (IRAC) classification). The most commonly investigated nanoparticle carriers were silica (8 studies), chitosan (11 studies), and lipids (4 studies). *Spodoptera litura* (5 studies), *Tetranychus urticae* (4 studies), and *Helicoverpa armigera* (4 studies) were the most popular target pests. In these studies, the researchers aimed to improve low water-solubility, decrease volatilization, improve stability, and provide slow release of the active molecules.

Studies conducted on insecticides, fungicides, and herbicides (including biocides) loaded onto nanoparticles. Insecticides: 35 studies have been conducted to date, where 12 tested their nano-insecticide on crop plants, 20 against the target pest, 5 on environmental issues, such as non-target toxicity or soil leaching, and 2 trials were done in field conditions. Fungicides: 28 studies have been conducted to date, where 10 tested their nano-insecticide on crop plants, 17 against the target pest, 5 on environmental issues, such as non-target toxicity or soil leaching, and no trials have been conducted in field conditions. Herbicides: 17 studies have been conducted to date, where 7 were tested against the target pest, 11 on environmental issues, such as non-target toxicity or soil leaching, and no trials have been conducted in field conditions. Crop host experiments were not included, since some herbicides are non-selective.

Nanoparticles as Carriers for Fungicides Starting in 1997, initial studies on nano-fungicides were conducted on incorporating fungicides into solid wood [36,72–74]. Since then, conventional fungicides (20 studies) and biocides with antifungal properties (6 studies) have been conducted with a wide range of nanoparticles (Table 2). Nine FRAC groups, and a range of essential oils not included in the fungicide groups, were studied. The most commonly investigated nanoparticle carriers were polymer mixes, silica, and chitosan. A wide range of fungi were used to check the efficiency of the nano-fungicide. However, few plants were tested, nor were there many toxicity studies. Similar to insecticides, nanoparticles were exploited to improve low-water-solubility issues, decrease volatilization, and improve stability while providing a slow sustained release.

Nanoparticles as Carriers for Herbicides Most of the herbicide nanocarrier studies primarily focused on reducing the environmental impact caused by herbicides (Table 3). When compared with insecticide and fungicide nanocarrier studies,

herbicide research clearly prioritizes reducing the non-target toxicity of the herbicides. Development of nano-particle based herbicides has also included a wider variety of nanoparticles. For example, montmo-rillonite clay layers coated with a pH dependent polymer [97], core–hollow shell manganese carbonate [98], nanosized tubular halloysite and platy kaolinite [99], amino-activated iron (II,III) oxide magnetic nanoparticles [100] and nanosized rice husks [101], have been used to date.

Nanoparticles and RNAi for Plant Protection The discovery of the RNAi pathway has heralded new and innovating approaches for the management of pests and pathogens. RNAi, a conserved eukaryotic mechanism, is involved in the growth, development, and host defense against viruses and transposons, that can also be hijacked to target insects, fungi, viruses, and weeds [114–118]. Figure 3 describes the general mechanism of application of dsRNA to target pathogen RNA. In plants, RNAi is triggered by dsRNA, which is processed into small-interfering RNA (siRNA) by Dicer-like (DCL) enzymes. These siRNAs are incorporated into a RNA-induced silencing complex (RISC); siRNAs then direct the RISCs through base pairing to degrade the pathogen RNA, by preventing it from being used as a translation template [114]. Since its discovery, the RNAi pathway has emerged as a powerful tool to combat plant pests and pathogens by genetic modification [119,120]. However, genetically modified organisms are controversial and highly regulated in most countries; thus, research into new dsRNA delivery methods is being undertaken.

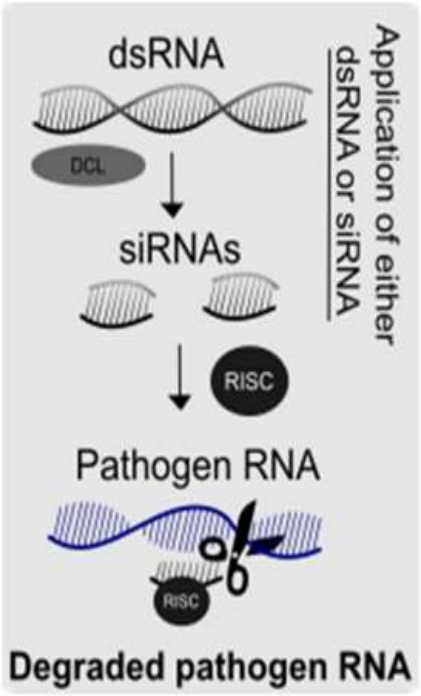


Fig: A brief overview of the RNAi pathway utilized for the application of RNAi-inducing molecules (dsRNA or siRNA) for gene silencing.

The screening of synthesized bio-nanoparticles revealed that these nanoparticles were effective in increasing the mortality percent of green peach aphid. After the glasshouse experiments, the metal oxide nanoparticle accumulations were analyzed in the fruits and leaves of green sweet pepper. The results showed that there was no any metal accumulation in any of the plant fruits. Foliar spray by synthesized of MgOH nanoparticles for green pepper leaves revealed that the foliar spraying leaves with 100–800 ppm metal nanoparticles are very beneficial to plant growth and produced healthy plants with greener leaves and high fruit quality compared to the control. Researchers made significant efforts toward the synthesis of nanoparticles by various means, including physical, chemical and biological methods.

Green methods for synthesizing nanoparticles with plant extracts are advantageous as it is simple, convenient, environment friendly and require less reaction time. Nanomaterials prepared by eco-friendly and green methods may increase agriculture potential for improving the fertilization process, plant growth and pesticides. In addition, this technology minimizes the amount of harmful chemicals that pollutes the environment. The green peach aphid is considered as a key pest on peach and globally important pest of a broad range of arable and horticultural crops, including Jordan. The pest is categorized as of the most important agricultural pest in the world. This devastated pest combats organophosphorus and carbamate insecticides by overproducing insecticide-degrading carboxyl esterases. Moreover, control of such a pest is becoming increasingly difficult, because the overproduction of resistance for aphid individuals when using chemical insecticides such as carbamates, organophosphates and pyrethroids.

Nanomaterials such as copper oxide (CuONPs), zinc oxide (ZnONPs), magnesium hydroxide (MgOHNPs) and magnesium oxide (MgONPs) were synthesized by different physical and chemical methods. With the growing needs to minimize the use of environmental-risk substances, such as insecticides, the biosynthesis of nanoparticles as an emerging highlight of the intersection of nanotechnology and biotechnology has received increasing attention. The rate of reduction of metal ions using plants has been found to be much faster as compared to microorganisms and stable formation of nanoparticles has been reported.

CONCLUSION AND FUTURE OUTLOOK

Nanotechnology can provide solutions for agricultural applications and has the potential to revolutionize the existing technologies used in pest management. Development of nanopesticides can offer unprecedented advantages like (i) improved solubility of poorly water-soluble pesticides, (ii) increased bioavailability and efficacy of pesticides when loaded onto nanoparticles and reduced pesticide toxicity, (iii) enhanced shelf-life and controlled delivery of actives, (iv) target-specific delivery of the active molecules and pH dependent release, (v) smart delivery of RNAi molecules for disease management, (vi) nanoparticles as carriers to slow down degradation of active molecules and improve the formulations' UV stability and rain-fastness, (vii) nanopesticides to improve the selective toxicity and overcome pesticide resistance.

Nanopesticides are an emerging technological advancement where, in relation to pesticide use, there is a lack of a clear definition of what is, and what is not a nanopesticide, by regulatory bodies. Unlike conventional pesticides, the effects of nanopesticides may be dependent on the uptake, bioavailability, concentration, and toxicity of the nanoparticles, as well as the ratio of the active bound to them. Also, there is limited data concerning the issue of pesticide resistance and how the addition of nanoparticles could conceivably reduce its incidence.

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PLANT DISEASE MANAGEMENT THROUGH BIOTECHNOLOGICAL APPROACHES

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In the field of agriculture, India has made amazing progress. The population is rising at a pace of 1.8 percent each year, and it is expected to reach 1.5 billion people by 2030. The country's demand for food and fiber is increasing, requiring better yields to feed the population on the existing land. Scarcity of food, malnutrition, fatalities, and a lack of resources for the green revolution have twisted our prayerful bowl to an agriculturally progressive country. Fungi, bacteria, viruses, phytoplasmas, and nematodes cause plant illnesses, which result in financial losses. These issues include decreased yields, poor quality, lower nutritional value, and contamination with pollutants. Control is required to ensure a sufficient quantity of food, feed, and fiber. Growers are currently spending enormous sums to achieve partial control of pathogens that attack crops and other plants, despite severe crop losses due to illnesses. Agriculture has traditionally seen reducing such losses as a top aim. Plant health control, in addition to the obvious benefits for farmers and processors, is a significant technique for raising food supplies without expanding the amount of land under cultivation. Plant biotechnology ushers in a new era for plant protection personnel, allowing them to maintain healthy crops while using less pesticides. Biotechnology's main goal is to provide natural security to an ever-increasing population. Genetic engineering has the potential to improve the ability of cultivars to endure or resist plant disease attack. For pathogens that are difficult to control using current methods, new approaches to plant disease control are especially necessary. Plants that have been genetically modified to be resistant to plant infections can help farmers avoid crop losses and minimize pesticide use.

DIAGNOSIS OF PLANT DISEASES USING BIOTECHNOLOGICAL APPROACHES

The first stage in controlling a plant illness is to be able to detect it and identify the disease-causing organism as soon as possible so that proper treatment can be administered. Many diseases, on the other hand, are only visibly detected after it is too late to avoid serious damage. The development of disease diagnosis kits has been a huge step forward in limiting disease-related crop damage. Modern biotechnological technologies have been used to develop kits for identifying plant diseases such as bacterial canker of soybean and tomato, and root rot at an early stage of infection. Diseases can be identified by detecting a distinguishing property of the organism, such as its genetic material - DNA or a protein. Antibodies that identify specific proteins from the disease-causing organism are used in these assays. To start breeding new kinds of varieties with higher yields, disease-free plants must be used, so DNA-based diagnostics are being standardized to identify and distinguish between various viruses. Improved detection and identification processes are becoming increasingly crucial as international trade in plant products grows and trading partners strive to protect themselves from disease introduction.

ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA)

Because of its simplicity, sensitivity, and versatility, the Enzyme- linked Immunosorbent Assay (ELISA) is one of the most extensively used serological tests for plant virus detection, identification, quantification, and comparison. A variety of disease detection kits have been developed for use at the suspected infection site. These kits, which require no laboratory equipment in most circumstances, are very valuable for growers and take only five minutes to complete. The

diagnostic kits are based on a method for detecting disease-causing organisms in plants that uses proteins called antibodies. The ability of an antibody to recognize and bind to a specific antigen, a substance associated with a plant pathogen, is used in this assay. The antibodies used in the diagnostic kits are produced by injecting a rabbit with an antigen (highly purified proteins) associated with particular plant disease. The antigen causes the rabbit to develop particular antibodies. Only the proteins (antigens) associated with the causative agent of a given plant disease are recognized and reacted to by the antibodies generated. A positive (disease presence) reaction is indicated by color changes on the unit's surface. ELISA kits have been developed to detect bacterial canker in tomatoes, root rot in soybeans, and viral infections in potatoes, among other things.

POLYMERASE CHAIN REACTION (PCR)

Nowadays, the Polymerase Chain Reaction (PCR) is a crucial tool in molecular biology. This allows MAS to be implemented quickly and effectively. Simple sequence repeats (SSRs) or microsatellites, as well as Single Nucleotide Polymorphisms (SNPs), are the most extensively utilized markers in key crops (SNPs). In any crop, SNPs are the most common type of marker. SSRs, are extremely dependable (i.e., repeatable), co-dominant in nature, relatively simple and inexpensive to employ, and generally polymorphic. As a result, freshly developed biotechnological technologies provide intriguing new methods to disease prevention. Plants that have been genetically modified to resist viruses, bacteria, fungi, and nematodes have showed some promise, but more study is needed to achieve the goal. DNA sequence amplification in vitro that is extremely strong. Denaturation, annealing, and extension are the three basic phases involved. For gene cloning, analysis, and manipulation, PCR is now often utilized. The use of PCR to create knockout mutants for various genes can be utilized to determine the role of that gene in that organism by comparing it to the wild/original strain. It has a lot of potential for improving the sensitivity of many nucleic acid probe-based tests. PCR is a technique for producing large numbers of copies of a nucleic acid sequence. By amplifying pathogen sequences to a detectable level, this approach allows us to identify a very little amount of a pathogen in a sample.

IDENTIFICATION OF RESISTANT GENES 'R GENE'

To protect crop plants from plant infections, disease resistant genes are being identified and engineered into them. Understanding pathogenesis at the biochemical and molecular level is essential for developing novel plant disease control techniques. The following are some of the most important research goals that have been considered in recent years:

1. The molecular basis of various plant diseases is being investigated.
2. Determination of resistance cultivars' ability to detect and respond to plant disease causing organisms.
3. Understanding the genetic pathways that lead to the emergence of novel disease strains with increased virulence. Moving/ transferring genes from one organism to another is no longer a secret science and has become ubiquitous. Genes giving disease resistance can now be introduced into crop plants. Direct approaches or vector-mediated methods can be used to accomplish this. The direct and vector-mediated methods, respectively, are best exemplified by the gene gun and Agrobacterium mediated methods.

MOLECULAR BREEDING

The elemental basis of plant breeding is the selection of specific plants with desirable traits, and the selection process typically revolves around the evaluation of a breeding population for one or more traits such as agronomic traits, disease resistance, or stress tolerance related traits in field or glasshouse conditions. A genetic marker is a gene or DNA sequence that may be used to identify individuals or species and has a known position on a chromosome. It can be defined as an observable variation (which may develop as a result of a mutation or modification in the genetic locus). Genetic markers can also be used to replace phenotyping, allowing selection in off-season nurseries and lowering costs by increasing the number of generations grown in a year. Using Marker Assisted Selection, the total number of lines that need to be checked can also be lowered (MAS). Because many lines can be removed following MAS early in a breeding scheme, more glasshouse and/or field space can be used more efficiently, which is generally limited because only key breeding material is kept. To distinguish between various genotypes, the markers likely to be utilized in MAS should be closely

related to the target locus (less than 5 cm genetic distance) and highly variable in breeding material, parents, or population. In order for MAS to be practical, the markers likely to be utilized must be easily assayable and the assay must be cost effective. Simple sequence repeats (SSRs) or microsatellites, as well as Single Nucleotide Polymorphisms (SNPs), are the most extensively utilized markers in key crops (SNPs). In any crop, SNPs are the most common type of marker. SSRs, are extremely reliable (i.e., repeatable), co-dominant in nature, comparatively simple and low-cost to employ, and usually polymorphic. As a result, freshly developed biotechnological technologies provide intriguing new methods to disease prevention. Plants that have been genetically modified to resist viruses, bacteria, fungi, and nematodes have showed some promise, but more study is needed to achieve the goal.

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AN INTRODUCTION OF HELPFUL INSECTS

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Beneficial insects are any of a number of species of insects that perform valued services like pollination and pest control. The concept of beneficial is subjective and only arises in light of desired outcomes from a human perspective. In agriculture, where the goal is to raise selected crops, insects that hinder the production process are classified as pests, while insects that assist production are considered beneficial. In horticulture and gardening, beneficial insects are often considered those that contribute to pest control and native habitat integration. Encouraging beneficial insects, by providing suitable living conditions, is a pest control strategy, often used in organic farming, organic gardening or integrated pest management. Companies specializing in biological pest control sell many types of beneficial insects, particularly for use in enclosed areas, like greenhouses. Some major helpful insects are described below:

PRAYING MANTIS

Adults are 5-10 cm long and green, brown or yellow in colour. Mantids have an elongated thorax and grasping forelegs, which they use to hold their prey while they eat. It complete one generation per year. Over winters as eggs in egg cases, which are glued to wood, bark, or other plant material. Mantis is non-selective feeders on nearly any sizable insect that moves fast enough to attract their attention. This can include pests and Beneficial's and even other mantis.

Praying mantis egg case

Praying mantis adult

LADY BIRD BEETLE

There are many species of ladybird beetles that vary in size, colour and pattern. Depending on species, colours are black, red and orange-red to almost yellow. Most species have coloured spots or markings on their backs. Adult has 1.0-5.0mm; Mature larva- 1.0-7.5mm. Overwinter as adults. Eggs (orange, elongated) are laid in clusters on underside of leaves and branches. Both the larvae and adults feed on pests. The grub and adult both are predatory in nature and feed on all soft bodies insects i.e. aphid, whitefly, jassid, scale, mite etc. The ladybird beetle larvae are known to eat 50 aphids a day.

LACEWING

Common species of lacewings include two green lacewing species, *Chrysoperla carnea* and *Chrysopa oculata*, and one brown lacewing species, *Hemerobius pacifus*. Lacewing eggs are white and lay singly or in groups on long stalks on the underside of leaves or branches. The brown and green lacewing larvae are very similar except for small differences in body shape and the brown lacewing's habit of moving its head from side to side while walking.

Eggs of ladybird beetle

Adult of ladybird beetle

Grub of ladybird beetle

Eggs of lacewing

Grub of lacewing

Adult of lacewing

The body length of adult - 10.0-20.0 mm and mature larva - 6.0-10.0 mm. *Chrysoperla carnea* and *Hemerobius pacificus* overwinter as adults; *Chrysopa oculata* as pupae. Up to four generations per year depending on temperature. The larvae, sometimes call aphid lions, are voracious predators capable of feeding on small caterpillars as well as aphids and other insects.

SYRPHID (HOVER) FLIES LARVAE

Larvae of hover

Adult of hover fly

Hover fly larvae are flattened, legless maggots with no distinct head and a tapered body. They are variously coloured (yellow, green to brown). Body length of adult - 8.0-15.0 mm and mature larva - 10.0-15.0 mm. It's complete several generations per year depending on temperature and location. Adults feed on nectar. The larvae of most species feed on aphids, mealy-bugs, and other small insects.

MINUTE PIRATE BUG

Adult anthocorids have a narrow, pointed head, flattened, smooth body with distinctive clear markings on their back. Body length of adult - 2.0-4.0 mm and mature nymph - 1.8-3.7 mm. Over winter as adults. It complete 3 to 4 generations per year. The adult and nymph attack on Aphids, spider mites, thrips, psyllids, whiteflies and small caterpillars.

Adult of anthocorid bug

Nymph of anthocorid bug

APHID MIDGE

Midge larvae

Midge larvae with killed aphids

Adults of the predaceous midge *Aphidoletes aphidimyza* are tiny (3mm long), delicate, long-legged brown flies that are active at night and thus rarely seen. Overwinter as pupae in soil. Eggs are laid in colonies of aphids. Aphid midge complete several generations per year. It attack on aphids.

Parasitic wasp (*Meteorus trachynotus*) a common leaf roller parasitoid

Braconid wasp parasite on cocoon of tomato hornworm

***Encarsia formosa* whitefly parasitoid**

Campoletis chlorideae*, larval parasitoid of *H. armigera

***Aphelinus mali*, apple wooly aphid parasitoid**

***Trichogramma* wasp, egg parasitiod**

POLLINATORS

The different bee spp. and other insects play important role in pollination including *Bumble bee, Mason bee,* Leafcutter bees, *Halictid (Sweat) bee, Digger Bee,* adult of butter fly and moths.

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BEETLES: BENEFITS AND NEGATIVE IMPACTS ON AGRO-ECOSYSTEM

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Coleoptera, a largest insect order, represents about 38% (3,87,100 species) of the insect species of the world (Zhang, 2011). Of the 3,87,100 species, there are approximately 17,455 species found in India (ZSI, 2012). It is the most popular insect order in terms of number of organisms. The members of this order are called beetles. They are the biggest community of species in the world. Beetles are profoundly present in nearly all possible terrestrial or marine habitat, but chance its species being found in tropical countries is higher than in the temperate ones. Sumptuous beetle diversity is found in the continental lands in contrast to isolated islands. Some species live deep underwater in tunnels, and some also able survive in the inter-tidal zone near the seashore. Beetles have invaded almost every ecosystem and devoured every potential source of food.

Beetles exhibit complete metamorphosis; have a distinct pupal stage between the larval and sexually mature adult stages. A high proportion of beetle species is capable of walking, and they have two sets of wings. In most species, the forewings (called as elytra) that shield the membranous hind wings, does not participate in flight. Flightless species may have reduced hind wings covered under elytra, or the elytra may be fused together with no hind wings at all. Some of them have vivid metallic colours, eye-catching patterns, or distinctive shapes E.g., Jewel beetles. There are considerable differences in size, body mass and shape, with the smallest adults less than 1 mm long and the largest around 20 cm. Many longhorn beetles have exceptionally long antennas, and the variety is almost infinite. Almost every biological life strategy is embodied in this community of insects that originated 240 million years ago in the Permian period.

BENEFITS OF BEETLES IN AGRO-ECOSYSTEM

In several respects, beetles are of great importance to agro-ecosystem. They are prominent decomposers, particularly in forests. As predators, they play a crucial role in decreasing the populations of problem insects, particularly caterpillars. Over 300 species are used as food, mainly as larvae; mealworms and rhinoceros beetle larvae are commonly consumed species. Many beetles have an important role to play as nutrient recyclers returning organic matter through multi-trophic interactions that contribute to soil fertility.

BEETLES AS DECOMPOSER

Dung roller (Fig. 1), for example, play an important role in the decomposition of dung into accessible nitrogen that can be assimilated into soil. They support our property by decomposing organic matter, transferring nutrients from the surface to the subsoil, increasing water infiltration, and decreasing runoff. By physically scraping dung from the soil, dung beetles often reduce flies and odours. This also helps to control dung-borne parasites.

BEETLES AS PREDATORS ON OTHER INSECTS

This character is of agriculturally important. There are several beetle families that are predators to crop pests. By feeding on caterpillars and other immature stages, as well as many soft-bodied insects and insect eggs, ground beetles and rove beetles help to control the populations of many insects. Most coccinellids (ladybird beetles) are highly beneficial, both larvae and adults feed on aphids and scale insects.

BEETLES AS POLLINATORS

Bees and butterflies are the first insects that come to mind when we think of pollinators. On the other hand, pollinators are a much broader category of insects that includes species from several insect groups, including beetles. On this planet, beetles have a long history. Soldier beetles, scarabs, long-horned beetles, sap beetles, and checkered beetles are examples of flower-visiting species that provide valuable pollination services that complement the role of other pollinators in plants. Bees and butterflies had yet to appear when flowering plants first appeared on the scene. In their absence, early plant-insect pollination relationships were shaped by the beetles. They frequent a wide range of flowering plants, especially those with clusters of smaller flowers, such as goldenrod, yarrow, spicebush, spirea, sunflower, and wintersweet.

BEETLES AS SEED PREDATORS OF WEED

Seed predation by ground beetles in farmland does have a beneficial effect, reducing weed numbers in fields and potentially improving agricultural productivity. Researchers have found that grass weeds have been reduced more than other weeds, which is essential because many UK farms have severe grass weed problems. Some of these grass weeds are increasingly resistant to herbicides and have a detrimental effect on productivity as they compete with the crop for resources, resulting in lower yields.

BEETLES AS SCAVENGERS

Several beetle types, including darkling beetles, scarab beetles, carrion-feeding beetles, and dermestid beetles, are scavengers. Dead trees, dead animals and plant matter, excrement, and other decaying products are broken down by scavenger beetles. Zoologists use dermatids like *Dermestes caninus* to clean dead animals' skeletons.

NEGATIVE IMPACTS ON AGRO-ECOSYSTEM

Beetles have some detrimental effects on agro-ecosystem which are as follows-

Beetles as stored grain pests

The most common storage beetle pests include bruchids (such as cowpea seed beetles and bean bruchids), grain borers (such as the larger and smaller grain borers), weevils (such as grain weevils), flour beetles, Khapra beetles, and dried fruit beetles. The larvae and confident adults of beetle pests feed on the seeds and grain, leaving tiny holes in them. A cloud of fine dust is sometimes detected around the holes, which is the excrement of these insects. Beetle damage renders grains and seeds unfit for human eating and, in severe cases, even for animal consumption.

Beetles as crop pests

There are many beetles that damage crop plants. These may damage roots, stems, leaves, flowers, and fruits. *Callosobruchus chinensis* on gram, mung, peas, cowpeas, lentil and arhar, *Bactocera rufomaculata* serious pest on mango, fig, guava, jackfruit, pomegranate, *Plocaderus ferruginea* on cashew, *Xyloatrechus quadripes* on coffee, *Dicladispa armigera* and *Leptisma pygmea* on rice etc.

Beetles as the transmitter of plant diseases/ pathogens

The role of beetles in the transmission of plant diseases is poorly understood. Disease transmission may occur if the beetles carry fungal spores, bacteria, viruses, plant-parasitic nematodes, or other pathogens on or in their bodies. The following are some examples of beetles that spread disease in crop plants-

1. The European elm bark beetle, *Scolytus multistriatus*, transmits the fungus that causes Dutch elm disease.
2. Potato flea beetle, *Epitrix cucumeris* spreads the pathogen of potato scab, *Actinomyces scabies.*
3. *Pantoea stewartii*, the bacterial pathogen of Stewart's wilt disease in corn, is spread by corn flea beetles, *Chaetocnema Pulicaria*, corn rootworms, and *Diabrotica* spp.
4. *Bursaphelenchus xylophilus is a pinewood nematode that causes pine wilt disease in many species of pines and conifers. The nematodes survive in the respiratory tracts of cerambycid beetles, Monochamus carolinensis, and M. alternatus and are transmitted from infected to healthy pine trees.*

Some amazing facts about beetles

- One Ambrosia beetle species, *Austroplatypus incompletes*, living in nutritional symbiosis with ambrosia fungus, is native to Australia. Beetles dig tunnels in dead or stressed eucalyptus trees to colonize and cultivate fungal gardens. This species is considered the first beetle to be a eusocial insect.
- Beetles account for one-quarter of all known species of plants and animals. There are more kinds of beetles than all plants.
- The Heaviest Insect: A Goliath Beetle from tropical Africa weighs in at 3.5 ounces.
- The Heaviest Water Insect: The Giant Water Bug of South America tips the scales at nearly two ounces.
- Longest Beetle: The nearly 8-inch, Long Horn Beetle, *Titanus giganteus*, from South America.
- The smallest beetle is the fringed ant beetle, *Nanosella fungi* (family Ptiliidae). At 0.25 mm in length, it is 16 million times smaller in volume than the largest beetle, Goliathus giganteus (family Scarabaeidae), which may have a body length of 10 cm.
- Two families of Coleoptera are bioluminescent (able to produce light). Fireflies (family Lampyridae) and glowworms (family Phengodidae) have light-producing organs in the abdomen.

Goliath beetle (*Goliathus regius*) is a native of western Africa. These beetles are the heaviest of all insects, yet strong fliers. The government of Togo issued a stamp on May 2, 1995, to commemorate the International Exposition for Wildlife Protection held that year in Paris.

MANAGEMENT OF BAKANAE DISEASE (*Fusarium moniliforme*) OF RICE

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Rice (*Oryza sativa* L.) is a staple food crop for more than 3 billion people around the world. Realizing the global importance, rice has molded the diets, culture and economy of millions of people**.** Rice is the food of more than 60 % of the world's population in south-eastern Asia. About 90 % of total rice grown in the world is produced and consumed in the Asian region. Rice provides 21 % of energy and 15 % of protein requirements of human population globally**.** Presently, the rice disease profile has changed in response to fluctuation in rice production situations. Diseases like foot rot or bakanae (*Fusarium fujikuroi*), blast (*Magnaporthe oryzae*), sheath blight (*Rhizoctonia solani*), brown spot (*Biplolaris oryzae*), false smut (*Ustilaginoidea virens*) and stem rot (*Sclerotium oryzae*) are of major economic significance. Among them bakanae caused by *Fusarium fujikuroi* is an important emerging disease of basmati rice. The disease has been reported from the South East Asia, Africa, America and European countries**.** It is economically important in the Asian rice growing areas owing to the significantly large amount of yield losses estimated at approximately 20 % in epidemic areas**.** It is also a serious problem in countries like, Japan, Taiwan, Thailand, Turkey, California and Philippines reported up to 20 – 50 % loss in Japan and 3.7-14.7 % loss in Thailand.

Bakanae disease of rice is also known as "foot rot" in India, "white stalk" in China, "man rice" in the Philippines and "bakanae-byo or elongation disease" in Japan.

Bakanae is a Japanese word which means bad or naughty seedling referring to the abnormal elongation, "thin noodle seedling", "foolish seedling" or "stupid rice crop".

Bakanae disease was first identified during 1828 in Japan. Shotaro Hori (1898) first time demonstrated the fungus *Fusarium heterosporium.* It was later put in the genus *Gibberella* under the name *G. fujikuroi* (Sawada). In 1917, Sawada indicated that the elongation of rice seedlings might be due to some stimuli derived from bakanae fungus hyphae. Subsequently, Kurosawa (1926) demonstrated the hypertrophic and elongation effect from culture filtrate of dried rice seedlings, rice plants and other sub-tropical weeds which was also called as "bakanae effect". In India, this disease was reported in the year 1931 by Thomas as foot rot disease of rice.

In recent years the emerging disease of rice is bakanae which causes severe loss to many varieties of basmati rice. It occurs in both upland and lowland rice fields. This disease is widely distributed in almost all the rice growing areas. Previously this disease was a minor disease but now it is becoming a major disease particularly in basmati rice varieties Pusa Basmati 1121 and Pusa Basmati 1509, which is most popular in farmers in all basmati rice growing areas**.**

SYMPTOMATOLOGY

The disease is caused by one or more *Fusarium* species and complex of disease symptoms including seedling blight, root rot, crown rot, stunting, and the most classical symptoms of etiolation, hypertrophy effect or excessive elongation of infected plants, foot rot, seedlings rot, grain sterility, grain discoloration with ultimate effect on yield and seed quality have been recorded from different regions of the world.

Infected plant

PATHOGEN

Bakanae is Japanese name meaning 'foolish seedling' caused by *Gibberella fujikuroi*, Sawada, Wollen worth (teleomorph) (anamorph: *Fusarium fujikuroi* Nirenberg) is emerging as a serious disease of rice in India, Taiwan, Japan and Thailand.

Foot rot or bakanae disease of rice caused by *Gibberella fujikuroi* (teleomorph) and *Fusarium fujikuroi* (anamorph). Bakanae is a monocyclic disease and the pathogen is seed and soil borne both, whereas, seedborne inoculum is more significant source as soilborne inoculum is reduced rapidly passage of time. Infested seed is primary source of inoculum and act as main means of spreading the disease from field to field. The conidia are disseminated by wind and water causing new infections in the rice field. The production of conidia on diseased or dead culms in the field coincides with the flowering and maturity of the crop. Therefore, seed infections occur through airborne ascospores during the flowering stage of the crop or conidia that contaminate the seed during harvesting. Ascospores and conidia adhering to the seed act as primary source of inoculum, germinate and infect seedlings through the roots and crown. The fungus becomes systemic within the plant but does not systemically infect the panicle. It can parasitize the plants without producing visible symptoms and can be isolated even from healthy looking seeds. Generally, the seed borne inoculum provides an initial site or focus for secondary infections.

MANAGEMENT

- Use of disease free seed as well as nursery for transplanting.
- Seed bio priming with bio agent like: *Trichoderma* spp.
- Seed treatment with fungicides like: Thiophanate methyl, Thiram and Propiconazol
- Use clean seeds to minimize the occurrence of the disease
- Use salt water to separate lightweight, infected seeds during soaking
- Use fungicides as seed treatments
- Because the disease is disseminated by spores on the seed's surface, treating diseased seed with a fungicide containing benomyl or benomyl-t (at 1-2 percent of seed weight) for dry seed coating can be helpful. It has also been established that soaking seed in a fungicide solution of 1:1000 for one hour or 1:2000 for five hours is beneficial. Avoid using benomyl on a regular basis since the fungus can get resistant to it.
- If benomyl resistance develops, apply a fungicide that contains triflumizole, propiconazole, prochloraz, or a thiram + benomyl combination.

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A CASE STUDY ON ECONOMIC IMPACT OF AGROMET ADVISORY SERVICES FOR SOYBEAN CROP IN HOSHANGABAD DISTRICT

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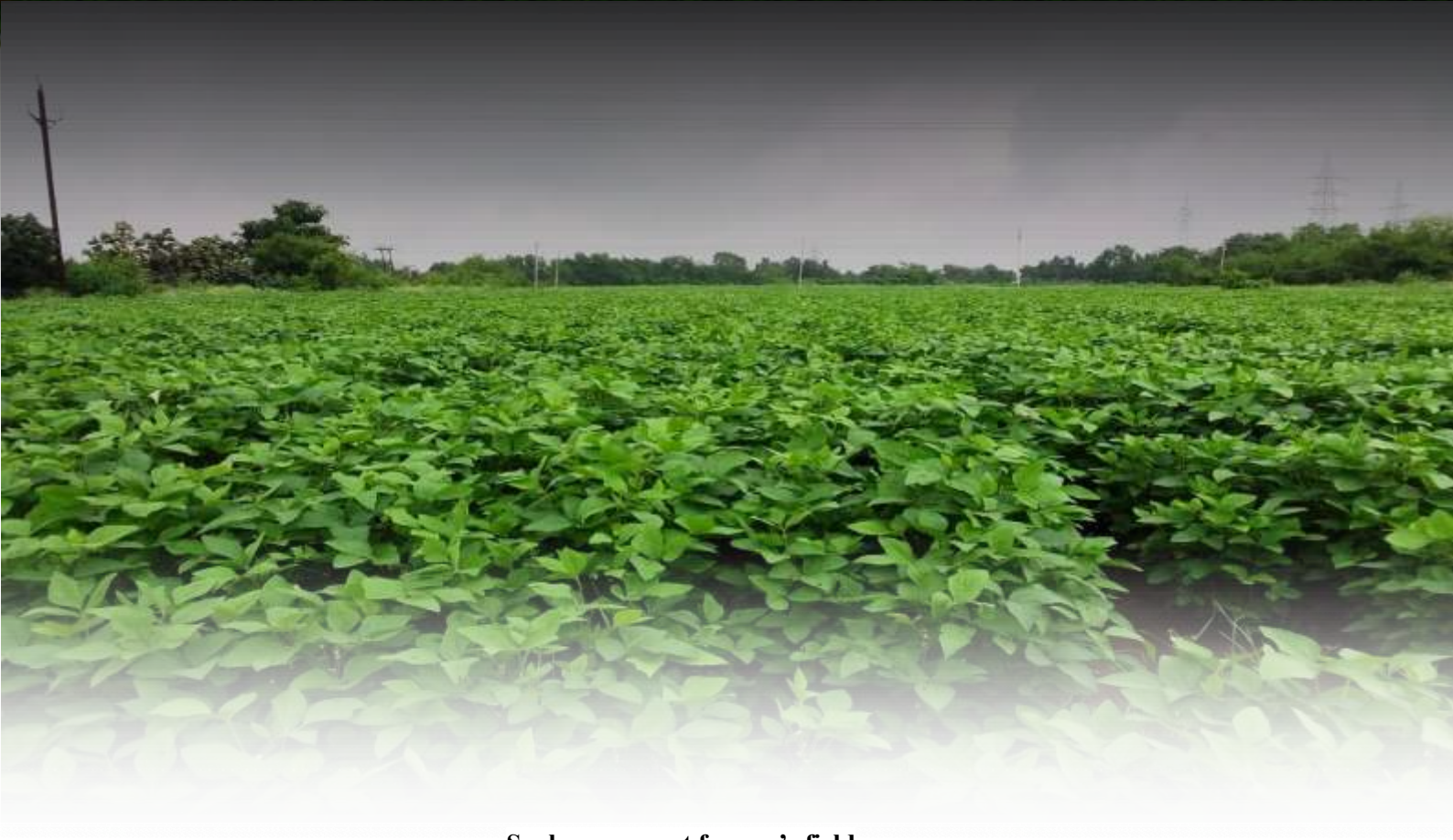
Weather is one of the most vital factors determining success or failure of agricultural production. It influences on every phase of growth and development of plant. Any variability in the weather during the cropping season, such as delayed monsoon, excessive rainfall, flood, drought, too-high or too-low temperatures would affect the crop growth and finally the quality and quantity of the yield. The losses in crop can be reduced by applying proper and timely crop management strategy by precise weather forecasts. Weather forecast also provides guidelines for selection of crops best suited to the anticipated weather conditions. The objective of the weather forecasting is to advice the farmers on the actual and expected weather and its impact on the various day-to-day farming operations i.e. sowing, weeding, time of pesticides spray, irrigation scheduling, fertilizer application etc. and overall crop management. Weather forecast helps to increase agriculture production, minimize losses and risks, reduce costs of production, improve quality of yield, increase efficiency in the use of water, labor and energy and reduce pollution with judicious use of agricultural chemicals. The weather forecasting scheme is operational at National Centre for Medium Range Weather Forecast, New Delhi for issuing location specific weather forecast five days in advance. The farmers will get benefit by using agromet advisory bulletin and weather forecast for making farm level decisions.

The Gramin Krishi Mausam Sewa Project located in the JNKVV - Zonal Agricultural Research Station (ZARS), Powarkheda is serving the farming community Hoshangabad and Narsingpur district of Madhya Pradesh. Progressive farmers have been taking keen interest in the agro-advisories and they are the foremost beneficiaries. The major objective of this project is to advise timely and need-based crop management practices. Weather forecast on rainfall, maximum and minimum temperature, wind speed, wind direction, cloud cover, maximum and minimum relative humidity are being received on every Tuesday and Friday from IMD, Bhopal. Once the forecast is received, the experts' opinion from different disciplines is obtained. Based on the advice, the agro advisories are being prepared on every Tuesday and Friday in Hindi as well as in English. Bulletins are regularly communicated to the farmers on real time basis through mobile SMS and whatsapp group. The weather forecast based agro-advisory bulletin contains weather forecast information for the next five days and crop management, which is based on weather forecast and alerts to the farmers well in advance, regarding rainfall variation, its amount and other weather variables including pest/disease problems. Thus, farmers can decide on crop management options, application of nutrients and strategies to overcome other problems. Weather forecast and weather based agromet advisories help in increasing the income of the farmers by suggesting them the suitable management practices according to the weather conditions. A study was, therefore, undertaken on adaptation of agromet advisory bulletin and economic impact of agromet advisory services for soybean during *Kharif* 2021. For assessing the impacts of agromet advisory services, each 25 users of agromet advisory services (AAS) and non-users of agromet advisory services (non AAS) were selected for soybean crop. The study area lays around 50 km range from ZARS, Powarkheda.

The farmers who followed the agromet advisories are able to reduce the input cost upto 3.61% and increase the net profit by Rs. 10270 (Table 1) as compared to the non AAS farmers, who did not follow the weather based information. More net return was earned by AAS farmers over non-AAS farmers. This can be due to low input cost, following weather based management practices and timely management of pests and diseases. This profit was due to the crop management done according to



Soybean crop at farmer's field

agromet advisory bulletins which suggested as timely land preparation and sowing, adoption of recommended seed rate and suitable varieties, timely weeding, harvesting and irrigation and pesticide applications as per the weather forecast.

The studies showed that the application of AAS, based on current and forecasted weather is a useful tool for enhancing the farm production and income. Due to judicious and timely utilization of inputs, production cost for the AAS farmers reduced. The increased yield level and reduced cost of cultivation led to increased net returns.

Table 1. Economic impact of AAS on soybean during *Kharif* 2021

Type	Land preparation & Sowing (Rs./ha)	Seed (Rs./ha)	Manure (Rs./ha)	Fertilizer (Rs./ha)	Pesticides/ Insecticide/ Herbicide (Rs./ha)	Harvesting & Threshing (Rs./ha)	Yield (q/ha)	Gross Return (Rs/ha)	Net Profit (Rs/ha)	B:C ratio
AAS	4500	2800	3000	4300	4400	5000	18.2	71890	47890	2.00
Non-AAS	3500	3500	3000	3900	6000	5000	15.6	61620	37620	1.51

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Khejri (*Prosopis cineraria* Linn.): A tree of desert

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Prosopis cineraria Linn. is a small to moderate sized tree found in the regions of Arabia and various parts of India such as Telangana, Andhra Pradesh, Rajasthan, Gujarat, Haryana, Uttar Pradesh and Tamil Nadu. The species is widespread in India's arid and semi-arid regions. Khejri is the state tree of Rajasthan, and it is linked to the socio-economic development of the Indian Thar Desert. Because of its food, feed, and medicinal values, this tree is known as "kalptaru," or "king of the desert." The local name khejri is thought to be derived from the name of a village called Khejrali in Rajasthan's Jodhpur district. The Khejri tree is an important tree for the Thar Desert, representing one of the lifelines in desert habitats due to its hard-climatic adaptation. This species embodies all five Fs: forest, fibre, fuel, fodder, and food. This tree also has mythological important in local communities.

GENERAL INFORMATION ABOUT TREE

Prosopis cineraria is an evergreen thorny tree, with slender branches armed with conical thorns and light bluish-green foliage. The leaflets are dark green with a thin cast of light shade. It coppices profusely.

Khejri Tree

Leaves

Pod

It produces new flush leaves before summer. The flowers are small and yellow or creamy white in colour; they appear from March to May after the new flush of leaves. This tree is a legume that improves soil fertility. It is an important component of the vegetation system. It is well adapted to arid conditions and can withstand the adverse effects of climate and browsing. It is drought resistant and tolerates dry and arid conditions so well that it is known as an aridity loving tree. It is the only indigenous tree species, which can withstand the rigorous and exacting conditions of the Rajasthan desert. It is a resistant tree which can withstand temperature extremes, ranging from 45 -48 degrees Celsius in the summer to less than 10 degrees Celsius in the winter. An unlopped 30 -35 years old tree produces about 4 -5 kg of air-dried pods in normal rainfall year during May -June months. Pods are brown to chocolate in colour on ripening and have a sweetish pulp.

TRADITIONAL USE OF KHEJRI

In Rajasthan state region, it has been used as a human diet for centuries. The dry pods of *Prosopis cineraria* are known as "Marwari Mewa," and they help to reduce summer thirst. As a result, farmers use it during lean times. *Prosopis* pods increase milk production in animals. Unripe pods are also used as vegetable and after boiling can be stored for lean periods. Boiled and dried pods are the important constituents of this region's famous dishes "Trikuta" and "Panchkuta".

Dry pod

Panchkuta

ECOLOGICAL SERVICES

Prosopis cineraria used to fix nitrogen, it improves fertility and physical characteristics of the soil. It has deep tap root system and hence it does not generally compete with other associated crops. The improved physical soil condition compared with higher availability of nutrients under the Khejri canopy explain the better growth of the crops associated with it. Due to its extensive root system, it stabilizes shifting sand dunes. It is useful as a windbreak and shelterbelt in afforestation of dry areas. Pods of Khejri are eaten by cattle, sheep, horses, mules, donkeys, goats, camel and other wildlife in desert. Specially, black buck and chinkara in western Rajasthan have survived by eating pods and leaves of this tree.

MEDICINAL USES OF KHEJRI

Leaves: Farmers typically collect leaves and compost to fertilize their agricultural land. The leaves also have fungicidal and insecticidal qualities that can be used to kill fungi and insects that harm plants. Humans utilize leaf extract to kill intestinal parasitic worms. The smoke produced when the leaves are burned can be used to treat eye ailments. Leaves are palatable and healthy feed for livestock.

Bark: The bark of *Prosopis* is a source of tannin, dye and fibres. It is used for preparation of medicines to cure stomach, skin and eye problems, and to cure rheumatism, leprosy, dysentery, bronchitis, asthma, leucoderma and piles. The bark is a prescribed medicine for scorpion sting. Gum of this tree is nutritive and good in taste. It is used by pregnant woman at the time of delivery.

Flower: *Prosopis* flower is pounded, mixed with sugar and used during pregnancy as safeguard against miscarriage.

Pods and Seeds: The pods are used in the treatment of urino-genital diseases. The seeds are reported to have a hypoglycaemic effect. Paste of seeds prevents the growth of arm pit hair follicles permanently. It is also considered as dry fruit of desert and eaten as vegetable and pickle by local people. This plant is recommended for the treatment of snake bite. *Prosopis cineraria* pods possess nutrient values like protein, iron, vitamins A, C and other micro minerals.

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ORGANIC FARMING: APPROACH AND ITS BENEFITS

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Despite extensive and frequent media warnings regarding the prevalence of pesticides and other chemical toxins in food and water, we have yet to begin seeking for and demanding non-toxic food. Many of us are cut off from the food production process, whether on the farm or in the sector where it is carried out. Food made in any form is currently available on the market as an industrial product.

ORGANIC FARMING APPROACHES

1. Traditional Farming Approach

Traditional farming in India stretches back to the Neolithic period, which lasted from 7,500 to 6,500 BC. Farmers in ancient India are known to have developed environmentally-friendly farming practices. Animal husbandry was an essential aspect of farming. Classical Indian plant science, Vrikshayurveda (Science of Plants) and Mrgayuveda (Science of Animals), in the form of Sanskrit hymns, is a rich textual corpus. Collection, selection, and storage of seeds, germination, sowing, various techniques of plant propagation, grafting, nursing, and irrigation, testing and classification of soil, selection of soil suitable to various plants/types of plants, manuring, pest and disease management, preventive and promotive care to cultivate healthy plants are all detailed in Vrikshayurveda. This knowledge system is alive and well.

2. Organic Farming Approach

The Indians' belief system, myths, rituals, and religious festivals incorporate these concepts of soil, plant, and animal health. Sir Albert Howard (1873-1947), a British botanist and pioneer of organic farming, noticed and documented these methods. For his refining of a traditional Indian composting system to what is now known as the Indore method, he was also dubbed the "Father of Modern Composting."

3. Sustainable Farming Approach

The dryland region of India is one of the most bio diverse parts of the country, as it does not grow high-input crops. These locations, while not "organic," can be termed "sustainable farming" due to lower input consumption. However, produce from these locations cannot be sold as organic since the certification organization will object to the use of certain chemicals, even in minor amounts.

4. Biodynamic Farming Approach

This is a holistic system of agriculture that seeks to connect nature with cosmic creative forces. The bio-dynamic farming method has developed since 1922, on a foundation of advice and instruction given by Rudolf Steiner, a German philosopher, known for his world view called Anthroposophy (Wisdom of man). The name "Bio-dynamic' refers to cosmic energies, that create and maintain life. This name was adopted by the first group of farmers inspired by Rudolf Steiner's advice. The term was derived from two Greek words "bios" (life) and dynamics (energy). The use of the word "method' indicates that one is not dealing merely with the production of another fertilizer, which is organic, but rather, involves certain principles. These principles on the practical application can provide healthy soil and healthy plants that in turn produces healthy food for man and animals. This approach has now become a distinct farming strategy of organic farming and the produces are certified as "DEMETER"

5. Natural Farming Approach

Natural farming, also known as do-nothing farming or no-till farming was popularized by Masanobu

Fukuoka, a Japanese agriculturist, in 1940. The most essential aspect of natural farming is to let nature play a dominant role to the maximum extent possible. In India, a number of practitioners have termed their method of farming as 'rishi khatib literally meaning "agriculture of the sages".

6. Permaculture Approach

Permaculture, a term coined by Australian ecologist Bill Mollison in the late 1970s, is gaining popularity. Permaculture is characterized as a farming system that has the potential for long-term rather than short-term yields from the soil. It emphasizes resource conservation, agroforestry, self-sufficiency, and small-scale operations carried out as close to the food consumer as feasible.

BENEFITS OF ORGANIC FARMING

The proponents of organic farming are of the view that toxic chemicals bearing fertilizers, pesticides, and herbicides should not be used anymore in agriculture. Farming as the natural way of farming, biodynamic farming, or organic farming is seen as the viable option in the long run. But experiences through the sustainable approach revealed that chemicals might be necessary to compensate for the yield or economic loss during the transition period from traditional or conventional farming to organic farming. For getting certified as organic, the use of chemicals may be reduced gradually and in the end, stopped altogether. The procedures may be detailed later. However, there are several benefits in organic farming.

In many countries, organic agriculture got promoted as a reaction to the high external input-based techniques ushered in during the green revolution. Consumer demand for better quality food also helped it. In the Indian context, the following benefits are considered important for the future of organic agriculture development.

- The irrigation, new seeds, and fertilizer required high initial investments and, thus, are beyond the reach of the majority of the small farmers in India. The emphasis on organic practices involving use of technique nitrogen-fixing crops and green manures, recycling nutrients through composting, deep rooting plants, avoiding soil loss, and locally developed pest control measures allow poor, risk-averse farmers to produce food and generate income for the families on a sustainable basis.
- The Small and marginal farmers engaged in rainfed farming produce a variety of crops that does not require much of chemical inputs. These farmers qualify themselves as organic producers. However they need to get educated on the scientific aspects of organic production to get their fields classified as pure organic farm.
- In many predominantly agricultural areas in India, land productivity is declining even with higher doses of external inputs. Such farmers on their own began exploring alternatives. Now organic farming is proved to be a viable option for them because of the increasing demands for organic food and official support to organic agriculture.
- The increasing number of middle-class consumers and their willingness to pay a premium for quality food has generated new demand for value-added products. Organically raised and processed food should find ready acceptance in the markets. This has created new opportunity for the agri entrepreneurs and organic food processors.
- Globalization and World Trade Organization regulations are expected to increase competition. On the other hand it may also offer an opportunity to organic producers in India to tap the market. Indian farmers have distinct competitive advantages.

SCOPE OF ORGANIC FARMING

Organic farming helps in rejuvenating the degraded soil and ensures the sustainability of crop production. Consumers and farmers are now aware of the hazards from the use of chemical pesticides. It is a common practice that farmers keep a part of their field (vegetables/rice) without the application of these pesticides. The produce from this field is for own home consumption and other is for selling in the market.

Now the consumers prefer to consume natural/ethnic foods, particularly organic foods across the world. Moreover, they are ready to pay a premium price for such foods. The demand for organic food is increasing day by day.

ECOLOGICAL BENEFITS

- Organic farming is much better for the environment as the energy consumption is much less than in the chemical farming.
- It also uses less manurial inputs and completely avoids the synthetic fertilizers which otherwise pollute the soil, water and air.

- It promotes biodiversity and a great variety of animals and plant inter action on earth.
- Organic farmers focus on preserving the habitats of all species and their surrounding environment, including the air and water.
- Organic farming releases much less carbon dioxide than other farming system

SOCIAL BENEFITS

- Organic farming practices can be adopted in small farms and benefit marginal farmers.
- It could reduce dependency on external inputs and costly technologies thus reducing the competitiveness and disparity among the farmers in a community.
- It will also lead to food security at the family level and national level. Organic farming is the revival of culture and brings back the indigenous knowledge, beliefs, and value system that are almost on extinction now
- It also contributes to employment generation at the community level.

ECONOMIC BENEFITS

- Reduction in the use of external inputs and increase in output of organic produces with greater potential to benefit the health of farmers and consumers
- More Productivity through the incorporation of natural process like natural cycles, nitrogen fixation and pest-predator relationship into the agricultural production process.
- Greater productive use of the biological and genetic potential of plant and animal species.
- Long term sustainability of production levels.
- Profitable and efficient production with emphasis on improved management and conservation of soil, water, energy and biological resources.

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MEDICINAL AND AROMATIC PLANTS (MAP) DISTRIBUTION AND CONSERVATION PRACTICES

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India has a diverse range of medicinal and aromatic plants that cover a large area with varying environmental conditions. More than 8,000 species make up India's herbal treasure, accounting for around half of all higher flowering plant species; over 70% of the country's medicinal plants are found in the Western Ghats' tropical forests. According to some sources, 1,800 species are used in Classical Indian medicinal traditions. Ayurveda employs 1200, Amchi 600, Unani 700, Tibetan 450 and Siddha 900. The growing herbal goods market offers a lot of potential for the Indian economy. Due to their quantitative and qualitative advantages, small-scale farmers can benefit from MAPs cultivation by improving their livelihoods and gaining access to a wider range of assets, as well as the ability to turn these assets into viable and long-term enterprises.

DISTRIBUTION OF MEDICINAL AND AROMATIC PLANTS

India is a wealthy nation. These 880 medicinal plants (10 percent of the total in active trade) are well dispersed among diverse life forms, with the majority belonging to the herbaceous category, according to a habit analysis. Herbs (41 percent), which include grasses, are followed by trees (26 percent), shrubs (17 percent), and climbers (17 percent) (16 percent).

Those 880 traded plants are divided into 151 families for Botanical basis. 79% of these are Dicots, with Monocot's accounting for 11%, Pteridophytes 5%, Gymnosperms 3%, and Fungi and Lichens each accounting for 1%. This shows that only a small percentage of raw pharmaceuticals belong to the plant kingdom's lower classes. 427 Indian medicinal plants are recognized as endangered species in the Red Data Book, with 28 being extinct, 124 endangered, 81 rare, and 34 unknown.

Medicinal and aromatic plants can be found in a variety of bio-geographical zones, habitats, and landscape features. Around 18% of these species are only found in the Himalayan and Trans Himalayan zones, which includes North East India, 4% in the Western Ghats, and 0.5 percent in the Desert zone. The remaining species (about 77%) are found across the country's numerous bio-geographic zones and have a wide range of distribution.

IMPORTANT CONSERVATION PRACTICES ADOPTED IN INDIA

The major reasons why medicinal plants, their study, appraisal, application, and conservation have become key aspects of developing market programmes are due to uncontrolled over-exploitation of wild plants, as well as habitat loss and alteration. Conservation is defined as "the management of human use of biodiversity to allow greater sustainable benefit to present generation while protecting its capabilities to fulfill the needs and wants of future generations" according to the conservation plan. There are mainly three scientific strategies to preserve the genetic diversity of medicinal and aromatic plants.

a. Legislation
b. *In-situ* conservation
c. *Ex-situ* conservation

LEGISLATION

There are no specific policies or regulations in India to protect the medicinal plants that grow in the forests. Existing forestry legislation concern environmental protection. The regulations developed by the Indian government for forest conservation, which directly or indirectly protect the wild herbal flora, are listed below:

a. Forest Act, 1927
b. Wildlife (Protection) Act 1972
c. Wildlife (Protection) Amendment Act 1991
d. Forest (Conservation) Act, 1980
e. Environment Protection Act, 1986
f. National biodiversity act, 2002
g. National forest policy, 1988

IN-SITU CONSERVATION

The preservation of a species in its natural habitat, or the site where it grows naturally, is known as in-situ conservation. Developed in conjunction with state forest agencies, a number of MPCAs were established across India's biogeographic zones. The list includes biosphere reserves, national parks, sacred sites, and Sacred Grooves. Plant diversity at the genetic, species, and eco-system levels can only be conserved in nature over time. In various and representative biogeographic zones, inter and intraspecific genetic variety should be preserved. Other

comparable in-situ conservation approaches include:

- It is a concept based on a zero-energy contribution of conservation of the frost in the Himalayan region which remains snowy.
- On-farm conservation.
- Home gardens.

INSIGHTS INTO *IN-SITU* MANAGEMENT

- Identifying those protected areas which are most important for medicinal plants.
- Develop a national policy on medicinal plant conservation and utilization in protected areas.
- Implement techniques for inventorying and monitoring medicinal and aromatic plants in protected areas.
- Promptly ensure that the conservation and use of medicinal plants are integrated into site management plans.
- Species that have been severely depleted due to overexploitation should be reintroduced to places where they once thrived.
- Create financial and societal incentives for the preservation of natural areas and wild species.

EX-SITU CONSERVATION

Ex situ conservation (conservation outside of natural environment) refers to the "off site conservation" of wild genetic resources in their native habitat as well as the long-term preservation of plant propagules in gene banks. (Seed banks, pollen banks, DNA libraries, etc.) and plant tissue culture repositories, as well as cryopreservation (in liquid nitrogen at -165°C to -196°C). It entails gathering, preserving, and maintaining natural genetic resources. Ex-situ conservation is a supplementary strategy for preserving genetic variety, lowering pressure on natural areas and increasing raw material availability. It can be used as field gene banks and can also assist in involving a larger number of people in the production and regeneration of therapeutic plants.

CONCLUSION

India offers a wide variety of medicinal and aromatic plants that grow in a wide range of climates. These plants are employed as antioxidants in pharmaceuticals, cosmetics, cookery, and, most recently, food technology. India's medicinal plant culture is one of the world's richest, oldest, and most diverse. The storage and long-term use of therapeutic plants have been studied extensively. Several sets of conservation recommendations have been compiled, including the necessity for integrated conservation approaches based on both in situ and ex situ tactics, as well as the construction of mechanisms for species inventorying and monitoring. For medicinal plants with dwindling supplies, judicious use of wild resources can be an appropriate conservation strategy. Medicinal & Aromatic Plants Genetic Resources, as a reservoir of unknown potentialities, should be explored and protected for the benefit of current and future generations, as they are critical to supporting human wellbeing while also contributing to the increase of rural populations' income.

Table 1. Bio-geographical distribution of traded medicinal plants

Bio-geographic Zones	No of Medicinal Plants Identified	Example Species
Trans – Himalayan	700	*Ephedra gerardiana, Hippophae rhamnoides, Physochlania praalta, Arnebia euchroma, Ferula jaeschkeana*
Himalayan	2900	*Aconitum heterophyllum, Arnebia benthamii, Dactylorhiza hatagirea, Podophyllum hexandrum, Picrohiza kurroa, Pistacia chinensis, Nardostachys grandiflora, Rubia sikkimensis, Coptis teeta*
Desert areas	500	*Tecomella undulata, Tribulus rajasthanensis, Citrullus colocynthis, Commiphora wightii, Acacia nilotica*
Semi-arid areas	1000	*Balanites aegyptiaca, Withania coagulens, Tribulus alatus, Commiphora wightii, Boswellia serrata, Canscora, Acacia nilotica.*
Western ghats	2000	*Myristica malabarcia, Garcinia indica, Coscinium fenestratum, Hydnocarpus pentatandra, Garcinia gummigutta, Vateria indica, Nilgirianthus ciliatus.*
North East India	2000	*Aquilaria malacensis, Smilax glabra, Ambroma augusta, Hydnocarpus kurzii, Vetivaria zizaniodes.*
Deccan peninsula	3000	*Embelia tsjeriam-cottam, Caesalpinia digyna, Screbera sweitenoides, Decalepis hamiltonii, Pterocarpus santalinus.*
Gangetic plains	1000	*Holarrhenaq pubescen, Mallotus philippensis, Pluchea lanceolata, Peganum harmala.*
Andaman & Nicobar Islands	1000	*Claophyllum inophyllum, Adnanthera pavonina, Barringtonia asiatica, Aisandra butyrace.*
Coastal islands	500	*Rhizophora mucronata Lam., Acanthus ilicifolius, Avicennia marina, Sonneratia caseolaris.*

Source-Lakshman, 2016

SILK INDUSTRY OF ASSAM AND ONGOING GOVERNMENT SCHEMES FOR ITS DEVELOPMENT

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Silk Industry of Assam is an age old agro based industry. It has been practiced from the days of free India. Assam occupies a unique place in the sericulture map of the country by producing all the varieties of silkworm *i.e* eri, muga, mulberry and tasar. Muga and eri silkworm is endemic to Assam. It is the only region after Myanmar where a rearing community exist. Sericulture industry constitutes a vital aspect and holds a significant position in the economy of Assam. Rearing of eri, muga and mulberry silkworm are playing an important role in the economic development of a large section of rural population of the state. Mulberry is at nascent stage and tasar is not commercially exploited in the state so far.

Assam has the monopoly of producing the 'Muga Silk', the natural golden color silk which contributes 82.29 per cent of the total muga silk production in the country (Anonymous, 2020). Assam holds the Geographical Indication for muga silk. The state also contributes almost 70.09 per cent of the total production of eri silk 'Ahimsa Silk' (Anonymous, 2020). Craze of Muga and eri silk products in national and international markets are gradually increasing due its eco-friendly behaviors, wide range of utility, unorthodox look etc.

In the backdrop of growing unemployment in the state, development strategies has been focusing the silk industry for its higher means of income and employment generation with low capital investment and short gestation period. Its impact in conserving the biodiversity and environment with sustained economic activities are remarkable. Rural employment generation which has become the major focus of the inclusive development in all the developing economies in the era of post-globalization has received enormous scope of expansion under the sericulture industry in Assam.

ONGOING GOVERNMENT SCHEMES

1. ASSAM SILK OUTREACH MISSION (MUGA MISSION)

It is a project undertaken by the Government of Assam through Sericulture department in the year 2017-18 for augmentation of muga silk production by 10 times in 10 years. It is funded under the State-Owned Priority Development (SOPD-ODS) scheme through a society called the ASOM Society. The project has basically the following components:

- Setting up of nursery and extension of some plantation both in Government and Private sector
- Strengthening of Government Sericulture Farms/ Centres/ VGRs.
- Support to Private Muga Rearers
- Development of Muga Silk Market
- Engagement of Manpower both Skilled and Unskilled
- Administrative Cost/Management Information System/ Project Monitoring/ Census/ Detailed Project Report.

2. SILK SAMAGRA

It is a central sector integrated scheme of Central Silk Board for the overall development of silk industry under implementation for three years from 2017-18 to 2019-20 in the country, implemented directly as well as through state governments. Central Silk Board has been supporting states towards implementation of various beneficiary-oriented components under vanya, mulberry and post cocoon sectors. The scheme catalyzes the efforts of state governments to improve the quality, productivity and production of raw silk besides, generating employment opportunities particularly to the destitute. The scheme has four basic components:

- Research & Development, Training, Transfer of Technology and I.T. initiatives

- Seed Organization
- Coordination and Market Development
- Quality Certification Systems, Export, Brand Promotion & Technology Upgradation

3. NORTH EAST REGION TEXTILE PROMOTION SCHEME (NERTPS):

It is an umbrella scheme of Central Government for Sericulture development in Assam under Integrated Sericulture Development Project (ISDP) and Intensive Bi-voltine Sericulture Developm-ent Program (IBSDP). The main objective of the NERTPS under Sericulture is to develop and modernize the sericulture sector in the state by providing the required Government support in terms of raw material, seed banks, machinery, common facility centers, design and marketing support, etc. Under North-Eastern Region Textile Promotion Scheme (NERTPS), three Muga P3 Basic Seed Stations and one SSPC have also been established.

Under sericulture sector of NERTPS (ISDP and IBSDP), there are 24 projects, covering mulberry, Eri and Muga silks are being implemented in all North Eastern states, with a total cost of Rs.822.94 crore of which Government of India share is Rs.693.76 crore. The objective of these projects is to establish sericulture as viable commercial activity, by creating necessary infrastructure and imparting skills to the locals for silkworm rearing and allied activities in the value chain. The projects are proposed to bring around 31,010 acres of plantation under mulberry, Eri and Muga sectors and expected to contribute additional production of 2,285 MT of raw silk during the project period and generate employment for 2,30,500 persons.

4. ASSAM AGRIBUSINESS AND RURAL TRANSFORM-ATION PROJECT (APART)

International Bank for Reconstruction and Development (IBRD) issued a loan of US$ 200 million to Republic of India in 2017 for financing 7 year duration project. An amount of US$ 132.80 million was dedicated for “Fostering Market-led Production and Resilience Enhancement” under which sericulture is considered as one of the beneficiary value chain.

Its main focus is to support the sericulture value chain to strengthen the sericulture industry in Assam. The planned interventions will be implemented by the ATMAs, and Department of Handloom and Textiles (including Sericulture directorate) in collaboration with Central Silk Board, Central Muga and Eri Research and Training Institute, Assam Agricultural University, North East Institute of Science and Technology, National Institute of Design, National Institute of Fashion Technology, Indian Institute of Technology, and other research, academic and private institutions.

The major interventions planned are:

- Organizing producers into producer groups
- Matching grants (CIG Grants) to these producer groups for community infrastructure such as community jali houses, nurseries, cocoon bank, rearing houses, cocoon drying chambers, grainage houses, and weaver workspace for collective actions
- Technical assistance for improved skill and design development
- Facilitating technology upgrad-ation and access to finance for the value chain stakeholders
- Upgrading existing marketing outlets, developing market channels, and launching branding campaigns.

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HYDROPONICS AND IT'S GROWING TECHNIQUES

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Hydroponics is a science of growing plants without use of soil but by use of an inert medium such a gravel sand, peat, coco coir, sawdust etc. which is added as a nutrient solution containing all the essential elements needed by a plant for its normal growth and development.

The term hydroponics was derived from tow Greek words- Hydro-water and Ponos- labour. **Dr. William F. Gericke** is known as father of hydroponics. In India hydroponics was first introduced at Kalimpong, Darjeeling. Tomato is the first crop raised in hydroponics. Israel is having maximum area under hydroponics in the world.

TECHNIQUES OF HYDROPONICS

There are two main variations for each medium: sub-irrigation and top irrigation. For all techniques, most hydroponic reservoirs are now built of plastic, but other materials have been used, including concrete, glass, metal, vegetable solids, and wood. The containers should exclude light to prevent algae and fungal growth in the nutrient solution.

1. Static solution culture

In static solution culture, plants are grown in containers of nutrient solution, such as glass Mason jars (typically, in-home applications), pots, buckets, tubs, or tanks. The solution is usually gently aerated but may be un-aerated. If un-aerated, the solution level is kept low enough that enough roots are above the solution so they get adequate oxygen. A hole is cut (or drilled) in the top of the reservoir for each plant; if it a jar or tub, it may be its lid, but otherwise, cardboard, foil, paper, wood or metal may be put on top. A single reservoir can be dedicated to a single plant, or to various plants. Reservoir size can be increased as plant size increases. A home-made system can be constructed from food containers or glass canning jars with aeration provided by an aquarium pump, aquarium airline tubing and aquarium valves. Whenever the solution is depleted below a certain level, either water or fresh nutrient solution is added. A Mariotte's bottle, or a float valve, can be used to automatically maintain the solution level. In raft solution culture, plants are placed in a sheet of buoyant plastic that is floated on the surface of the nutrient solution. That way, the solution level never drops below the roots.

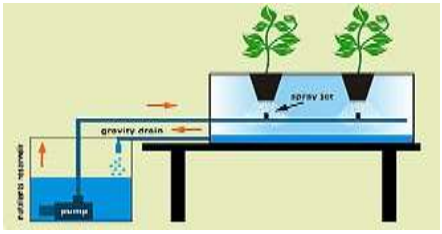
2. Continuous-flow solution culture

In continuous-flow solution culture, the nutrient solution constantly flows past the roots. It is much easier to automate than the static solution culture because sampling and adjustments to the temperature, pH, and nutrient concentrations can be made in a large storage tank that has potential to serve thousands of plants. A popular variation is the nutrient film technique or NFT, whereby a very shallow stream of water containing all the dissolved nutrients required for plant growth is recirculated in a thin layer past a bare root mat of plants in a watertight channel, with an upper surface exposed to air. As a consequence, an abundant supply of oxygen is provided to the roots of the plants. A properly designed NFT system is based on using the right channel slope, the right flow rate, and the right channel length. The main advantage of the NFT system over other forms of hydroponics is that the plant roots are exposed to adequate supplies of water, oxygen, and nutrients. NFT, because of its design, provides a system where all three requirements for healthy plant growth can be met at the same time, provided that the simple concept of NFT is always remembered and practiced. The result of these advantages is that higher yields of high-quality produce are obtained over an extended period of cropping.

3. Aeroponics

Aeroponics is a system wherein roots are continuously or discontinuously kept in an environment saturated with fine drops (a mist or aerosol) of nutrient solution. The method requires no substrate and entails growing plants with their roots suspended in a deep air or growth chamber with the roots periodically wetted with a fine mist of atomized nutrients. Excellent aeration is the main advantage of aeroponics.

Aeroponic techniques have proven to be commercially successful



for propagation, seed germination, seed potato production, tomato production, leaf crops, and micro-greens. Since inventor Richard Stoner commercialized aeroponic technology in 1983, aeroponics has been implemented as an alternative to water intensive hydroponic systems worldwide.

The advantage of aeroponics is that suspended aeroponic plants receive 100% of the available oxygen and carbon dioxide to the roots zone, stems, and leaves, thus accelerating biomass growth and reducing rooting times. NASA research has shown that aeroponically grown plants have an 80% increase in dry weight biomass (essential minerals) compared to hydroponically grown plants. Aeroponics used 65% less water than hydroponics. NASA also concluded that aeroponically grown plants require ¼ the nutrient input compared to hydroponics.

4. Fogponics

Fogponics is a derivation of aeroponics wherein the nutrient solution is aerosolized by a diaphragm vibrating at ultrasonic frequencies. Solution droplets produced by this method tend to be 5–10 µm in diameter, smaller than those produced by forcing a nutrient solution through pressurized nozzles, as in aeroponics. The smaller size of the droplets allows them to diffuse through the air more easily, and deliver nutrients to the roots without limiting their access to oxygen.

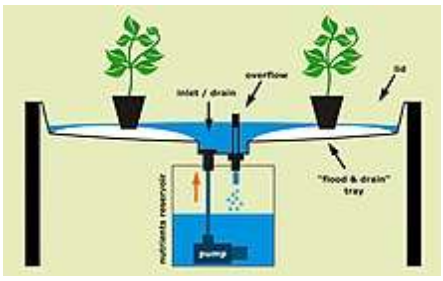
5. Passive sub-irrigation

Passive sub-irrigation, also known as passive hydroponics, semi-

hydroponics, or *hydroculture*, is a method wherein plants are grown in an inert porous medium that transports water and fertilizer to the roots by capillary action from a separate reservoir as necessary, reducing labor and providing a constant supply of water to the roots. In the simplest method, the pot sits in a shallow solution of fertilizer and water or on a capillary mat saturated with nutrient solution. The various hydroponic media available, such as expanded clay and coconut husk, contain more air space than more traditional potting mixes, delivering increased oxygen to the roots, which is important in epiphytic plants such as orchids and bromeliads, whose roots are exposed to the air in nature.

Hydroculture compared to traditional farming in terms of crops yield per area in a controlled environment was roughly 10 times more efficient than traditional farming, uses 13 times less water in one crop cycle than traditional farming, but on average uses 100 times more kilojoules per kilogram of energy than traditional farming.

6. Ebb and flow (flood and drain) sub-irrigation



There is a tray above a reservoir of nutrient solution. Either the tray is filled with growing medium (clay granules being the most common) and then plant directly or place the pot over medium, stand in the tray. At regular intervals, a simple timer causes a pump to fill the upper tray with nutrient solution, after which the solution drains back down into the reservoir. This keeps the medium regularly flushed with nutrients and air. Once the upper tray fills past the drain stop, it begins recirculating the water until the timer turns the pump off, and the water in the upper tray drains back into the reservoirs.

7. Rotary

A rotary hydroponic garden is a style of commercial hydroponics created within a circular frame which rotates continuously during the entire growth cycle of whatever plant is being grown.

While system specifics vary, systems typically rotate once per hour, giving a plant 24 full turns within the circle each 24-hour period. Within the center of each rotary hydroponic garden can be a high intensity grow light, designed to simulate sunlight, often with the assistance of a mechanized timer.

Each day, as the plants rotate, they are periodically watered with a hydroponic growth solution to provide all nutrients necessary for robust growth. Due to the plants continuous fight against gravity, plants typically mature much more quickly than when grown in soil or other traditional hydroponic growing systems.

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CHALLENGES IN COCOA POLLINATION

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Cocoa pods

Chocolate

As exception, non-apis insect pollinators play significant role in cocoa pollination. Cocoa (*Theobroma cacao* L.) in the family Malvaceae is one of the 13 most important commercial crops in the world, fully depends on insects for pollination and successful production. The pollination in cocoa is exclusively accomplished by ceratopogonid midges, *Forcipomyia squamipennis* (Ceratopogonidae: Diptera). The Ivory Coast (South coast of West Africa) is the leading cocoa producing country in the world. It is cultivated in an area of about 78,000 ha in India with the total production of about 16,050 MT. It is grown as an under-storey intercrop with sufficient shade in southern states of India. The Tamil Nadu ranks first with an area (26,969 ha) whereas Andhra Pradesh ranks first in terms of production (8,000 MT) and Kerala ranks first in productivity (785 kg/ ha).

There are three cocoa varietal types namely Criollo, Forastero and Trinitario. The Forastero types are known to perform well under Indian conditions. It can be propagated through seeds, patch budding and softwood grafting.

The demand for cocoa continues to increase, particularly as a result of newly emerging chocolate markets in India and China. Here, the budding relationship of ceratopogonid midge and chocolate flower is discussed.

Biology and Phenology of cocoa flowers

Cocoa flowers have hermaphrodite and cauliflory nature. After 2-3 years of planting, flower cushions *i.e.*, thickened flower producing leaf axils are formed. Every cushion bears up to 50 flowers per flowering season. There are two flowering seasons per year, which yield 100 flowers per year. The pentamerous flower is about 15 mm in diameter. A petal consists of a pouch which conceals the anthers and a wide tip. The function of the tip is unknown, but it does not specifically attract pollinators. A particular aspect of cocoa flowers is the outer whorl of purple staminodes around the style. Right after anthesis, these staminodes align parallel to the style. Pollinators move around on the inner side of the staminodes, thereby rubbing their pollen grain-carrying bodies against the style. On older flowers, staminodes are somewhat withered and flexed away from the style, which obstructs pollen deposition on the style. The ovary consists of 40-70 ovules with axile placentation. At least 20 ovules need to be successfully fertilized for a pod to develop and mature. Maximum pollination is achieved when pollination intensity, *i.e.*, the number of pollen grains deposited on the style, exceeds 115. Usually, a mature pod contains 30-40 beans. Floral morphological characteristics can differ greatly among varieties. However, even the most noticeable differences (white *vs.* red sepals) have no effect on pollination.

Self-incompatibility

Cocoa trees are self-incompatible means self-pollination will not result in fertilization hence cross-pollination is the only way for successful fertilization. Self-incompatible trees are mostly cross-compatible *i.e.*, they are able to successfully fertilize flowers on other trees, including trees of the same variety. Incompatibility takes place at the stage of gamete fusion *i.e.*, incompatible gametes are unable to fuse. The underlying mechanism is of a genetic nature. Following unsuccessful fertilization due to incompatibility, the flower drops off after 2–3 days. Even within a single variety, not all trees are necessarily either self-incompatible or self-compatible. However, the proportion of self-incompatible trees of a certain variety is determined by the specific

Cocoa flowers

Artificial pollination of cocoa flowers

Cover protecting pollinated flowers

variety. Self-compatible varieties that are cross-incompatible can restrict bean yield. In commercial plantations, it is therefore recommended to always plant different varieties. Self-compatible hybrids produce larger fruits with a higher dry bean yield.

Cocoa pollinator, *Forcipomyia* sp. - A Chaos of delight

Forcipomyia sp. (ceratopogonids) are biting midges of 1–4 mm size. The females visit cocoa flowers more frequently than males to feed protein-rich pollen grains, necessary for egg maturation. Besides ceratopogonids, other small dipterans like Cecidomyiidae (gall midges), Chironomidae (non-biting midges), Drosophilidae (fruit flies), Psychodidae (moth flies) and Sphaeroceridae (small dung flies) have been documented. Up to date, pollen grains have not been detected by microscopic observation on insects other than *Forcipomyia* sp. Only *Forcipomyia* sp. are morphologically able to pollinate cocoa.

They breed in humid, decaying organic material such as cocoa leaf litter, decomposing cocoa pod husks and banana pseudostems. Besides being moist, these breeding substrates are cooler than the ambient environment and provide dark conditions which all benefit ceratopogonid breeding.

***Forcipomyia* sp.**

The *Forcipomyia* eggs hatch 3 days after deposition. Twelve days later, larvae transform into pupae. Pupation lasts 3 days and the adults live for 1–12 days. A complete life cycle thus covers about 28 days. Female ceratopogonids, in need for sugary nectar, start pollinating cocoa flowers early in the morning (5-8 am) and also actively visit flowers in the afternoon (4-6 pm). Ceratopogonids carry pollen grains on their thoracic hairs and their flight can cover long distances up to 50 m. However, midges mostly deposit pollen from a certain cocoa tree on flower stigmas of neighboring cocoa trees. There are 5-7 times more *Forcipomyia* midges in the upper crop canopy than lower canopy. Since wind speed above the canopy is higher than below, it can be expected that wind could play an important role in horizontal pollinator distribution over the field. Besides feeding on flower nectar, adult ceratopogonids also suck the blood of other insects and mammals. Ceratopogonids can be abundant and exceed one million individuals/ ha during rainy period and decreases again with the onset of a dry period.

Conclusion

1. As exception from other crops, pollination of cocoa trees should be keenly observed to obtain increased yield. The present yield gap in cocoa is linked with inadequate pollination. It was found that during the dry season, the number of ceratopogonid pollinators were lower than in the wet season. The rotten, moist organic materials like banana pseudostems, cocoa pod husks and leaf litters could be used as an ideal breeding substrate for ceratopogonid midges to increase their reproduction.
2. Dry bean yield can also be increased through hand pollination or indirectly by improving breeding opportunities, had a significant impact compared with normal agricultural practices.
3. The breeding places should be protected from pesticide applications. The narrow spectrum insecticides might be recommended for spraying.
4. *Forcipomyia* sp. can be mass reared and released at peak flowering times for efficient production.
5. Promotion of self-compatible trees.
6. Recommended to plant different varieties in single plantation.

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BIOSENSORS IN PLANT DISEASE DIAGNOSIS

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A biosensor is an analytical device, used for the detection of an analyte, that combines a biological component with a physicochemical detector. It is an analytical device which converts a biological response into an electrical signal. It detects, records, and transmits information regarding a physiological change or process. It determines the presence and concentration of a specific substance in any test solution. A sensor that integrates a biological element with a physiochemical transducer to produce an electronic signal proportional to a single analyte which is then conveyed to a detector. Any device that has specific biochemical reactions to detect chemical compounds in biological samples.

PRINCIPLE OF BIOSENSOR

1. Immobilization of biological material

The biological components is immobilized on the transducer surface.

Gluter aldehyde Enzymes for immobilization.

2. Surface treatment to transducer

Surface may be treated with 3-aminopropy l –tri ethoxysilane.

3. Interaction of analyte with biological material.

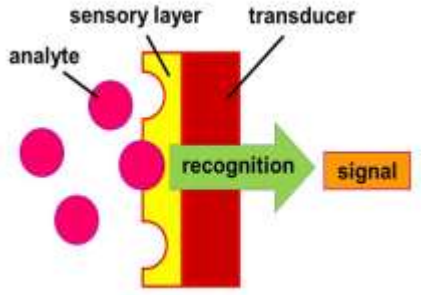
Produces a physical change close to the transducer surface. Change in the mass of biological components as a result of the reaction.

4. Conversion of biological signal

The transducer detects the signal and convert into the electrical signals.

5. Amplification of signal

The signal is then processed and interpreted and is displayed into the suitable units.

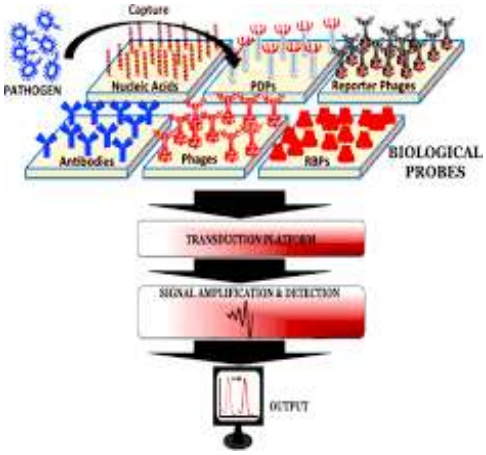


BIOSENSORS IN AGRICULTURE

A biosensor has been developed for the detection of the fungus *Phakopsora pachyrhizi* that causes Asian rust or Soybean rust. Biosensor for the detection of aflatoxin in olive oil has been developed. Aflatoxins produced by molds *Aspergillus flavus* and *Aspergillus parasiticus* are carcinogenic to humans. Concentrations of herbicides, pesticides and heavy metals in agricultural lands is increasing. Biosensors can be used to measure the levels of pesticides, herbicide and heavy metals in the soil and ground water. Biosensors can also be used to forecast the possible occurrence of soil disease.

APPLICATION IN PLANT DISEASE DIAGNOSIS

A wide variety of sensors have been developed and commercialized for various applications. Depending on the operating principle of the sensor, the analytes could be detected using a sensor based on electrical, chemical, electrochemical, optical, magnetic or vibrational signals. The limit of detection could be enhanced by the use of nanomaterial matrices as transducers and the specificity could be enhanced by the use of biorecognition elements such as DNA, antibody, enzymes, etc.



BIOSENSOR PLATFORMS BASED ON NANOMATERIALS

Nanoparticles display electronic and optical properties and can be synthesized using different types of materials for electronics and sensing applications. The high surface area, high electronic conductivity and plasmonic. Properties of nano materials that enhance the limit of detection. The immobilization of the biorecognition element, such as DNA, antibody and enzyme, can be achieved using various approaches including biomolecule adsorption, covalent attachment, and encapsulation. The nanomaterials used for biosensor construction include metal and metal oxide nanoparticles, quantum dots, carbon nanomaterials such as carbon nanotubes and graphene as well as polymeric nanomaterials.

ADVANTAGES OF BIOSENSOR

Biosensors are sophisticated tools for detection and monitoring.

Biosensors are more specific and provide more accurate readings. It is very easy to use. They can measure non-polar molecules that do not respond to most measurement devices. No need of continuous monitoring.

DISADVANTAGES OF BIOSENSOR

Heat sterilization is not possible as this would denature the biological part of the biosensor. Cost is high. Reproducibility- it is not possible the same type of biosensor gives the same result. Its sensitivity sometimes may be a problem. Reusability- Some type of biosensor such as colorimetric test strips has single use. Obstacle is the tendency to focus only on the scientific basis of the technology.

CONCLUSION

Because of the useful features of biosensors, their utilization in the bio-monitoring of biological hazards, commonly recorded in agriculture and food sectors has been necessitated. The constant application of pesticides in controlling pathogens has led not only to pathogen resistance but also, bioaccumulation and bio-magnification of the chemicals with subsequent health hazards and environmental pollution. Therefore, the demand for biosensors in the market has increased tremendously.

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RNA INTERFERENCE A NEW TOOL FOR INSECT PEST MANAGEMENT

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Meeting the food requirement of billions of people is a Herculean undertaking for Indian agriculture today, especially given that the population is expected to grow at an exponential rate in the next years. This necessitates bringing additional area under cultivation as well as enhancing agricultural output. India's population is expected to reach 2,000,000,000 by 2040, and we'll need to increase output from the current level of 800 million t of key crops. Insect pests limit agricultural yield to a greater extent than other biotic factors. However, pesticides cause plenty of issues, and their cost is out of reach for most farmers as a result, there is a pressing need to find an efficient, environmentally friendly pest control solution, and RNA interference (RNAi), also known as Gene Silencing, is set to play a key role. It is now feasible to manage insect pests using this RNAi technique by silencing some of the key genes that play a role.

GENERAL MECHANISM OF RNAi

RNAi is an innate immune response that works by destroying certain mRNA molecules to suppress gene expression. The RNAi pathway in the cell is initiated by an RNase III enzyme called Dicer, which processes dsRNAs into short (21–25 nucleotide) small interfering RNAs (siRNAs). These siRNAs are integrated into the RNA induced silencing complex, a protein complex (RISC). Once formed, the RISC is guided to a specific mRNA that is complementary to one of the strands of the siRNA causing its degradation. The RISC's main component, argonaut protein, mediates target identification and cleavage. According to Whangbo and Hunter (2008), there are three forms of RNAi responses: cell autonomous, environmental, and systemic, with the latter two being referred to as non-cell autonomous RNAi. In cell autonomous RNAi the silencing effect is included inside the cells where dsRNA is constitutively produced or exogenously injected in cell. Whereas in environmental RNAi silencing signal is immediately taken up by cells from the nearby environment, such as gut or hemocoel. If the silencing signal spreads to neighbouring cells from an epicenter of cells, then systemic RNAi is triggered. With regard to the effort to apply RNAi to pest management, the focus has been on non-cell autonomous RNAi. This mechanism is also known as posttranscriptional gene silencing (PTGS) in plants.

RNAi IN INSECT PEST MANAGEMENT

- A scientific confirmation that the introduction of dsRNA into the cell elicited RNAi process in the free-living worm *C. elegans* created a new fascinating field of RNAi in numerous domains of study, including entomology, in the year 1998.
- The choice of gene for RNAi-mediated silencing can be varied, but it usually falls into one of two categories: silencing of genes that result in immediate control, such as genes involved in insect–plant interactions, digestion, moulting, and so on, and silencing of genes that result in long-term management, such as genes involved in pheromone biosynthesis, pheromone reception, migration, flight, diapause, and so on.
- Mao *et al.* (2007) demonstrated that transgenic cotton-mediated silencing of cytochrome P 450 may be used to manage the cotton boll worm, *Helicovera armigera* Hub., without the use of chemicals.
- Baum *et al.* (2007) proved that RNAi's approach is feasible in the management of the coleopteran pest the corn root worm (*Diabrotica virgifera virgifera* LeConte).

PLANT MEDIATED- RNAi AGAINST INSECT PEST

- The tremendous success of RNAi facilitated plant biotechnologists to utilize the various physiologically important genes from insects as ingestible insecticides through plant mediated expression of cognate dsRNA. The era of plant

mediated RNAi (PM-RNAi) is a new line of defence against insects and nematodes.

- By suppressing the Rack1 (Receptor of Activated Kinase C) and C002 genes, the PMRNAi has been successfully used to inhibit the green peach aphid *Myzus persicae* Sulzer, which transmits over 100 types of plant viruses.
- Similarly, Mao *et al.* (2007) successfully silenced the allelochemical, gossypol detoxifying gene of *H. armigera* using an artificial diet containing dsRNA for CYP450 monooxygenases gene and developing dsRNA expressing transgenic plants, resulting in a two-fold weight loss in treated larvae when compared to control larvae.

IMPARTING PLANT RESISTANCE TO VIRUSES

The enzyme RNA dependent RNA polymerase sequence-specific degradation of the targeted viral mRNA causes resistance to RNA viruses. According to research, siRNA or dsRNA molecules that are complementary to the viral coat protein genes can cause RNAi. Crops such as tobacco, squash, and papaya have all proven this.

Table 1. Summary of studies to reveal roles of the genes in insecticide detoxification and resistance by RNAi

Target gene	Insect	dsRNA delivery method	Suppression of transcript (%)	Insecticide treatment	Remarks	Reference
CYP321E1	*Plutella xylostella*	Injection	13–54	Chlorantraniliprole	Increased susceptibility	----
CarEA1 & A2	*Locusta migratoria*	Injection	86–97	Chlorpyrifos	Increased susceptibility	Guo *et al.*, (2012)
CYP409A1 & CYP408B1	*Locusta migratoria*	Injection	99	Deltamethrin	Increased susceptibility	Zhanag *et al.*, (2013)

CONCLUSION

Current studies indicate that RNAi is a valuable tool to address various fundamental questions in insect toxicology and has great potentials for insect pest management. Despite these recent advances, many practical, financial, technical, regulatory, and safety concerns still exist for the use of RNAi in pest management strategies.

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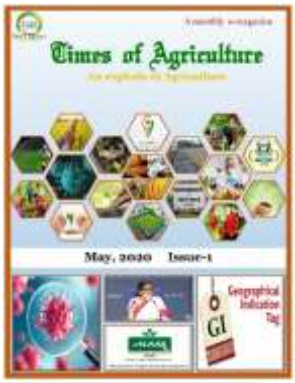

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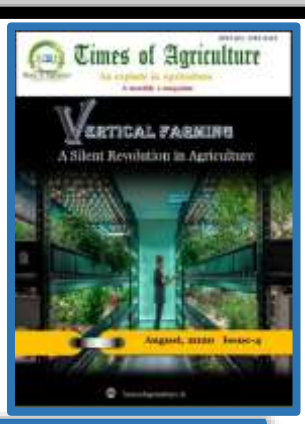
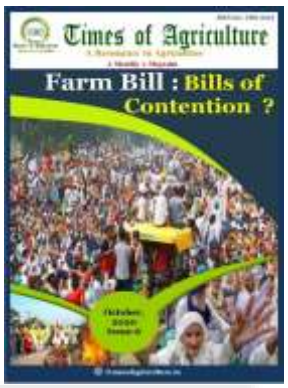


4-August

5-September



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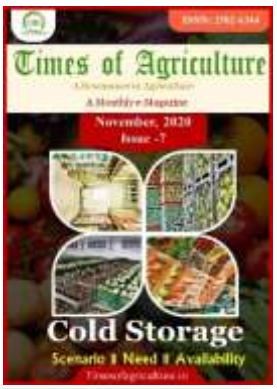

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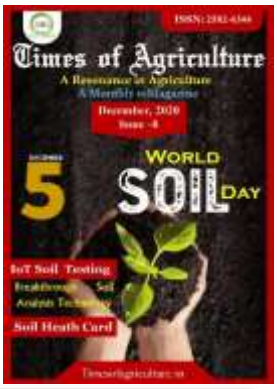

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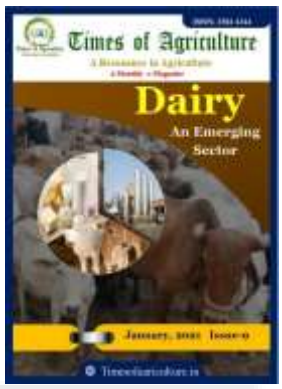

9-January

10-February

11-March

12-April