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## ***From the Editor-in-chief's Desk***

*I am happy and proud to announce the release of the fifth issue of AgriTech Today Magazine. In this issue, we were excited to include the cover story on Role of ChatGPT in Agricultural Engineering.*

*ChatGPT can find several applications in agriculture and allied sciences. It can assist farmers in crop management by providing real-time information on weather conditions, pest and disease identification, and optimal planting times based on local data. Additionally, it can offer guidance on sustainable farming practices, such as crop rotation and irrigation management, to improve yield and reduce environmental impact. ChatGPT can also be employed in supply chain management, helping farmers connect with buyers and distributors more efficiently. Furthermore, it can serve as a knowledge resource, offering information on agricultural best practices and the latest research findings to empower farmers with up-to-date insights for informed decision-making.*

*It gives me great pleasure to inform you that we have curated and finalized 59 articles for publication in this issue.*

*My sincerest hope is that this issue will provide readers with valuable insights into agricultural technologies and innovations. I extend my heartfelt gratitude to the dedicated editorial team and the talented authors for their invaluable contributions in bringing this issue to fruition. Your efforts have played a pivotal role in making AgriTech Today Magazine a source of enlightenment and knowledge in the agricultural domain.*

***Editor-in-chief***



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# Role of ChatGPT in Agricultural Engineering: Transforming the Future of Agriculture

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## Cover Story

An interdisciplinary field known as "Agricultural Engineering" integrates engineering theory with agricultural sciences to create ground-breaking approaches to sustainable farming. A number of industries, including agriculture, have been transformed in recent years by the application of artificial intelligence (AI) and machine learning technology. Among these developments, ChatGPT, a language model created by OpenAI for artificial intelligence, has become a potent tool in the agricultural engineering community. ChatGPT offers a wide range of advantages by utilising deep learning and natural language processing, including crop management, precision farming, farm automation, and resource conservation. We shall examine ChatGPT's substantial contribution to agricultural engineering and how it might change farming in the future in this post.

### Crop Management and Precision Agriculture

#### A. Decision Support Systems

For farmers and agricultural engineers, ChatGPT can serve as an intelligent decision support system. ChatGPT can offer insightful analysis and suggestions by looking at a great quantity of data, such as weather patterns, soil conditions, crop health, and historical data. These suggestions can include ideal planting dates, suitable crop kinds, irrigation plans, and pest control techniques. This

helps farmers make wise decisions and maximize the output of their crops.

#### B. Disease and Pest Identification

It is essential for preventing yield losses to identify and treat crop diseases and pest infestations. In order to effectively recognise symptoms and provide suitable remedies, ChatGPT can be trained on large datasets of plant diseases and pests. With the help of image recognition software, ChatGPT can analyse pictures of harmed plants and give farmers immediate advice, enabling them to act quickly to reduce losses.

#### C. Nutrient Management

Crop development and sustainability depend on effective fertilizer management. ChatGPT may examine information on soil composition, nutrient needs, and crop nutrient uptake models to suggest specific fertilizer application methods. ChatGPT assists farmers with minimizing fertilizer waste, minimizing environmental impact, and maximizing crop output by offering exact advise on nutrient needs.

### Farm Automation and Robotics

#### A. Autonomous Machinery

Advancements in robotics and automation have transformed farming practices, improving efficiency and reducing labor-intensive tasks. ChatGPT can integrate with autonomous machinery and robotic systems, enabling farmers to control and monitor operations remotely. Through natural



language commands, farmers can instruct the machinery to perform specific tasks such as planting, harvesting, and irrigation. ChatGPT also assists in real-time troubleshooting and maintenance, minimizing downtime and optimizing operational efficiency.

### **B. Drone Technology**

Drones equipped with various sensors and cameras have become valuable tools in agriculture. ChatGPT can collaborate with drone systems to interpret aerial data, including multispectral and thermal imagery, to identify crop health, monitor irrigation patterns, and detect potential problems such as water stress or nutrient deficiencies. By processing this data and providing actionable insights, ChatGPT empowers farmers to make data-driven decisions and optimize resource allocation.

### **ChatGPT in Soil and Water Conservation**

#### **A. Data Analysis and Predictive Modeling**

ChatGPT can be utilized to analyze vast datasets related to soil properties, hydrological data, and land use patterns. By processing and interpreting this data, the model can help identify vulnerable areas prone to erosion and suggest appropriate conservation measures. Moreover, ChatGPT's predictive modeling capabilities can forecast erosion and sedimentation rates, enabling proactive conservation planning.

#### **B. Decision Support Systems**

Integrating ChatGPT into decision support systems empowers conservationists, farmers, and policymakers to make informed choices. The model can assist in recommending optimal crop rotations, irrigation strategies, and land management practices to minimize erosion and water wastage while maximizing agricultural productivity.

#### **C. Precision Conservation**

Precision conservation involves targeting specific areas with site-specific conservation practices. ChatGPT can assist in identifying these areas by analyzing data from remote sensing and geospatial sources. This targeted approach leads to efficient resource utilization and improved conservation outcomes.

#### **D. Communication and Outreach**

Effective communication is vital for the successful implementation of any conservation initiative. ChatGPT can contribute to improving public awareness and outreach efforts by generating easily understandable and relatable content about soil and water conservation. Whether it's social media posts, articles, or educational material, the model can deliver valuable information to a wider audience.

#### **E. Challenges and Considerations**

While ChatGPT presents exciting possibilities, there are several challenges that need to be addressed. Ethical considerations, bias in data, and model transparency are some of the critical issues that should be carefully managed. Additionally, the accuracy and reliability of the model's output must be validated against real-world data to ensure its practical applicability.

### **Sustainable Resource Utilization**

#### **A. Water Management**

Water scarcity is a significant concern in agriculture, particularly in regions facing drought or limited water resources. ChatGPT can analyze historical weather data, crop water requirements, and soil moisture levels to assist in optimizing irrigation schedules. By providing accurate predictions and recommendations, farmers can

reduce water wastage, improve water use efficiency, and ensure sustainable water management practices.

### **B. Energy Optimization**

Agricultural operations consume substantial amounts of energy, contributing to greenhouse gas emissions. ChatGPT can analyze energy usage patterns, climate data, and crop requirements to suggest energy optimization strategies. This includes efficient equipment scheduling, renewable energy integration, and intelligent power management systems. By reducing energy consumption and promoting renewable sources, ChatGPT helps farmers achieve more sustainable farming practices.

### **Knowledge Sharing and Education**

#### **A. Accessible Information**

ChatGPT serves as an easily accessible platform for farmers and agricultural engineers to acquire information and knowledge. It can provide instant answers to questions related to crop diseases, farming techniques, and best practices. ChatGPT can also offer guidance on regulatory compliance, farm certifications, and government schemes. This democratization of information empowers farmers, particularly those in remote areas, to enhance their agricultural practices and stay up to date with the latest advancements.

#### **B. Language Translation**

Agriculture is a global industry, and language barriers can hinder knowledge exchange and collaboration. ChatGPT's language translation capabilities enable seamless communication between farmers, researchers, and experts worldwide. It facilitates the sharing of innovative

ideas, research findings, and best practices across different regions, promoting cross-cultural learning and fostering international collaborations in agricultural engineering.

### **Conclusion**

Sustainable farming techniques now have more options because to the incorporation of ChatGPT into agricultural engineering. ChatGPT provides farmers and agricultural engineers with insightful information, suggestions, and on-demand support in the areas of precision agriculture, farm automation, resource utilisation, and knowledge sharing. ChatGPT uses AI and machine learning to improve crop management, decrease resource waste, and support more effective and sustainable agricultural practises. The integration of ChatGPT into soil and water conservation engineering offers immense potential to transform the field and contribute to sustainable environmental management. By leveraging the model's capabilities in data analysis, decision support, and communication, conservation efforts can become more efficient, effective, and accessible to all stakeholders. However, it is essential to address ethical concerns and validate the model's outputs to ensure responsible and reliable applications. It is important to recognize that ChatGPT should supplement rather than completely replace human expertise. The most significant developments in agricultural engineering will come through teamwork between AI systems and human experts, ensuring a prosperous future for farming and food production.

\* \* \* \* \*

# Maturity Indices and Method of Harvesting of Vegetable Crops for Quality Seed Production

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The principles dictating at which stage of maturity a vegetable should be harvested are crucial to its subsequent storage life and quality. Post harvest physiologist distinguishes three stages in life span of vegetables: maturation, ripening and senescence.

## Maturation of seed

There are two maturation stages in seed

### 1. Physiological maturation

Utmost accumulation of dry substance in seed is reported in this stage. The moisture present in the seed at this stage will be in declining order (25-30%) and is expressed with utmost dry weight of seed, germination and vigour potential, respectively. The physiological maturation is corresponded for individual seed and this maturation will not be the identical for the population, due to differential flowering habits (Malarkodi and srinathi, 2007).

### 2. Harvestable maturation

Whole population achievement of 80% physiological maturity is considered as the harvestable maturity. At this stage seed contain less moisture content than the physiological maturation (18-20%). Normally, harvesting of the seed crops done at harvestable maturity stage for getting high quality seed (Elias and Copeland, 2001).

## Harvesting

Usually, the crop harvested at harvestable maturity will have the greater seed yield than the physiological maturity. In crops the maturation will not be always homogeneous but there will be mingling of matured, immature and over matured

based on the time of anthesis and fertilization. Hence finest time of harvest for a given seed crop is essential as beyond the point losses will be lesser than the potential seed yield. Hot dry weather greatly increases the rate of natural seed drying on the plant. Seed moisture can form the most vital sign of a crop's fitness for harvesting.

Vegetable seed crops are divided into three groups depending on the state of seed at harvest time (Rashid and Singh, 2000).

### a. Dry seed

Before harvesting the seed is dried on the plant. e.g. okra, brassicas, lettuce, peas, beans, beet and onion.

### b. Fleshy fruits

First of all ripened fruit are harvested from the plant and kept for drying, then after dried seed are collected from the fruits. e.g. chillies, ribbed gourds and bottle gourd.

### c. Wet fleshy fruits

In these types of fruits containing a high level of moisture due to the seed has a gelatinous or mucilaginous coating adhering to it. This has to be detached after seed extraction by a fermentation process or treatment with dilute acids. (e.g. tomato, brinjal, cucumbers and pumpkins).

## Method of Harvesting

The seed or fruit are harvested by manually or mechanically, depending upon the size of production, cost and accessibility of skilled labour and or of appropriate harvesting machines (McCormack, 2004).

## Maturity Indices and Method of Harvesting of Vegetable Crops for Quality Seed Production

| Crops                                | Maturity indices                                                                                                            |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Dried seed</b>                    |                                                                                                                             |
| Amaranthus                           | Inflorescence is converted yellowish brown.                                                                                 |
| Onion                                | Dark black colored of seed with silver-colored capsules.                                                                    |
| Carrot                               | 3 <sup>rd</sup> umbel turn brown and 2 <sup>nd</sup> umbel are fully dried.                                                 |
| Radish                               | Pod converted in to brown color.                                                                                            |
| Turnip                               | Brown and parchment like color developed in plant.                                                                          |
| Coriander                            | Whole plant started to show light yellow to brown color.                                                                    |
| peas                                 | Pod become parchment like.                                                                                                  |
| Beans                                | Earliest developed pod is dried and remaining are turned yellow.                                                            |
| <b>Wet fleshy fruits</b>             |                                                                                                                             |
| Brinjal                              | Fruit turn to yellow to brown in colour.                                                                                    |
| Tomato                               | Firmness of fruit is reduced and skin of fruit converted dark red in colour.                                                |
| Cucumber                             | Fruit converted yellowish to brown in colour, stalk adjacent to the fruit withers for compliant actual seed maturity.       |
| Watermelon                           | Tendrils wither on fruit bearing shoots, fruit skin colour near to the soil is pale yellow and give dull sound on thumping. |
| Pumpkin                              | Rind becomes hard and fruit converted into orange or golden colour.                                                         |
| True potato Seed                     | Berries become soft and converted in to green to straw colored.                                                             |
| Bitter gourd                         | Fruit become soft and converted in to red colour.                                                                           |
| <b>Fruit dried before extraction</b> |                                                                                                                             |
| Chillies                             | Fruit colour change into yellowish red.                                                                                     |
| Bottle and Sponge gourd              | Rind become hard colour change to light brown to yellow                                                                     |

(Source: Geetha Rani, 2006)

### 1. Hand picking

Seeds of some crops like solanaceous fruits (brinjal, pepper, tomato), cucurbits and sweet corn

are conveniently harvested by picking fruits by manually. The tiny seeded fruits or seed heads of vegetable crops like onion, carrot, okra or chilli can be cut with a knife or secateurs. Frequently it is suitable to cut off the whole plant with a sickle, as in the case of lettuce, chicory, brassicas, radish and peas. The legumes are, however, usually harvested by pulling up the whole plant and then threshed to recover the seed (e.g. peas and beans). Although hand harvesting methods are labour intensive, they allow plants to be harvested individually or even at several stages of crop growth. Manual harvesting provides more protection and the maximum potential seed yield per unit area, when compared with the mechanical harvesting. In plants requiring after ripening, the larger the plant part are cut and removed with the ripening seed results in higher seed yield (e.g. the small seeded vegetable crops like lettuce and brassicas.)

### 2. Mechanical harvesting

Vegetable seed crop may be harvested by employing a suitable mechanical harvester, especially in the large-scale commercial seed producing farms where the manual labour is costly. In the mechanical harvesting, cutting and threshing operations may be carried out by two separate machines or both the operations may be performed by a single combined machine. The cutting operations can be mechanized, using mowing, windrowing machines, which are most conveniently used for crops like peas, beans, spinach, carrot and brassicas.

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## Application of micropropagation in plants: A brief review

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Micropropagation is the practice of rapidly multiplying stock plant material to produce many progeny plants, by using a variety of tissue, cell and organ culture methods (Altman and Loberant, 1998). Micropropagation indicates the aseptic culture of small sections (i.e., explants) of tissues and organs, in closed vessels with defined culture media and under controlled environmental conditions. Plant cell or tissue culture technique depends mainly on the concept of totipotency which refers to the ability of a single cell to regenerate the entire plant by

technology is widely used to provide a huge number of plantlets for planting from seedless plants, plants with difficulty of asexual reproduction or where micropropagation is the cheaper means of propagating (e.g., Orchids).

Micropropagation is one of the most commercially efficient and practically oriented plant biotechnology that have rapid generation of a large number of clonal plants of many plant species and also in many cases micropropagation is practiced in production of virus or other pathogen free plants



expressing the full genome by cell division (Brown et al 1995). Plant tissue culture medium contains all the nutrients required by the plant for their normal growth and development. It is mainly composed of macronutrients, micronutrients, plant growth regulators, source of carbon, other organic components and gelling agents in case of solid medium. The pH of the media is adjusted between 5.4 – 5.8 which affects both the activity of the plant growth regulators and the growth of the plants (Murashige 1974; Loberant and Altman, 2010). This

(Thorpe et al 2007; Idowu et al 2009). Moreover, in the generation of transgenic plants and somatically bred plants micropropagation is now act as the technical link. The ability to regenerate entire plants from cells, tissues, or organs that have "foreign" DNA inserted and expressed is important for the efficient production of transgenic plants, if not the only one. Moreover, micropropagation is used for germplasm storage and the protection of endangered species (Hussain et al 2012).

### Methods of Micropropagation

Based on genotypes and economical values, multiplication of plantlets through in-vitro process may be achieved with the following 333335 different methods:

#### Meristem Culture

Meristem is the region of cells capable of division and growth or small population of rapidly proliferating cells that can produce whole plants. In this method of micropropagation, the meristem along with few subtending leaf primordia is placed into a suitable growing medium where they are induced and allowed to grow new meristem. After some weeks when an elongated rooted plantlet is produced and reached a considerable height, these plantlets are transferred into the soil. A disease-free plant can be produced by this method and also this technique can be successfully utilized for rapid multiplication of various plant species.

#### Callus Culture

Callus is an unorganized, undifferentiated mass of cells in vitro condition. In callus culture, selected plant tissue is placed in an artificial growing medium with other favorable conditions until the callus is formed. After the production of callus, they are transferred into a culture medium containing plant growth regulators for the induction of adventitious organs. Then, few weeks old new plantlet is exposed gradually to the environmental condition.

#### Suspension Culture

Suspension culture is the cell culture of plant in which the single cells or small aggregates of cells are allowed to grow in suspension media and allow to function and multiply. In this method, cells or groups of cells are dispersed and allowed to grow in

an aerated and sterile liquid culture medium. Such method is commonly used for studying cell growth and development and to extract certain components from plant cells in industrial scales.

#### Embryo Culture

In embryo culture method, the embryo is excised and placed into a culture medium with proper nutrient in aseptic condition. To acquire a quick and ideal growth into plantlets, it is transferred to soil. To overcome the embryo and to produce interspecific and intergeneric hybrids, embryo culture is commonly used.

#### Protoplast Culture

In protoplast culture, the plant cell is isolated with the help of wall degrading enzymes and cultured in a suitable culture medium under controlled condition to reform the cell wall and callus. After few weeks, under suitable conditions, the cell develops a cell wall followed by an increase in cell division and cellular differentiation and grows into a new plantlet.

#### Stages of Micropropagation

In short, steps of micropropagation can be divided into five stages

##### Preparation of donor plant

It is the initial stage of micropropagation. In this stage the mother plants are selected and grown under controlled conditions before using them for culture initiation.

##### Culture Initiation and Establishment

In this stage the explants are established in a suitable culture medium. This stage involves the isolation of the explant from the selected stock mother plant followed by treatment with bactericide and fungicide and rinsing with sterile distilled water. Then the explant is surface sterilized by using the disinfectants like sodium hypochlorite and mercuric

chloride and rinsing with sterile distilled water and then the explant is established on an appropriate culture medium.

### Multiplication

The rapid multiplication of shoots or rapid somatic embryo formation in a defined culture medium is performed in this stage. During shoot multiplication stage, the propagules or shoot is multiplied by repeated subcultures in well-defined environment and optimized culture media along with plant hormones until the desired planned number of plantlets is attained.

### 4. Rooting

In this stage, the shoots are placed for the development of roots to a define nutrient medium containing more auxin and cytokinin ratio which is performed in the laboratory.

### 5. Acclimatization

In this stage, the plantlets are weaned and hardened which is done by transferring gradually from high to low humidity and from low to high light intensity. Then the plants are transferred to an appropriate substrate and gradually hardened under greenhouse condition.

### Conclusion

Micropropagation is one of the best options for mass multiplication of plant simultaneously diseases, pest free, uniformity and true-to-type propagation methods. This micropropagation process can be carried out in control environment condition throughout the year irrespective of the

season compared to the conventional propagation methods. New opportunities have been created for producers, farmers and nursery owners for high quality planting materials of fruits, vegetables, ornamentals and forest tree species.

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# SFMT (Surf Field Mastitis Test) – A Diagnostic Method for detection of Sub clinical mastitis in Dairy Animals

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Bovine mastitis is an inflammatory response of the udder tissue in the mammary gland caused due to physical trauma or microorganism infections. It is considered the most common disease leading to economic loss in dairy industries due to reduced yield and poor quality of milk. This disease not only reduces the milk production potential of the dairy animals (to the tune of 20 to 25%) but the milk produced by the affected animals is also unfit for human consumption. Annual losses in the dairy industry due to mastitis was approximately 526 million dollars in India, in which subclinical mastitis are responsible for approximately 70% of these losses. This is partly because at the very least, every one out of five Indian cow and buffalo is affected with bacterial infection of the udder called 'mastitis'.



## Mastitis

The infectious agent enters through the milk canal, interacts with the mammary tissue cells and multiplies. The mammary tissue reacts to these toxins and becomes inflamed. The infection rate of mastitis in cows with pendulous udder is higher than those having non-pendulous udder.

Bovine mastitis can be classified into 3 classes based on the degree of inflammation, namely clinical, sub-clinical, and chronic mastitis. A clinical bovine mastitis is evident and easily detected by visible abnormalities, such as red and swollen udder, and fever in dairy cow, and the milk of the affected cow appears watery with presence of flakes and clots.

Chronic mastitis is an inflammatory process that lasts for several months, with clinical flare-ups occurring at irregular intervals. Contrary to clinical mastitis, sub-clinical mastitis shows no visible abnormality in the udder or milk, but milk production decreases with an increase in the somatic cell count (SCC). The loss contributed by sub-clinical mastitis is very hard to quantify, but it accounts for more financial losses in the herd than do clinical cases. Subclinical or hidden form of mastitis is 15-40 times more common than the clinical mastitis. Research conducted in India over the past 4 decades has shown that about 25% of cows and 15% of buffaloes are afflicted with subclinical form of mastitis. An early diagnosis of hidden mastitis is imperative to save the udder and prevent transmission of disease producing organisms to other animals in the herd. As subclinical mastitis is antecedent to clinical mastitis, many surf test positive quarter (s) will develop clinical form of the disease in future. It is also important from public health viewpoint in so far as the milk of animals affected with sub-clinical mastitis contains bacteria and their toxins. Therefore, lack of diagnosis of sub-

clinical mastitis is a serious challenge to the dairy industry.

Hence, at KVK, Kalikiri an OFT trial was conducted demonstrating that a 3% solution of a house-hold detergent like Surf Excel can be used for an early farmer's level detection of sub-clinical (hidden) mastitis. This test has been named as Surf Field Mastitis Test.

**The desirable features of this innovative mastitis detection test include:**

- Compatibility with the technical capabilities of farmers who happen to be mostly illiterate in the developing countries. Owing to a facile nature of the test procedure, even an illiterate farmer can learn to conduct this test within a few minutes.
- Desirable sensitivity (72.81 and 66.22 in cows and buffaloes respectively) of detection with other expensive similar tests like California Mastitis Test and the gold standard of mastitis diagnosis i.e. microbiological examination of aseptically collected milk samples.
- Availability of the required reagent, i.e. Surf Excel Powder in almost every village.
- User's friendly nature of the test.

**Procedure of Surf Field Mastitis Test and its interpretation:**

- Prepare a 3% solution of the household detergent i.e., Surf Excel. To this end, dissolve 5-6 teaspoonfuls of the Surf Excel powder in ½ liter of ordinary water. Pour this solution into a plastic bottle, apply a lid and place the bottle in a dark place. This reagent is good for about 3 months.
- Collect 10-15ml of milk from each teat in separate container like tea cups. If Surf Field

Mastitis Test paddle is available, there is no need to collect milk samples into tea cups as the milk from individual quarters of cow and buffalo can be collected into individual receptacle of this paddle.

- Mix the milk from individual teat and Surf solution (3%) in approximately equal proportions (i.e. add 10-15 ml 3% surf solution).
- Rotate the mixture of milk and surf solution for about 15-20 seconds.
- Examine the mixture for thickening or any other change.

**Interpretation**

If the hidden form of mastitis (subclinical mastitis) is present in the quarter of udder, the mixture (milk + surf solution) will thicken (i.e. gel formation) within 15 seconds. If the udder is free of subclinical mastitis the mixture remains liquid and there is no thickening of mixture of milk and surf solution.

The milk from surf test positive quarters of udder is not wholesome for human consumption and should be discarded.



**Positive for SFMT test**

### Instructions to the farmers regarding SFMT

- All farmers should conduct Surf Field Mastitis Test on all quarters of all milch animals at fortnightly intervals. In the event of a positive test reaction in one or more udder quarter(s), immediately contact the local veterinarian for treatment and advice on mastitis treatment and control.
- Whenever there is reduction in quarter yield, Surf Field Mastitis Test should be conducted to rule out the possibility of mastitis as the cause of reduced milk yield.
- Lactating animals should be divided into Surf test positive and Surf test negative groups. The Surf test negative group (mastitis

free animals) should be milked first because the germs, which cause mastitis are transmitted from mastitis-affected (surf test positive) to healthy animals through milkers' hands at the time of milking.

- Always conduct Surf Field Mastitis Test when purchasing new cows and buffaloes. Purchase only surf test negative cows and buffaloes.
- Milk from surf test positive animals is unfit for human consumption because it contains a lot of germs, their toxins and pus cells (somatic cells) and abnormal milk constituents.

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# Recirculating Aquaculture system (RAS), Biofloc technology (BFT) and Aquaponic system: an Overview

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Recirculating aquaculture system is a technologically advanced system for farming fish or other aquatic organisms that involves reusing the water in the production with less than 10% of total water volume replaced daily. The technology can be utilised for any species grown in aquaculture by employing mechanical and biological filters. However, to compensate for high operating expenses, it is typically used to cultivate high-value species (barramundi, catfish, eels, perch, prawns, salmon, seabass, seabream, prawns, sturgeon, trout and tuna) with high stocking densities and year-round production.

## Working principle

The basic principle of recirculation is that the water flows from the outlet of the fish tanks to a mechanical filter, then to a biological filter before being aerated and free of carbon dioxide and then returned to the fish tank. Some additional water treatment components, such as oxygenation with pure oxygen, ultraviolet or ozone disinfection, automatic pH management etc., can be incorporated, depending on the needs, to enhance the water quality and control the occurrence of any disease inside the system.

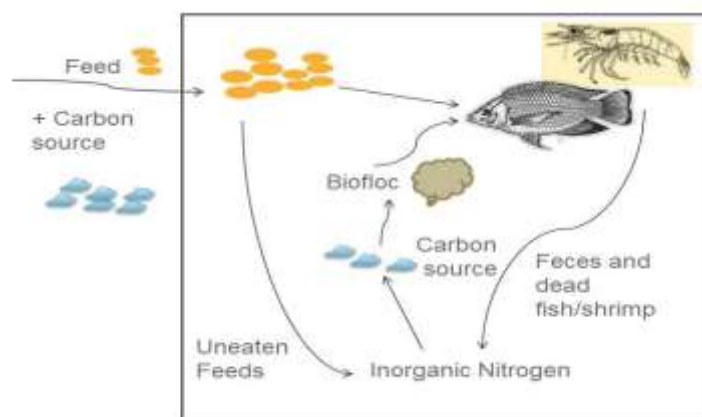
## Biofloc technology

Biofloc technology (BFT) is based on maintaining high levels of microbial bacterial floc in suspension, maintaining constant aeration and adding a suitable carbon source to allow aerobic decomposition of the organic material. Manipulation



of the C/N ratio converts toxic nitrogenous wastes into beneficial microbial protein and helps improve water quality under a zero-water exchange system. For optimum growth of bacterial population for ammonia and nitrite assimilation, there is a need to maintain a C: N ratio of the culture unit between 10:1-20:1.

Fish species that can tolerate high solid concentrations are omnivores in feeding, tolerant to poor water quality, and fluctuations of ammonia are





best suited for bio floc systems. The production of shrimps, tilapia, and carp that consume the flocs directly has realised most of the advantages of biofloc technology.

### Working principle

An initial microbial inoculum is prepared following the standard protocol, and the inoculum is added to the tanks after 24 hrs of incubation. The system is kept well aerated before the introduction of fish stocked after forming optimum floc volume. Zero or limited water exchange is done. Feed is provided to the fish at @2-3 % of their body weight, and a carbon source is added to the tank. The tank is maintained with vigorous aeration and mixing so that ideal conditions are created for the growth of microbes. Microbial population assimilate harmful nitrogenous compounds like ammonia excreted by fish for their growth and are converted into microbial proteins on which fish feeds.

### Aquaponic system

Aquaponics is a bio-integrated production that combines recirculating aquaculture with hydroponics to produce fish and plants in a closed-loop system that resembles nature's ecosystem.

### Working principle

Fish are raised in a tank, and the water from the fish-rearing tank passes through the filters (both mechanical and biological filters), which remove the fish's solid wastes (mechanical filtration) and the

dissolved toxic wastes like ammonia is converted to nitrates (biological filtration) that are accessible for plants. Once this nutrient-rich water passes through the plant beds, plants uptake the nutrients, and the filtered water is returned to the fish tank. Aquaponics provides a sustainable means of production, especially in areas where the land and water resources are limited by using cost-effective and non-chemical nutrient sources and the reuse of filtered water.

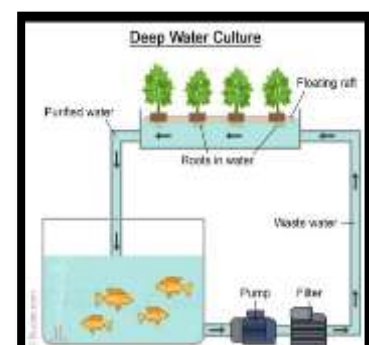
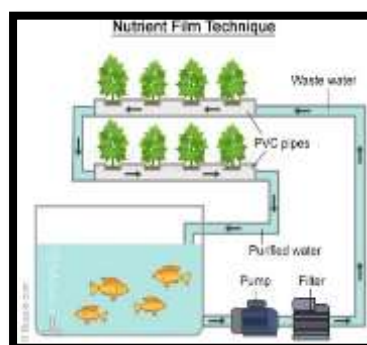
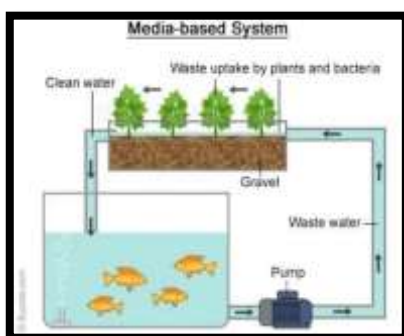
### Different types of aquaponic systems

#### Media Filled beds

Plants are grown in a container filled with media (expanded clay pebbles, gravel, perlite). Water from fish tanks may not require mechanical filtration because the solid material is broken down while passing through the media. Moreover, the media provides a large surface area for the growth of beneficial nitrifying bacteria. This is the most straightforward technique and requires comparatively fewer components. The method can be used for small-scale aquaponics.

#### Nutrient Film Technique

In NFT, nutrient-rich water from fish tanks passes through horizontal PVC pipes with small cups or holes for holding plants. The plant roots are in direct contact with nutrient-rich water flowing through pipes and absorb the same. This technique is suitable for leafy green vegetables with small



roots. Plants with large invasive roots will hinder the water flow and clog the pipes. This technique needs biofilter because the system's surface area is not much exposed to air.

### Deep Water Culture or Raft system

Plants are grown on the rafts (foam or polystyrene) floating on the water surface. The plants can be erected within the holes directly, or net pots filled with media can be placed in the pits for

additional support on the raft and the roots remain dangling in the water column. Extra aeration is needed under rafts because the seeds remain submerged in water. Rafts can be placed directly over the fish tank, or a separate raft tank can be used, the latter being used most often. This technique is most promising, production efficient, and used mainly for large-scale operations.

**Table 1: Plant and Fish species used for aquaponics**

| Vegetables                                                                                | Fruits                                              | Flowers               | Herbs                                            | Fish species                                                                                                          |
|-------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Lettuce, beans, squash, zucchini, broccoli, pepper, cucumber, carrot, onion, reddish etc. | Strawberries, watermelon, cantaloupe, tomatoes etc. | Most garden varieties | Basil, thyme, cilantro, Lemongrass, oregano etc. | Tilapia, trout, Bluegill, carp, freshwater prawns, aquarium fishes like goldfish, tetra cichlids, guppies, Oscar etc. |

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# The Development of Agriculture in India through Agri-Entrepreneurs

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Agriculture plays a vital role in the Indian economy, employing a significant portion of the population and contributing to food security and rural development. In recent years, the emergence of agri-entrepreneurs has brought about a transformative change in the agricultural sector. This paper explores the development of agriculture in India through the contributions of agri-entrepreneurs and highlights their role in driving innovation, technology adoption, and sustainable practices.

## Empowering Farmers

Agri-entrepreneurs have empowered farmers by bridging the gap between traditional farming practices and modern techniques. They provide farmers with access to advanced technologies, improved farming methods, and quality inputs such as seeds, fertilizers, and machinery. By promoting knowledge-sharing and skill development, agri-entrepreneurs help farmers enhance their productivity and profitability, ultimately leading to the socio-economic development of rural communities.

## Technological Advancements

Agri-entrepreneurs have been at the forefront of integrating technology into agriculture. They have leveraged innovations like precision farming, IoT (Internet of Things), data analytics, and automation to optimize resource utilization, monitor crop health, and enhance overall farm management. These technological advancements have led to increased efficiency, reduced wastage, and improved crop yields. Agri-entrepreneurs have

played a pivotal role in bringing such cutting-edge solutions to the doorstep of Indian farmers.

## Market Linkages

One of the significant challenges faced by farmers in India is the lack of direct market access. Agri-entrepreneurs have addressed this issue by establishing direct market linkages between farmers and consumers, eliminating intermediaries and ensuring fair prices for agricultural produce. They have created platforms for farmers to sell their products directly to consumers, hotels, restaurants, and export markets. This not only increases farmers' incomes but also ensures the availability of fresh and quality produce to consumers.

## Sustainable Agriculture Practices

Agri-entrepreneurs are driving the adoption of sustainable agriculture practices in India. They promote organic farming, crop diversification, water conservation, and efficient use of resources. Through education and training programs, they create awareness about the importance of environmental stewardship and the long-term benefits of sustainable practices. Agri-entrepreneurs also encourage the use of renewable energy sources, such as solar-powered irrigation systems, to reduce dependence on fossil fuels and mitigate the environmental impact of agriculture.

## Start-up Ecosystem

The rise of agri-entrepreneurs has contributed to the growth of a vibrant start-up ecosystem in the agricultural sector. Entrepreneurial ventures focusing on agri-tech, farm management, agricultural logistics, and value addition have

proliferated in India. These start-ups attract investment, generate employment opportunities, and foster innovation. The government and various organizations have also launched initiatives and incubation centres to support agri-entrepreneurs, providing them with funding, mentorship, and a conducive environment to thrive.

### **Women Empowerment**

Agri-entrepreneurship has emerged as a pathway for women's empowerment in rural areas. Women-led agri-enterprises are providing employment opportunities and financial independence to women. By promoting women's participation in agricultural activities, agri-entrepreneurs are breaking gender barriers and challenging traditional norms. The increased involvement of women in agriculture not only boosts the sector's productivity but also enhances gender equality and social development.

### **Policy Reforms and Government Support**

Recognizing the significance of agri-entrepreneurship in agricultural development, the Indian government has implemented policy reforms and provided support to encourage entrepreneurship in the sector. Initiatives like the

Atam nirbhar Bharat Abhiyan and the Start-up India campaign have created a favourable environment for agri-entrepreneurs to flourish. The government has introduced schemes for easy access to credit, subsidies, research and development grants, and infrastructure development, enabling agri-entrepreneurs to overcome challenges and scale their operations.

### **Conclusion**

Agri-entrepreneurs have emerged as catalysts of change, revolutionizing the agriculture sector in India. Their contributions in empowering farmers, adopting technology, creating market linkages, promoting sustainable practices, and fostering a thriving start-up ecosystem have had a profound impact on agricultural development. The combined efforts of agri-entrepreneurs, government support, and policy reforms are paving the way for a more resilient, productive, and sustainable agriculture sector in India. It is imperative to continue nurturing and promoting agri-entrepreneurship to achieve long-term agricultural growth, rural prosperity, and food security.

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## Recent Advances in Sorghum Breeding

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Sorghum (*Sorghum bicolor*(L) has been a vital source of food especially for the people in the Semi-Arid Tropics. Sorghum is emerging as a crop with diverse end-uses such as food, feed, fodder, fiber and fuel which makes it ideal for both subsistence and commercial farming (Hao *et al.*, 2021). It has received increasing attention as a good source of slowly digestible starch (Simnadis *et al.*, 2016) and exclusive bioactive flavonoids (Yang *et al.*, 2015). It has great potential as being sustainable staple food and fodder crop, because of its hardiness and low water requirement. Being more resilient to adverse environmental conditions, sorghum performs well under high temperature and drought conditions and occupies even the marginal fertile area for cultivation. It is the main source of livestock feed and industrial uses in developed countries like USA, Canada and Australia. As a C<sub>4</sub> crop with low input requirements and high net return, sorghum is more resilient to adverse environmental conditions and performs well under water shortage and increasing temperature.

### Domestication and Distribution

*Sorghum bicolor* (L.) Moench is a single cultivated species. It is an annual crop, often branched with many tillers and have thick culms. Sorghum was first domesticated in Africa (Harlan and De Wet, 1971) probably in the Ethiopia Sudan region (Doggett, 1988). Domesticated sorghum has been classified into five basic races: *bicolor*, *guinea*, *caudatum*, *kafir* and *durra* (Harlan and de Wet, 1972) having different geographic origin. Genomic studies have clearly

indicated that the sorghum races are genetically diverse. *Bicolor* is the most primitive race derived from the wild progenitor *S. bicolor* subsp. *verticilliflorum* (Ananda *et al.*, 2020). Kafir is the main source of male sterile genes and is photo insensitive whereas Guinea is photo sensitive; Caudatum is having recent origin and mainly used for beer brewery. Durra is widely used in crop-improvement programs (Cuevas *et al.* 2017). The improved sorghum types were spread by the movement of people and trade routes into India (1500–1000 BC), the Middle East (900–700 BC) and eventually into the Far East (AD 400). Most of the wild types have characteristic phenotypes of profuse tillers, inflorescences with spreading branches, shattering and dark-colored small seeds. Early domestication of sorghum was associated with improvement in seed size and panicle type such as larger, compact ear heads with non-shattering seeds

### Sorghum Genetic resources

In Sorghum, immense range of genetic variability is available in Africa where domestication first occurred followed by Asia due to the early introduction of the crop. The existing sorghum germplasm contains four major types such as grain sorghum with high seed yield, forage sorghum with good biomass and regeneration capacity, sweet sorghum with juicy, sugary stems and broom sorghum with long fibrous ear heads (Dahlberg *et al.*, 2011). Weedy sorghum such as Johnson grass and spontaneous sorghum (shatter cane) are widespread in temperate zone. Johnson grass (*S. halepense*), is one of the world's worst weed

which reproduces through both seed and rhizome. Knowledge on wild progenitors of sorghum (*Sorghum bicolor*) helps in exploiting the underutilized gene pool for developing climate-resilient sorghum cultivars. In Sorghum, approximately 2,56,000 germplasm accessions are being conserved Globally. Gene bank at ICRISAT conserves the largest collection of about 42,000 accessions and these accessions are well characterized for various morpho-physiological and agronomic traits (Ashok Kumar *et al.*, 2013). Other institutions include Australian Tropical Crops and Forages Genetic Resources Center which has the largest collection of Australian wild sorghum, National Bureau of Plant Genetic Resources in India with about 20,000 collections ([www.nbpgr.ernet.in](http://www.nbpgr.ernet.in)) and the Institute of Crop Germplasm Resources in China with 16,874 collections (<http://www.icgr.caas.net.cn>).

### Breeding programmes

Because of the huge availability of diverse genetic resources, great progress has been made in sorghum breeding in the past decades. Stable, high-yielding sorghum varieties have been recently developed through breeding programmes utilizing sorghum landraces especially with traits such as photoperiod insensitivity, dwarf stemmed suitable for machine harvest, resistance to abiotic and biotic stress. Breeding methods followed for the improvement of sorghum cultures with higher yield quality include selection, hybridization, heterosis breeding, mutation breeding and population improvement. In India, essentially all the sorghum types cultivated are white (including tan-plant types) or red (non tannin grain types), which are used for human food. At present, the emphasis in India is more on breeding improved, dual purpose

(grain and fodder) open pollinated varieties and hybrids.

### Modern breeding concepts

Modern breeding approaches are urgently needed to accelerate the breeding for sorghum varieties combined with high genetic yield potential and stress tolerance. Molecular marker techniques enhance breeding efficiency by improving the accuracy of selection process and also by reducing the time required for cultivar development (Hasan *et al.*, 2021). Conventional breeding techniques can be strengthened through modern breeding concepts and technologies such as high throughput, genomic map-based marker - assisted selection and through integrated breeding platforms supported by modern data management system. Because of diverse germplasm collections, its adaptation to harsh environments and value for comparing the genomes of other cereal crops such as rice and maize, sorghum is the main target for plant genomic mapping. Knowledge of the available genetic variation, molecular breeding approaches and genomic selection strategies is required for exploring genetic gain for a range of important traits such as grain yield, biomass production, drought tolerance and stem sugar accumulation.

Sorghum is highly suitable for association mapping due to its self-pollinating mating system and its medium-range patterns of linkage disequilibrium (Hamblin *et al.*, 2005). Genome-wide association studies using high density SNP array technologies for the identification of single-nucleotide polymorphisms (SNPs) and next-generation sequencing (NGS) platforms have opened the way for genomic selection (GS). Next generation sequencing (NGS) provides tools for sequencing the entire genome of species instead of few selected genomic regions and capture single

nucleotide polymorphisms (SNPs) throughout the genome. Genomic selection is a viable tool that predicts the genetic values of individuals using genome-wide markers and permits the use of molecular markers with both major and minor effects in developing the prediction model to predict the phenotypes of untested individuals. In recent years, such techniques have the potential to improve the effectiveness of advance breeding techniques and thereby the accelerate selection gain.

Developing new sorghum varieties tailored with ideal traits is possible through genome-based technologies. Genome sequencing of wild as well as improved sorghum genotypes will provide new genomic variations for sorghum domestication and diversification. Small genome size (730 Mb), simple (10 chromosomes, diploid) and complete genome sequence availability (Paterson *et al.*, 2009) make sorghum an amenable crop for the application of genomics-based approaches. Genomic research in sorghum is further accelerated because of the availability whole genome reference sequence, based on the elite line BTx623 (Paterson *et al.*, 2009).

#### Future thrust

Based on the breeding objective, precision molecular breeding of sorghum should be carried out; For example, slow digestibility, low cholesterol, antioxidant and other health benefits are the characteristic features of grain sorghum. Increasing the protein content especially lysine and starch (especially amylopectin) are the future thrust area in sorghum breeding. The goal of future breeding is to increase protein (especially lysine) and starch contents and reduce tannins. Although great progress has been made in locating the genetic loci for traits, advanced techniques such as high-throughput sequencing, pan-genomes and epigenomes has to be integrated to identify the

superior alleles and the functional regulation network underlying the complex agronomical traits and the stress resilience of sorghum. An enormous amount of research on molecular markers has been accomplished in the recent past in sorghum, there is still an immense need to develop breeder-friendly high-throughput markers for the important traits for stress tolerance along with nutrient traits like grain iron and zinc concentration.

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# Use of Nano-Trace Minerals in Livestock Feeding

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Feeding adequate amounts of balanced diets containing required quantity of trace minerals to the animals is one of the important factors for maintenance of good health and optimum production. Nutritional inadequacies occur in almost all parts of the world especially in livestock reared under traditional farming system. Grazing ruminants are the most likely species to suffer from under nutrition due to insufficient supply of nutrients through the forage they graze upon. The Indian farmers small & marginal exclusively depend on straw based feeding system to meet the nutrient requirements. These crop residues are not only low in energy and protein but also deficient in minerals. In the tropics under-nutrition is cited to be one of the major constraints towards efficient animal production and inadequate trace mineral nutrition is perhaps a more limiting factor in this regard compared to the deficiency of energy and protein. Grasses & cereal straws fed livestock usually does not receive mineral supplementation, except for common salt and must depend largely on forages to supply their mineral requirements. However, only rarely, can forages completely satisfy all mineral requirements for livestock. Therefore, mineral supplementation can be a low cost input for the improvement of livestock production. However, mineral supplementation in excess than the need of the animals may yield only diminishing returns and excretion through feces to environment is a major source of pollution (Eguia *et al.*, 2009). Hence, to elicit the maximum benefit out of the supplementation a specific strategy must be chalked out prior to the start of the mineral supplementation.

Many factors influence the availability of minerals to animals. The availability of mineral to the animal does not solely depends upon the amount the feed contains, rather depends upon the chemical form in which the mineral is present and presence of other dietary components with which it interacts at the site of absorption or metabolically. Traditionally, inorganic salts such as oxides, sulfates and carbonates have been added to the diet to provide the desired amount to meet the requirements of the animals. These are broken down to varying extents during digestion to 'free' ions' and are then absorbed. However, they may also complex with other dietary molecules and become difficult to absorb or, if completely bound, totally unavailable to the animal. Thus, the availability of the element may decrease substantially. Because of these uncertainties, excess amount of minerals over 20-30 fold higher than the normal requirement are provided in the diet than the minimum amount required for the optimum performance, resulting in over-supply and unnecessary wastage, extra cost and obvious environmental pollution. Alternatively organic sources of minerals are promising, as they have much higher bioavailability than inorganic sources of minerals (Sridhar *et al.*, 2015). However, organic sources of minerals are much costlier than traditional inorganic sources (Zhao *et al.*, 2014).

Recently, it has been demonstrated that material at nano meter dimension exhibit novel properties different from its normal sized particles. Such as, greater specific surface area, higher surface activity, high catalytic efficiency and stronger adsorbing ability which are due to the advantage of



size effect and high surface reactivity (Zhang *et al.*, 2001). Bioavailability of the trace minerals can be enhanced by increasing the surface area and nano minerals are used to enhancing the bioavailability in livestock (Rajendran *et al.*, 2013). Liao *et al.*, (2010) reported that nanoparticle showed new characteristics of transport and uptake and exhibit higher absorption efficiencies and reaches deeper into the tissues. The nano-sized particles are having higher potential than their conventional sources and reduces the quantity required (Sri Sindhura *et al.*, 2014). Thus, nanotechnology applications have the great potential to advance the science of mineral nutrition and as trace mineral supplement in animals, require very lower doses than the conventional organic and inorganic sources.

### **Importance of trace mineral supplementation in livestock**

The importance of mineral elements to the health and well-being of animals has been recognized for centuries even though, individual elements involved were discovered later. They are required for maintenance, growth and reproduction of animals. Livestock most commonly suffer from nutritional deficiencies due to stress of high level of production and deficient feeding leading to poor reproductive performance. Micro minerals are very essential part of animal's ration which is required only in smaller amounts and excess feeding of some of these may show toxicity symptoms. Trace elements are needed in less than 100 ppm in the diet (NRC, 2001) of ruminants. For optimum reproductive performance in farm animals, twenty-two such elements have been identified. The important trace minerals include copper, cobalt, manganese, selenium iodine, iron, chromium and molybdenum where as others are of less practical value.

Trace minerals play wide variety of role in the animal body. They are involved in several biological processes, such as component of metallo-enzymes and enzyme co factors. These works both as activator of enzymes involved in intracellular detoxification mechanism of free radicals and in stabilization of secondary molecules. Some of these trace minerals are component of hormones and thus directly involved in regulation of endocrine activities. Due to its involvement in carbohydrate, protein and nucleic acid metabolism, any change in its level may alter the production of reproductive and other hormones. Its deficiency may affect embryonic development, post-partum recovery activities and over all fertility of animal will be impaired. In male animals it may change spermatogenesis and affect libido. Most of the non-conventional feeds are deficient in trace minerals and are likely to increase chances of reproductive problems.

### **Brief history of nanotechnology**

Richard Feynman, also known as father of Nanotechnology brought the concept of nanotechnology in year 1959. For his work in this field, he also received Noble prize in 1965. In 1974, Prof. Norio Taniguchi introduced the term 'nanotechnology'. First book on nanomedicine called "Nanomedicine" came in year 1999 by R. Freitas. In 2000 - "National Nanotechnology Initiative" (NNI) was launched in the USA.

### **Nanotechnology**

Definitions of nanotechnology are as diverse as its applications. Basically, it is the ability to design and control the structure of an object at all length scales from the atom up to the macro scale. The term nano technology has been derived from the Latin word *nanus*, meaning *dwarf*. Nanotechnology is

defined as the technology of materials and structures, whose size is in nanometers.

**The differences in the properties of nanoparticles are due to:**

The physical, chemical, electrical, optical, mechanical and magnetic properties at an atomic scale are quite different from those present at a larger scale, even when compared with those present at a scale of microns (10<sup>-6</sup>) (Buzea *et al.*, 2007).

**The mechanisms of action of the nanoparticles are as follows (chen *et al.*, 2006).**

- Increase the surface area available to interact with biological support
- Prolong compound residence time in GIT
- Decrease influence of intestinal clearance mechanisms
- Penetrate deeply into tissues through fine capillaries
- Cross epithelial lining fenestration (e.g. liver)
- Enable efficient uptake by cells
- Efficient delivery of active compounds to target sites in the body

**Effects of feeding nano-trace minerals in livestock production**

So far, very little information is available on the suitability and efficacy of nanoparticles on the performance of animals and most of the studies regarding use of nanotechnology in animal nutrition is focused mainly to assess the effect of supplementation of nano particles of minerals in the diet of non-ruminants, as we know the bioavailability of inorganic sources of trace minerals is quite low and alternatively organic sources of minerals are having much higher bioavailability than inorganic sources of minerals (Sridhar *et al.*, 2015) but the disadvantage with organic sources of

minerals is that they are much costlier than traditional inorganic sources of minerals (Zhao *et al.*, 2014). Some of the nano mineral proven to at laboratory include nano zinc, nano copper, nano chromium, nano iron and nano selenium. These can be used at lower doses and can provide better result than the conventional sources and indirectly prevents environmental contamination also.

### Conclusion

Studies so far have indicated that the application of nano minerals in animal production, immunity and reproduction is promising. Because, applications of nano-minerals are immensely useful, the safety in application of nanominerals needs to be assessed before it is being applied in the livestock industry. However, work on use of nano particles of minerals is still very limited and needs to be taken up.

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# Solar-Powered Irrigation Systems: A Sustainable Solution for Irrigation

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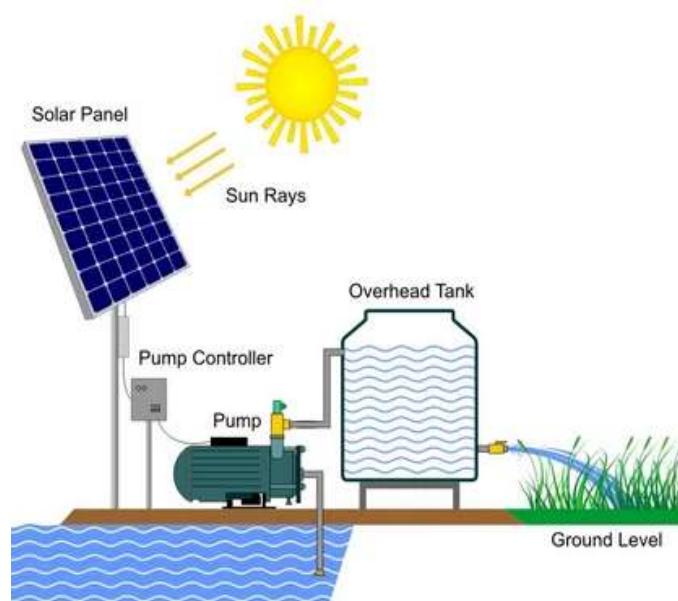
Solar-powered irrigation systems (SPIS) are innovative and environmentally friendly technologies that harness solar energy to pump water for agricultural purposes. These systems offer a sustainable solution to address the challenges of water scarcity, rising energy costs, and climate change impacts on agriculture. By utilizing solar power, farmers can improve crop yields, enhance food security, and reduce greenhouse gas emissions, making them an essential component of modern and sustainable agriculture.

## The Need for Solar-Powered Irrigation Systems

- **Water Scarcity:** Agriculture is the largest consumer of freshwater worldwide. As water resources become scarce due to increasing demand and climate change, it becomes crucial to adopt efficient irrigation methods to make the best use of available water.
- **Energy Costs:** Conventional irrigation systems that rely on grid electricity or fossil fuels are becoming cost-prohibitive due to rising energy prices. Solar-powered systems offer a cost-effective alternative by utilizing freely available solar energy.
- **Climate Change:** Climate change is altering precipitation patterns, leading to more frequent droughts and extreme weather events. Solar-powered irrigation can provide a resilient water supply, enabling farmers to cope with these changing conditions.

## How Solar-Powered Irrigation Systems Work

The Solar Power Irrigation system consists of



- **Solar Panels:** The heart of a solar-powered irrigation system is photovoltaic (PV) solar panels that convert sunlight into electricity. These panels are mounted on structures, such as ground-mounted arrays or rooftops, and capture solar energy throughout the day.
- **Solar Pump:** The solar-generated electricity powers a solar pump that lifts water from a water source, such as a well, river, or pond, and delivers it to the irrigation system.
- **Storage and Distribution:** Some solar-powered irrigation systems include energy storage using batteries to ensure a continuous water supply, even during low-sunlight periods. The water is then distributed through pipes or drip irrigation systems to the crops.



**Fig.1 Diagram of Solar Powered Irrigation System**

### Advantages of Solar-Powered Irrigation Systems

Solar Powered Irrigation system possessed several advantages over electric or diesel powered irrigation system. The various advantages are:

- **Energy Independence:** Solar-powered systems provide farmers with energy independence, reducing their reliance on grid electricity or fossil fuels. This independence shields them from fluctuating energy prices and power outages.
- **Environmental Benefits:** Solar irrigation significantly reduces greenhouse gas emissions compared to conventional diesel-powered pumps. It is a clean and renewable energy source, contributing to the fight against climate change.
- **Cost-Effectiveness:** While the initial investment for solar-powered irrigation systems might be higher, the long-term operational and maintenance costs are lower than conventional systems. Additionally, many governments and organizations offer

financial incentives and subsidies to promote solar adoption in agriculture.

- **Access to Water:** Solar-powered irrigation systems can reach remote and off-grid areas that lack reliable electricity supply. This expands access to water for farming and supports rural development.

### Types of Solar-Powered Irrigation Systems

**a) Solar Direct-Drive Pumps:** These systems use the direct electricity generated by solar panels to power the pump, providing a simple and cost-effective solution for small-scale irrigation needs.

**b) Solar Water Pumping Systems with Energy Storage:** These systems incorporate batteries to store excess solar energy during peak production hours. The stored energy can be used during periods of low sunlight, ensuring continuous water supply.

**c) Solar Drip Irrigation Systems:** Drip irrigation is a water-efficient method that delivers water directly to plant roots. When combined with solar power, it optimizes water use and reduces wastage.

**d) Solar Micro-Irrigation Systems:** These systems integrate solar power with advanced micro-irrigation technologies, such as sprinklers and drip lines, to precisely control water application, leading to higher water-use efficiency.

### Challenges and Solutions

The various challenges to install SPIS are

- **Initial Investment:** The upfront cost of solar-powered irrigation systems can be a barrier for small-scale farmers. Governments, financial institutions, and development organizations can provide financial support, subsidies, and micro-financing options to make these systems more affordable.
- **Technical Knowledge:** Farmers may lack technical expertise to install and maintain



solar-powered systems. Training programs and extension services can be established to build the capacity of farmers and technicians in solar technology.

- **Water Management:** Solar-powered irrigation systems must be complemented by effective water management practices to ensure efficient use of water resources. Training on water-saving techniques and proper scheduling can help farmers make the most of their solar-powered systems.
- **Maintenance and Repairs:** Regular maintenance is crucial for the smooth operation of solar-powered systems. Establishing local service centers and

providing access to spare parts can ensure timely repairs and maintenance support.

### Conclusion

Solar-powered irrigation systems have emerged as a game-changer in modern agriculture, providing a sustainable, clean, and cost-effective solution to address water scarcity and energy challenges. By harnessing the power of the sun, these systems empower farmers to cultivate their land efficiently and improve their livelihoods. Governments, agricultural organizations, and development partners should continue to promote and support the widespread adoption of solar-powered irrigation systems to achieve a more sustainable and resilient agricultural future.

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# Success Story of Progressive Woman Farmer: Smt. Sujata Sharanabasappa Patil

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Smt. Sujata Patil w/o Sharanabasappa Patil is a 44 years old enthusiastic woman farmer from Kamalapur taluka, Kalaburagi district and her main occupation is agriculture and allied activities. After completed of education and helped her husband to raise income. She owning 11 acres of land situated on Bidar-Srirangapattana National Highway-218 main road between Mahagaon and Kamalapur towns in which 9 acres has well fertile land and other 02 acre has medium to low fertile land. She was having many components like field crops, horticulture crops, dairy unit etc but the overall income was poor as the holding was not properly utilized scientifically and the units were not integrated. She came in contact of ICAR-Krishi Vigyan Kendra, Kalaburagi-I under University Of Agricultural Sciences, Raichur scientists and progressive farmers and also in touch of agriculture and allied departments for inputs, facilities and technical information. Scientists guided here for adopting technologies for the best production like Integrated Farming System, Integrated Pest and Disease Management, Integrated Nutrient Management, Integrated Dairy Management and Scientific stall-fed goat farming etc.

As a result now Sujata Patil grow various field crops like redgram, soybean, green gram, black gram, wheat, maize, ground nut, sesame, sugarcane and different horticultural crops like Thai lime, lemon, Jamun, different varieties of guava, mango, jamun, custard apple, sapota, water melon, red



banana, papaya, noni, citrus, curry leaf and drumstick, vegetables like tomato, brinjal, chilli, onion, bottle guard, bitter guard, ridge guard, cucumber, cluster bean etc. grown as a sole crop as well as intercrop and flowers like sugandh raj, rose, marigold, jasmine and millets like pearl millet, foxtail millet, browntop millet and sorghum and 200 teak, sandalwood and some medicinal plants on bunds. She is also having modern farm implements

like mini tractor, Rotovator, plough, tillers, bed maker, trolley, ridge and furrow maker, drip pipeline, sprinklers, sprayers, venchuri and filter, high-tech stall-fed goat farming and dairy unit, vermicompost unit, nursery sheds, open well, farm pond, mini check dam and bore well recharge points. She also rears 10 cows, 15

buffalos, 100 desi poultry birds, fishery, 10 bee keeping boxes, 05 sheeps, 100 goats, horse, Mudhol and Dauber breed dogs as well.

## Training and support

Smt. Sujata Patil besides family support, her interest, dedication and technical guidance and various training was taken from the KVK scientists



and experts from Agriculture Department motivated her and she adopted new technologies and implement them in her fields this led to success.

Sujata gained the knowledge about agriculture and enhanced her technical knowledge regarding cultivation of different types of crops, soil testing, vermicomposting, dairy etc. she implemented components like dairy, goatry, poultry, fishery, field and horticulture crops and used new technologies viz. sub surface drainage in field, spraying mango special in mango, high density planting in guava, solar fencing, alerting alarm new technologies in red gram like used improved varieties, seed treatment, nipping, usage of pulse magic, integrated pest and disease management, usage of pheromone traps, yellow sticky traps, solar light traps, processing unit, value addition, branding and direct marketing etc. and also adopted application of nutrients based on soil test results, use of green manure, farmyard manure, compost,



vermicompost, liquid fertilizers and bio fertilizers for enhancing soil health.

### Importance for Farmers

Sujata is earning an income of approximately Rs. 15 to 16 lakhs per annum from all the sources. She was also grading and producing value added

products like Jave Godi, uppit rawa, huggi rawa from wheat, mango and lemon pickles etc., under her “Rangamma Farms” also production and sale of



breeds of dogs & goats & nursery seedlings of fruits and vegetables and get more profits adopted all new scientific technologies and succeed. Influenced by her nearly 45 farmers of neighbouring villages have been converted in to Integrated Farming System and attracted surrounding farmers in adopting new technologies.

### Achievements

Recently she had been honoured by Government of Karnataka prestigious “**Krishi Pandit Award**” during 2022-23 under farm women category, “**Best Horticulture Farm Women**” during 2021-22 from University of Horticultural Sciences Bagalkote under Horticulture: women empowerment theme, she was received “**Best Farm Women-2020-21**” state level award and leading newspaper Vijaya Karnataka daily’s ‘Best farmers Award’ held at Bengaluru, Karnataka on January-2021 and she was recognised as district level with ‘**Best Farm Women**’ by the Vijaya Karnataka daily and “**Krishi Ratna**” award from District Krishik Samaja, Kalaburagi on the occasion of farmer’s day respectively.

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# Khejri: A Sacred Tree

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India is a land of diverse flora and fauna, where trees hold immense cultural, ecological, and economic importance. Among the many trees that grace the Indian landscape, the Khejri (*Prosopis cineraria*) stands out for its unique qualities and deep-rooted significance. This deciduous tree, native to the arid regions of India, has been revered for centuries and continues to play a vital role in the country's ecological balance and sustainable development. The tree is frost and drought resistant and tolerates extreme temperature ranging from 40–45 °C in summer to less than 10 °C in winter. It is capable of growing in areas of rainfall ranging from 100–600 mm. The tree can withstand the hottest winds, the driest season and stay alive where other plants cannot survive. It can be safely said that khejri is a tree of the desert.

The tree grows on a variety of soil but prefers alluvial, consisting of various mixtures of sand and clay. It can tolerate moderate salinity of soil but dries up in very high salinity. It also acts as an effective soil binder and is a great stabilising agent in sandy soils. Khejri is known by many local names in zonal districts of Rajasthan, popularly it is called khejri or *khejra*. It is also called *jant* or *janti* in areas like Alwar, Sikar, Jhunjhunu, Churu, Jaipur, Bharatpur, Karoli, Dholpur, Samal village in Udaipur, and Banswara and Dungarpur districts of Rajasthan. Each part of the tree, from root to pod, finds some use or another. The extent of its importance is highlighted in its recognition as the 'state tree' of Rajasthan. Since all parts of khejri are useful it is called the '*kalpavriksha* of the desert'. It is also known as the 'king of the desert' and the 'wonder tree'. It is a symbol of socio-economic development in the area. It is a socially preferred tree species and is regarded as the lifeline of desert dwellers. Owing to its



multiple uses and services rendered, khejri has been the most common agroforestry species for centuries. The unripe pods are green, and locally known as 'sangria' or 'sangar'. The dried green beans of the khejri are stored and used for cooking round the year. It is one of the ingredients of the famous panchkuta, a local dish cooked with five vegetables. The dried mature pods, locally called 'kho-kha', have a sweetish pulp and are also edible and much liked by local children. They are used as fodder for livestock. Even the bark having an astringent bitter taste was reportedly eaten during severe famines of 1899 and 1939. The gum of the tree obtained during May and June is nutritive and good to taste.

The Role of Khejri in Human and Environmental Mitigation

## Ecological Significance

**Soil Conservation:** Khejri plays a vital role in preventing desertification and conserving the fragile soil of the Thar Desert. Its extensive root system helps bind the soil, reducing erosion caused by wind and water. As a result, the tree helps maintain the integrity of the desert ecosystem, preserving the delicate balance of sand dunes and preventing land degradation.



**Wildlife Habitat:** Khejri serves as a valuable habitat for various desert-dwelling wildlife species. The dense canopy provides shelter and nesting sites for birds, while the tree's pods serve as a source of food for several desert animals, including antelope, gazelles, and camels. The presence of Thar Shobha contributes to the overall biodiversity of the Thar Desert.

- **Fuelwood and Timber:** The dense wood of Khejri is highly valued for fuelwood, providing a sustainable source of energy for cooking and heating in rural households. Additionally, the timber derived from Khejri is used for construction, furniture making, and various local crafts, contributing to rural economies.
- **Fodder for Livestock:** Khejri leaves and pods serve as a nutritious fodder source during times of fodder scarcity. Livestock, particularly camels, goats, and sheep, heavily depend on Khejri foliage for sustenance in arid areas.

### Environmental Mitigation and Conservation

Khejri offers numerous environmental benefits, contributing to ecological balance and mitigating environmental challenges:

- **Carbon Sequestration:** Khejri has the ability to sequester carbon dioxide from the atmosphere, helping to mitigate the effects of climate change. Its extensive root system aids in soil carbon storage, enhancing soil fertility and productivity.

- **Soil Conservation:** Khejri's deep-rooted system prevents soil erosion and helps stabilize the desert ecosystem. It aids in maintaining the structure and integrity of the soil, thereby reducing land degradation and desertification.
- **Nitrogen Fixation:** Khejri, through its symbiotic relationship with nitrogen-fixing bacteria, has the unique ability to convert atmospheric nitrogen into a form that can be utilized by other plants. This process improves soil fertility and supports the growth of other vegetation in arid areas.

The Bishnoi community in Rajasthan, known for their deep reverence for nature, has played a crucial role in the conservation of Khejri trees. They have a longstanding tradition of protecting these trees and have even sacrificed their lives to prevent their destruction.

### Varieties of khejri in india

Exploring the Varieties of Khejri Trees in India

1. *Prosopis cineraria* var. *cineraria*: This is the most common variety of Khejri found in India. It has a moderate-sized, spreading crown with branches that extend horizontally. The bark is rough and greyish-brown, providing protection against extreme temperatures. The leaves are compound and double-pinnate, composed of numerous small leaflets. It exhibits excellent drought tolerance and is known for its nitrogen-fixing abilities.
2. *Prosopis cineraria* var. *rajasthanica*: This variety is native to the arid regions of Rajasthan, particularly the Thar Desert. It has a distinctive morphology, with a tall, straight trunk and a broad crown that provides ample shade. The leaves are smaller in size compared to other varieties, and the tree exhibits exceptional adaptability to arid conditions. *Prosopis cineraria* var. *rajasthanica* plays a crucial role in





preventing desertification and supporting local biodiversity.

3. *Prosopis cineraria* var. *microphylla*: This variety is found in the arid regions of Gujarat and parts of Maharashtra. It is characterized by smaller-sized leaves and a more compact growth habit. *Prosopis cineraria* var. *microphylla* is known for its ability to withstand high salinity levels in the soil, making it suitable for coastal regions with saline conditions. It plays a crucial role in stabilizing coastal ecosystems and providing protection against coastal erosion.
4. *Prosopis cineraria* var. *albida*: This variety is found in parts of South India, particularly in the arid regions of Karnataka and Andhra Pradesh. It is characterized by a smaller stature and a bushier appearance compared to other varieties. *Prosopis cineraria* var. *albida* is highly valued for its nitrogen-fixing abilities, contributing to soil fertility and supporting agricultural practices in these regions.

### Characteristics of Thar Shobha:

1. **Drought Tolerance:** Thar Shobha showcases exceptional resilience to prolonged droughts, which are a common occurrence in the Thar Desert. It possesses deep-rooted systems that allow it to access water from deeper layers of the soil, ensuring its survival during prolonged dry spells.

2. **Leaf Morphology:** Thar Shobha exhibits distinct leaf morphology compared to other Khejri varieties. Its leaves are smaller in size and have a unique shape, resembling elongated and feathery structures. These modified leaves help reduce water loss through transpiration, enabling the tree to conserve moisture in the arid environment.
3. **Canopy Structure:** The canopy of Thar Shobha is denser and more compact compared to other Khejri varieties. This unique structure provides increased shade and helps protect the tree from excessive heat and intense sunlight, a crucial adaptation for survival in the scorching desert.



### Propagation

Khejri mainly propagates through seed germination. Regeneration through seeds is confined to moist climate; in places that are dry, the tree regenerates itself using root suckers, which are also produced on removal of the main trunk. The trees can also be successfully raised by sowing, in conjunction with field crops in irrigated lands. The root system of khejri is long and well-developed and penetrates deeper and deeper for subsoil water. Growth above the ground is slow. Very deep roots help in securing firm footing and in obtaining moisture from deep soil layers.

### Diseases of khejri and their management

Khejri (*Prosopis cineraria*) is a hardy tree species native to arid and semi-arid regions of India. While it exhibits natural resilience to various environmental stressors, it can be susceptible to certain diseases that can impact its health and productivity. Effective disease management strategies are crucial for preserving the health and vitality of Khejri populations.

1. **Gummosis** (Bacterial Infection): Gummosis is a bacterial infection caused by *Xanthomonas albilineans*. It is characterized by the formation of gummy exudates on the branches and trunk of Khejri trees. Gummosis can weaken the affected tree, leading to reduced growth and productivity.

#### Management

- Pruning: Infected branches and trunks should be pruned and removed to prevent the spread of the bacteria.
  - Sanitation: Proper sanitation practices, such as removing and disposing of infected plant material, can help reduce the disease's prevalence.
  - Chemical Control: In severe cases, copper-based bactericides may be applied to affected trees following appropriate guidelines.
2. **Wilt** (*Fusarium oxysporum*): Wilt disease caused by the fungus *Fusarium oxysporum* affects the vascular system of Khejri trees, leading to wilting, yellowing of leaves, and eventually tree death. It primarily spreads through contaminated soil or infected plant material.

#### Management

- Soil Sterilization: Soil sterilization techniques, such as solarization or fumigation, can help reduce the pathogen load in the soil and limit disease transmission.

- Crop Rotation: Practicing crop rotation with non-host plants can help break the disease cycle.
  - Resistant Varieties: Selecting and promoting disease-resistant Khejri varieties can be an effective long-term strategy for disease management.
3. **Leaf Spot** (*Alternaria* spp. and *Cercospora* spp.): Leaf spot diseases caused by *Alternaria* and *Cercospora* fungi can lead to the development of circular or irregular lesions on Khejri leaves. Severe infections can cause premature leaf drop, defoliation, and reduced photosynthetic capacity.

#### Management

- Pruning: Infected branches and trunks should be pruned and removed to prevent the spread of the bacteria.
- Sanitation: Proper sanitation practices, such as removing and disposing of infected plant material, can help reduce the disease's prevalence.

#### Insect pests of khejri

Khejri (*Prosopis cineraria*) can face insect pest infestations that can impact its growth and productivity.

4. **Stem Borer** (*Adetomyrrhynchus* sp.): Stem borers are the larvae of certain beetles that tunnel into the stems of Khejri trees, causing damage to the vascular tissues. Infestation by stem borers can lead to wilting, dieback, and even tree mortality.

#### Management:

- Cultural Practices: Regular pruning and removal of infested branches can help control the spread of stem borers.
- Biological Control: The use of natural enemies such as parasitic wasps or predators that prey on stem borers can be effective in managing their populations.

5. **Pod Borer** (*Maruca vitrata*): Pod borers are the larvae of moths that infest the pods of Khejri trees, leading to damage and reduced pod quality. Infested pods often show signs of tunneling and frass (excrement) inside.

### Management

- Cultural Practices: Regular inspection and removal of infested pods can help reduce pod borer populations.
- Biological Control: Encouraging natural predators and parasitoids that attack pod borers can provide effective control.
- Chemical Control: In severe cases, insecticides approved for use on Khejri may be used following recommended application rates and timing.

6. **Leafhoppers** (*Empoasca* spp.): Leafhoppers are sap-feeding insects that can cause yellowing and curling of Khejri leaves. Heavy infestations can lead to reduced photosynthetic activity and stunted growth.

### Management

- Cultural Practices: Regular monitoring and early detection of leafhopper populations can help prevent outbreaks.
- Biological Control: Beneficial insects, such as ladybugs and predatory wasps, can naturally control leafhopper populations.

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# Farm Planning: Must for Profitable Farming

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Farm planning in agriculture is a pre-planned thinking to properly utilize the available resources to maximize the income. To be able to compete in the national and international market there is need to reduce cost of cultivation as well as to improve the quality of produce which is possible only through proper farm planning. Farm planning becomes more important as the farmer has to face emerging challenges of globalization, depletion of under-ground water table, decline in influx of migrants, increasing cost of production, etc. Various surveys revealed that there is a lack of proper planning at farmers' level. Proper planning must have provisions for proper use and conservation of natural resources (like use of leaf color chart for nitrogen management, zero-till cultivation of crops, growing crops having less water requirement, etc.), judicious use of agro-chemicals (like integrated approach for pest control, using insecticides on economic threshold level, etc.) and increasing net income from the farm. Domestic needs of farming family in terms of vegetables, pulses, oil seeds, fruits, etc. should also be kept in view so as to have a least dependence on market. In brief, farm-planning is an act of proper analysis from all possible angles about the activity/enterprise to be started and to make it a success.

## Farm-planning depends upon

- Selection of crops to be grown and concerned subsidiary occupations to be started.
- Area to be allocated under each crop and the size/volume of the selected enterprise.

- Quantity of inputs needed such as seed, fertilizer, pesticides, labor, etc.
- Source and time of procuring inputs.
- Way to dispose of the farm produce. Whether to store the harvested produce or to sell it immediately after harvest?
- Marketing of the produce at the right time and right market place.
- Price volatilization of commodities during the year/season.

## Successful farm planning needs

- Complete knowledge of recommendations for all the crops which can be acquired by reading farm literature, through discussions with agricultural experts, through TV, Radio and internet programs, by attending seminars and farmers' training camps, etc.
- Knowledge about soil type and fertility status of the soil.
- Knowledge about the quantity and quality of irrigation water available at the farm is also very important as under-ground water of some of the districts of the state is brackish and due attention must be given while selecting the crops to be grown under such situations.
- Keep in mind the available scarce resources such as land, labor, FYM, animals, machinery, irrigation water, capital, etc. to decide the possibilities about the quantum of area to be put under different



crops/enterprises. Care should be taken to include rented-in and rented-out resources.

- Preparation of different improved alternative farm plans while keeping in view the weaknesses of the existing plan, available resources, profitability of different crops and possible risks (which may be due to price fluctuations or decline in yield). These plans can be compared on the basis of net returns and the plan providing higher net returns can be accepted for implementation. There should be a scope for making changes (which may be required due to adverse weather or changes in prices) in the accepted farm plan.
- Assessment about the required inputs like seed, fertilizer, pesticide, capital, labor, machinery, etc. for the accepted farm plan should be made in advance. Quantity of inputs and place from where to procure these inputs must also be taken care of.
- Proper maintenance of farm records for the preparation of optimum farm plan. This enables the farmer to have accurate information about the costs and returns from different crops/enterprises. Farmer can give priority to the activity providing higher net returns. The activity producing lower net returns can be reduced or eliminated from the plan to make farming more economical.
- Maintenance of farm records enables the farmer to assess whether added costs have increased the returns or not and if increased, then to what extent? Farming remains economical so long as the added returns are higher than the added costs which are the base for the expansion of farming/enterprise.

- National and international marketing structure, import and export possibilities also needed to be kept in view.

### How to plan for horticulture

Planning for enterprises other than crops must be there to adjust the work force spared due to decreasing size of the holdings and continuous mechanization in agriculture. In horticulture, both vegetable and fruit cultivation can be added in the agriculture plan. Vegetable crops are of short duration, risky but highly profitable whereas fruit cultivation is long duration and less risky enterprise. The following points must be kept in mind while planning the establishment of fruits orchards as it requires long run decisions to make it a sustainable business.

- Locality survey to assess the already existing area and the possible markets for horticulture crops is must for a good start.
- Quality seedling, soil, water and labour availability including family labour is perquisite for this enterprise.
- To face the volatile prices in vegetables and fruits, their processing and value addition must also be planned so as to sustain this business over long time. For this purpose, continuous interaction with the agri-experts of Punjab Agricultural University and Department of Horticulture, Punjab is necessary.
- To increase the farmer's share in net returns, the concept of self-marketing in both fruits and vegetables must be added in the farm planning.

### Advantages of farm planning

- Beneficial to assess the gap between potential yield and yield realized by the farmer which

enables him to find remedial measures. Profitability of subsidiary occupations can be worked out and planning can be modified to reduce the losses or to improve the profits.

- Comparison of different crop rotations and subsidiary occupations can be easily made which is pre-requisite for proper planning.
- Farmer can assess the amount of capital required and the loan to be taken. Farmer can implement the plan by taking loan well in advance and from the right institute of his choice.
- Weaknesses in the existing farm plan can be identified which is very useful in preparing improved plan.

- Useful for government for making various policies.
- Useful for providing feed back to the research system.

The farmer needs to prepare the plan well in advance to take full advantage of the existing resources. In view of the swift changes in technology, farming has not remained an easy task. Majority of the farm activities are dependent upon weather; therefore, they have to be carried out at a specific period of time. So, success in farming lies on proper farm planning. This will not only help in optimum utilization of the limited resources but will improve the income level and living standard of the farmer also.

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# Green Nanotechnology: Paving the Way for Sustainable Development

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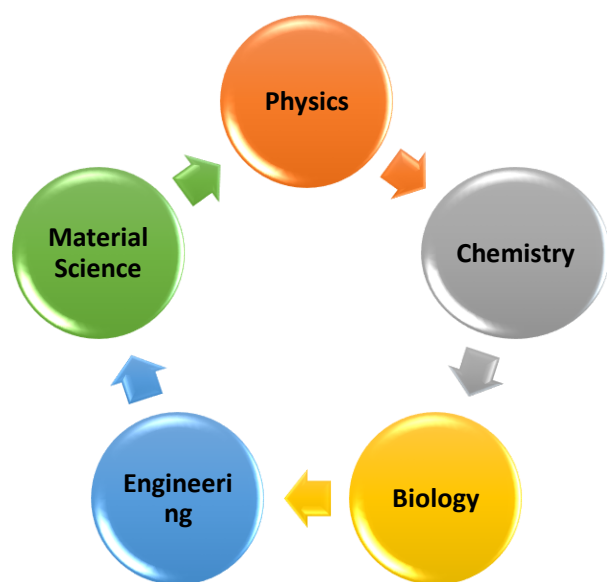
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Nanotechnology is a rapidly emerging field that explores the manipulation and control of matter at the nanoscale. At this scale, materials exhibit unique properties and behaviors, allowing scientists to design and create new materials with enhanced functionalities and performance. The term "nano" refers to one billionth of a meter, which is about the size of a few atoms or small molecules. Nanotechnology involves the manipulation, measurement, and modeling of materials and devices at this nanoscale level. It encompasses various interdisciplinary fields enabling researchers to address challenges and create innovative solutions in diverse industries and sectors.



**Figure 1: Interdisciplinary fields encompassed by nanoparticles**

The applications of green nanotechnology span across numerous fields, including electronics,

medicine, energy, manufacturing, aerospace, food science, packing industry, agriculture, genome manipulation, textiles science, cosmetics and environmental science. For instance, in electronics, researchers use nanotechnology to develop smaller, faster, and more efficient devices. In medicine, green nanotechnology enables targeted drug delivery systems, reducing overall dosages and minimizing side effects. Additionally, diagnostic imaging techniques that utilize nanomaterials allow for more precise and efficient diagnoses, thus lowering healthcare waste and resources.

The use of nanomaterials in energy applications is another significant aspect of green nanotechnology. By incorporating nanotechnology into the development of solar cells and energy storage devices, researchers are striving to increase energy efficiency, decrease reliance on fossil fuels, and promote renewable energy sources. Nanotechnology also plays a crucial role in water purification processes, providing sustainable solutions to combat water scarcity.

The textile industry is another area where green nanotechnology holds great promise for sustainable development. By integrating nanotechnology into textile production, researchers are able to enhance the properties of fabrics in an eco-friendly manner. For example, nanotechnology can be used to create waterproof and stain-resistant textiles without the need for harmful chemicals. This not only prolongs the lifespan of the garments but

also reduces the consumption of water and energy used in cleaning and maintenance.

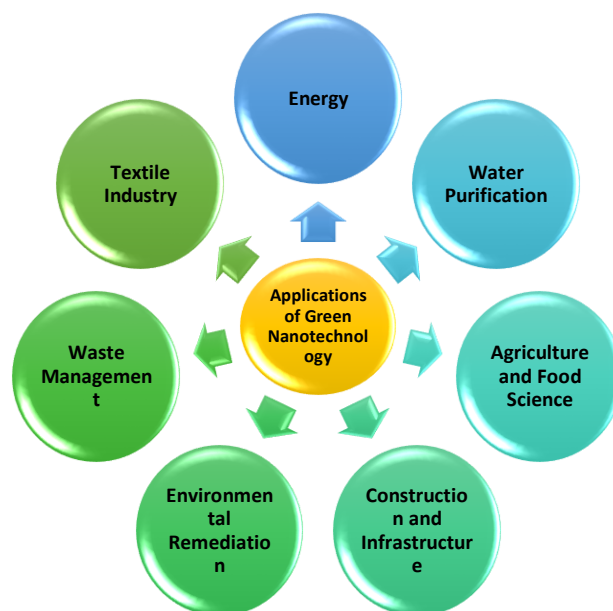
Moreover, nanotechnology can be utilized to incorporate antimicrobial properties into textiles, reducing the need for excessive washing and harmful disinfectants. This can have a positive impact on water resources and the environment as a whole. As nanotechnology continues to advance, it holds the promise of revolutionizing industries and transforming our daily lives by enabling groundbreaking innovations and advancements in a wide range of fields.

### Understanding Sustainable Development

Sustainable development, at its core, entails meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. Green nanotechnology plays a crucial role in paving the way for sustainable development by offering innovative and eco-friendly solutions. By harnessing the unique properties and behaviors of materials at the nanoscale, scientists can design more efficient and sustainable products across diverse industries. This includes developing smaller and more energy-efficient electronics, targeted drug delivery systems in medicine, and renewable energy solutions in the field of energy. Furthermore, incorporating nanotechnology into textile manufacturing enables the production of environmentally friendly fabrics with enhanced properties, reducing the reliance on harmful chemicals and conserving resources. Embracing the advancements in green nanotechnology empowers us to address the challenges of today while preserving our planet for future generations, truly paving the way for sustainable development.

### Applications of Green Nanotechnology in Sustainable Development

Nanotechnology, particularly in its green form, offers a wide range of applications that contribute to sustainable development across various sectors.



**Figure 2: Applications of Green Nanotechnology**

- A. **Energy:** Nanomaterials are harnessed to enhance energy efficiency and promote renewable energy sources. Nanotechnology enables the development of more efficient solar cells, capable of converting sunlight into electricity with higher conversion rates. It also facilitates the production of lightweight and high-capacity batteries for energy storage, increasing the viability of renewable energy integration. Moreover, nanomaterials can improve catalytic processes in fuel cells, leading to cleaner and more sustainable energy generation.
- B. **Water Purification:** Green nanotechnology plays a significant role in water treatment and purification. Nanomaterials such as carbon nanotubes and graphene oxide have



excellent filtration properties, effectively removing contaminants and pollutants from water sources. Additionally, nanotechnology-based solutions can help in desalination processes, addressing water scarcity issues by producing freshwater from saltwater sources in a more energy-efficient manner. This contributes to sustainable water management and the availability of clean drinking water.

**C. Agriculture and Food Science:**

Nanotechnology is being employed to enhance agricultural practices and promote sustainable food production. Nanosensors can monitor soil conditions, enabling precise and targeted delivery of fertilizers and pesticides, thereby reducing the environmental impact.

**D. Construction and Infrastructure:**

Nanomaterials are being used to develop advanced construction materials with enhanced properties. For example, adding nanomaterials to concrete can improve its strength, durability, and resistance to environmental factors, leading to longer-lasting and more sustainable infrastructure. Nanotechnology also enables the development of smart coatings that can self-clean, self-heal, or provide insulation, reducing maintenance costs and energy consumption.

**E. Environmental Remediation:**

Nanotechnology offers innovative solutions for environmental remediation and pollution control. Nanomaterials can be utilized to effectively remove pollutants from air, soil, and water. For instance, nanoparticles can adsorb or catalytically break down harmful

contaminants, contributing to the clean-up of industrial waste sites or reducing air pollution from vehicle emissions. These nanotechnology-based solutions help mitigate environmental damage and promote a healthier ecosystem.

**F. Waste Management:**

Nanotechnology can revolutionize waste management by offering more efficient and sustainable methods of recycling and waste treatment. Nanoscale catalysts can facilitate the conversion of waste materials into valuable resources through processes such as catalytic degradation or gasification. Additionally, nanomaterials can enhance the efficiency of water and wastewater treatment systems, reducing the environmental impact.

**G. Textile Industry:**

Nanotechnology has significant applications in the textile industry, promoting sustainability in fabric production and enhancing textile properties. By incorporating nanomaterials into textiles, it is possible to develop fabrics with enhanced functionalities and improved sustainability. For instance, nanotechnology allows for the creation of fabrics with increased durability and longevity, reducing the need for frequent replacements and minimizing textile waste. Nanocoatings can also be applied to textiles to provide properties such as water repellency, stain resistance, and UV protection, reducing the need for chemical treatments and extending the lifespan of the garments. Additionally, nanotechnology enables the development of smart textiles with integrated sensors, enabling monitoring of vital signs or environmental conditions. This can lead to

advancements in wearable technology and promote sustainability by integrating multiple functionalities into a single textile material. By leveraging nanotechnology in the textile industry, sustainable practices can be fostered, such as reduced water and energy consumption, as well as the use of eco-friendly materials.

### **Green Nanotechnology in Renewable Energy-**

Green nanotechnology is revolutionizing the field of renewable energy by providing innovative solutions for enhanced energy efficiency and sustainable power generation. Nanotechnology plays a crucial role in improving the performance of renewable energy systems and reducing their environmental impact.

One application of green nanotechnology in renewable energy is the development of highly efficient solar cells. Nanomaterials, such as quantum dots and nanowires, can be integrated into solar cell technology to enhance light absorption, enable more efficient charge transport, and improve overall energy conversion efficiency. These advancements allow solar cells to generate more electricity from sunlight, making solar energy a more viable and sustainable alternative to traditional fossil fuels.

Furthermore, nanotechnology is utilized in the development of advanced energy storage systems. Nanomaterials, such as graphene and carbon nanotubes, can significantly enhance the energy storage capacity and performance of batteries and supercapacitors. By incorporating nanotechnology into energy storage devices, renewable energy sources like solar and wind power can be efficiently stored and used when needed, addressing the intermittency challenges associated with these sources.

In addition, green nanotechnology plays a crucial role in fuel cell technology, enabling sustainable power generation through electrochemical reactions. Nanomaterials, such as platinum nanoparticles, are widely used as catalysts in fuel cells, facilitating the efficient.

### **Addressing Environmental Challenges with Green Nanotechnology**

Green nanotechnology offers immense potential in addressing various environmental challenges and promoting sustainable development. By harnessing the unique properties of nanomaterials, it provides innovative solutions to mitigate pollution, conserve resources, and reduce the environmental impact of various industries.

One significant environmental challenge that green nanotechnology addresses is air pollution. Nanomaterials, such as titanium dioxide nanoparticles, can be incorporated into coatings or filters to capture and degrade harmful pollutants like nitrogen oxides and volatile organic compounds. These nanotechnology-based solutions enable cleaner air and contribute to improved public health.

Another area where green nanotechnology has a positive impact is in water treatment and purification. Nanomaterials, including graphene oxide and carbon nanotubes, can effectively remove contaminants and pollutants from water sources, such as heavy metals and organic pollutants. With their high surface area and unique properties, nanomaterials offer more efficient and sustainable water purification methods, contributing to clean water availability and resource conservation.

Green nanotechnology also plays a crucial role in waste management. Nanomaterials can be utilized to develop more efficient and sustainable recycling processes. For example, nanotechnology-

based catalysts enable the breakdown of complex waste materials into valuable resources, reducing the accumulation of waste in landfills and promoting a circular economy.

### **Conclusion: The Future of Green Nanotechnology in Sustainable Development**

Green nanotechnology has emerged as a powerful tool in driving sustainable development across various industries and sectors. By harnessing the unique properties and behaviors of nanomaterials, scientists are able to design and create innovative solutions that address environmental challenges while promoting resource conservation and efficiency. The applications of green nanotechnology in electronics, medicine, energy, and textiles have showcased its immense potential in revolutionizing industries and transforming our daily lives. From smaller and more energy-efficient devices to targeted drug delivery systems, nanotechnology offers sustainable

solutions that reduce waste, conserve resources, and enhance performance.

In the future, green nanotechnology is expected to play an even more significant role in sustainable development. As research and development in this field continue to advance, we can anticipate breakthroughs in areas such as environmental remediation, waste management, and advanced materials for clean energy generation. These advancements will contribute to a more sustainable and resilient future, where industries and technologies are aligned with the principles of sustainable development.

To fully realize the potential of green nanotechnology, it is essential to foster interdisciplinary collaborations, promote responsible innovation, and prioritize the ethical and environmental considerations associated with nanomaterials. By integrating green nanotechnology into our sustainable development efforts, we can pave the way.

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# Millet Cultivation: Current Status in the Eastern Ghats Section of Tamil Nadu

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Millets are a group of small-seeded cereal food grain crops. With an annual production of 15.53 million ton, millets are grown on nearly 12.45 million ha of land in India, accounting for 10% of the country's food grain basket. India is the [largest producer](#) of millet as of 2021, with a total share of 41%, followed by Niger (~12%) and China (~8%). Sorghum and pearl millet are major millets, and minor millets group is made up of six cultivated species, including small millet, Indian barnyard millet, kodo millet, foxtail millet, finger millet and proso millet. Millets have been an integral part of our diet for centuries. They offer a plethora of health benefits and are also good for the environment with low water & input requirements for production. With the aim to create awareness and



A farmer at Burgur (Erode district) showing millet grains

increase production & consumption of millets, the United Nations, at the behest of the Government of India, declared 2023 as the '[International Year of the](#)

[Millet](#)'. To assess status of millet cultivation, existence of variability in it, collection of landraces and wild relatives, an exploration survey was carried in the Eastern Ghats section in Erode and Namakkal districts of Tamil Nadu, which are traditional millet growing belts. Majority of the areas are uneven terrains or hills with their elevation ranging from 200 to 1400 m MSL and an average annual rainfall around 900 mm in the northern Erode district, whereas ca.1350 mm in Kolli Hills. Red-sandy soils prevail in the surveyed areas. The inhabitants (*Hindu Uralis*, *Malayali*, *Soliga*, *Lingayat* and *Badagas*) are primarily dependent upon agriculture for their livelihood and economy. Millets were grown in *kharif* season except proso-millet, which is grown in *rabi* season. Random sampling was followed in most cases. A total of 47 millets germplasm were collected belongs to 12 species namely, *Echinochloa crusgalli* (1), *E. frumentacea* (3), *Eleusine coracana* (7), *E. indica* (1), *Panicum miliaceum* (5), *P. sumatrense* (8), *Paspalum scrobiculatum* (1), *Pennisetum americanum* (5), *Setaria italica* (11), *S. pumila* (1), *Sorghum bicolor* (3) and *Sorghum propinquum* (1).



Chen-thinai: A variant in foxtail millet

In little millet (*P. sumatrense*), different names are used to depict the variability such as 'jaminsamai', 'karuppusamai', 'arasamai', and





**Variability in foxtail millet germplasm**



**Variability in little millet germplasm**

‘kattavattisamai’, and grain colour variation (with shades of yellow, white, grey) was found in the collections. Proso millet (*P. miliaceum*) is characterized broadly by two kinds of grain colour - shiny golden yellow and greyish black. In foxtail millet (*S. italica*), there are three landraces - Mookanthinai (only inflorescence harvested), Koran thinai (three months crop) and chen-thinai (red grains), which tend to differ in grain colour and crop duration. Chen-thinai is also nutritionally superior and rich in antioxidants. Medium variability with respect to grain colour and size in finger millet, sorghum and pearl millet was observed. *S. propinquum* (PT/23-50), collected probably for the first time for Bureau from this area and it is added to the primary gene-pool of sorghum. Kodo (*P. scrobiculatum*) and barnyard millets (*E. crusgalli* and *E. frumentacea*) were hardly found under cultivation. A semi-domesticated millet ‘korala’ (*S. pumila*; syn. *S. glauca*) was collected from Burgur area hamlets in Erode district, where it was grown along with little millet as a mixed crop. Its grains are used similarly to that of little millet. Overall, in a remote tribal area of Gundri, located near the Karnataka border, Thamarakarai in Burgur areas and a few pockets in Selur Nadu, Alathur Nadu and

Thiruppuli Nadu in the Kolli Hills could find reasonable cultivation of millets.

Till ca. 2005, millets formed the staple food and cultivated in all these areas. Due to the menace of wild animals namely, wild-boar, peacock, wild



**A rare germplasm of semi-domesticated ‘Korala’ (*Setaria pumila*; PT/23-91) collected from Burgur area in Erode**

elephants during the past 15 years, people tend to switch over to flower crops such as marigold, and cash crops such as castor, tapioca, and potato in Thalavadi belt

and high-value plantation crops such as black pepper, coffee, and cardamom in Kolli Hills. People mentioned that drastic reduction of jackal and wild-dogs population in these areas due to expansion of cultivation negatively correlated with increasing population of peacock and wild-boar, otherwise these animals steals eggs of peacock and hunts peachicks and wild-boarlets.

The area under traditional crops has been reduced drastically. Kodo millet (locally called 'Aarenga'/'Arika') was extinct from Thalavadi, Gundri and Kolli hills and farmers expressed the desire to grow/revive this crop. Millet-growers also expressed marketing problems faced by them and expressed their demand of fixing up MSP. Now some private agencies with government supports (e.g., Malai Millets Farmers Producers Company Ltd., Thalavadi; Dimbam cooperative farmers

produce association) make good initiatives to buy back millet produce and value addition to revive their cultivation. Celebrating International Year of Millet 2023 increases awareness about millet consumptions, its health benefits, diversification in the millets product and value addition among people. This leads to increase the demand for millets in the market and encourage millet growers to grow the crops in sustainable manner.

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# Estrus Detection Aids in Dairy Cattle

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Reproduction plays a pivotal role in the success and profitability of dairy farming operations worldwide. Timely and accurate detection of oestrus (estrus) in dairy cattle is a crucial aspect of reproductive management, as it directly impacts conception rates and overall herd productivity. However, accurately identifying oestrus in cows can be a challenging task for dairy farmers, given the subtle and often short-lived behavioral and physiological changes that accompany this critical stage of the estrous cycle. Advancements in modern farming techniques have introduced a variety of oestrus detection aids that assist dairy farmers in detecting and monitoring oestrus more effectively. These aids range from traditional observation techniques to innovative technological solutions that leverage cutting-edge sensors and data analytics. The integration of such aids into dairy management practices not only improves breeding efficiency but also optimizes the overall reproductive health and genetic potential of the dairy herd. In this article, we delve into the significance of oestrus detection in dairy cattle and explore the various aids available to facilitate accurate and efficient oestrus detection.

## Importance of estrus detection:

- **Maximizing Reproductive Efficiency:** Accurate estrus detection enables timely insemination, increasing the likelihood of successful conception. Identifying cows in estrus at the right time optimizes the chances of fertilization,

leading to higher pregnancy rates and a more efficient breeding program

- **Reducing Days to First Service and Breeding Interval:** Effective estrus detection helps minimize the time interval between calving and the subsequent successful breeding. Reducing the days to first service and the breeding interval contributes to a more regular calving pattern and improved reproductive performance
- **Cost-Effectiveness:** Early detection of estrus ensures that cows are inseminated at the optimal time, minimizing the number of insemination attempts required to achieve pregnancy. This cost-effective approach reduces expenses associated with artificial insemination procedure
- **Managing Resources and Labor:** Efficient estrus detection allows farmers to focus their resources and labor on cows that are ready for breeding, rather than routinely inseminating animals that may not be in estrus. This targeted approach streamlines breeding management practices

Therefore, a well-managed estrus detection program contributes to a sustainable and profitable dairy operation. Higher reproductive efficiency leads to increased calf production, improved milk yield, and enhanced overall herd performance, ensuring the long-term success of the dairy business.

## Visual estrus detection

Visual estrus detection in dairy cattle involves direct observation by trained personnel/ farmer himself to identify behavioral and

physical signs of estrus in cows. It is one of the traditional and commonly used methods for detecting cows in heat. Key behavioral signs of estrus include mounting other cows, restlessness, increased vocalization, sniffing other cows genitals, and standing to be mounted. Additionally, physical signs like swollen and red vulva, clear vaginal mucus discharge, and increased activity can also indicate estrus. Detecting estrus in modern dairy cows poses challenges due to reduced estrus signs and shorter durations. Estrus detection rate greatly depends on the timing, duration, and frequency of observation, along with comprehensive record-keeping. Estrus observation demands dedicated farm staff/farmer who understand estrus signs. Longer and more frequent observations are necessary for accurate estrus detection in dairy cattle.

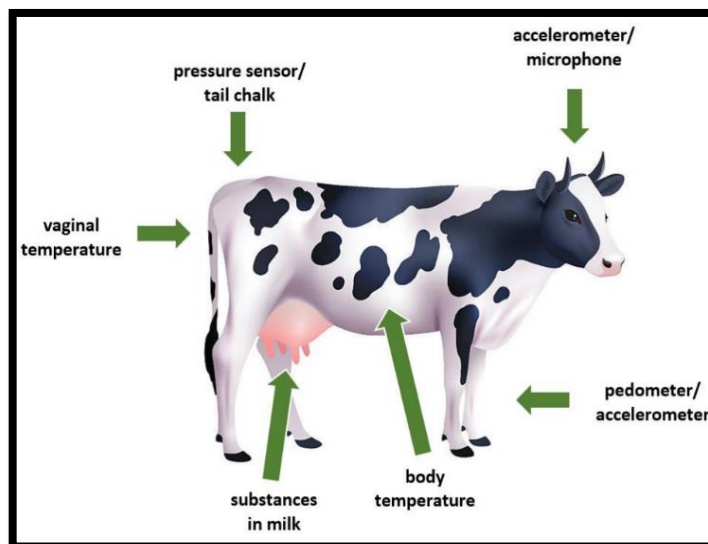
### Different Estrus detection aids:

To address the impact of estrus detection rate on reproductive performance and the limitations of visual estrus detection, farmers have turned to innovative technologies. These advancements offer enhanced estrus detection by monitoring behavior, either independently or in conjunction with visual observation. These technology-driven solutions empower farmers to improve their reproductive management practices, ensuring timely insemination and optimizing overall herd productivity.

### Heat detection patches

Heat detection patches are popular aids for estrus detection in dairy cattle. Applied to the cow's tailhead or flank, they change color when mounted by other cows during estrus. They are easy to use and provide visible color changes, allowing farmers to monitor multiple cows conveniently. However, they rely on mounting activity, potentially missing cows

without mounting behavior. Combining patches with other methods like visual observation or technology ensures better accuracy and efficiency in detecting estrus in cows.



**Figure 1: Different estrus detection aids**

### Tail paint or chalk

This is the simplest and cost-effective method for estrus detection in dairy cattle. Applied to the cow's tailhead, it changes color when mounted by other cows during estrus, indicating signs of heat. However, as in heat detection patches this method relies on mounting behavior and may miss cows without such activity.

### Tail ring for estrus detection:

Tail rings are simple and cost-effective tools that are manually attached to the cow's tail. They work based on the principle that when a cow is mounted by another cow during estrus, the tail ring moves or shifts its position. This movement or shifting of the tail ring serves as a visual indicator to the farmer or herdsman that the cow has exhibited signs of estrus and has been mounted. Tail rings are relatively easy to install and remove, making them convenient for use during the breeding season. They do not require any complex technology or data



interpretation, making them accessible to most farmers, even those with limited resources.

However, it's essential to recognize that tail rings rely solely on mounting activity for estrus detection. Cows that do not display mounting behavior may go undetected, potentially leading to missed estrus cycles. To overcome this limitation, tail rings can be used in conjunction with other estrus detection methods to maximize accuracy and increase the chances of detecting cows in heat.

### Tail-head RFID chip

Example of Tail-head RFID chip are Heat Wath II and Cow Chips are estrus detection aids utilizing RFID technology for detecting standing estrus in dairy animals through pressure-sensitive chips placed over the tail-head region. Celotor ([www.celotor.com](http://www.celotor.com)) employs two gadgets, one attached to the female dairy animal and the other to a teaser bull, for timely artificial insemination. While these technologies offer valuable insights, they may not provide information about the mounting animal or account for homosexual behaviors in cows. Proper sex ratio in the herds is essential for the successful operation of Celotor. Understanding the limitations of these aids is crucial for optimizing reproductive efficiency and herd productivity

### Pedometers and accelerometers

Pedometers are small devices attached to the cow's leg or collar that track and record the cow's movement and activity. During estrus, cows tend to display increased activity, including walking more and engaging in mounting behavior. Pedometers monitor these activity patterns and provide data that can indicate potential estrus events.

Farmers can use this data to identify cows showing unusual levels of activity, suggesting that they may be in heat. Pedometers and accelerometers

offer several advantages for estrus detection. They provide continuous and objective monitoring of cow activity, reducing the reliance on visual observation and human judgment. These devices enable real-time data collection, allowing farmers to promptly detect estrus events and make timely breeding decisions.

Pedometers and accelerometers offer valuable advantages for estrus detection in dairy cattle, but they have limitations. They rely on activity levels, which may not always accurately indicate heat, leading to false positives or negatives due to environmental stress or changes in routine. Technical issues can cause data inaccuracies or missed estrus events. Initial costs and ongoing maintenance may be challenging, and cow discomfort can impact accuracy. Interpreting data requires specialized knowledge. Integrating these aids with other methods can enhance overall estrus detection accuracy and effectiveness.



**Figure 2:**  
**Pedometer on**  
**leg for estrus**  
**detection**

### Automated Heat Detection Systems

Automated Heat Detection Systems are cutting-edge technologies employed in dairy cattle management to revolutionize estrus detection.

Consisting of strategically placed cameras and sensors within barns, these systems continuously monitor cow behavior in real-time. Advanced algorithms and artificial intelligence analyze the data, accurately identifying signs of estrus, such as mounting, restlessness, and increased activity. When cows display estrus-related behaviors, the system generates alerts, notifying farmers of potential heat activity. This 24/7 monitoring ensures no estrus events go unnoticed, enabling timely breeding decisions during the cow's fertile period. Automated Heat Detection Systems reduce labor intensity, provide valuable data insights for herd management, and ultimately enhance reproductive efficiency. While requiring initial investment and maintenance, these systems leverage technology to optimize estrus detection, leading to improved conception rates and more productive dairy herds.

### **Hormonal Estrus Detection**

It involves using specific tests to measure hormone levels in dairy cattle to determine their reproductive status and estrus activity. Progesterone tests, conducted on blood or milk samples, assess the levels of this hormone, which indicate whether a cow is cycling or in estrus. Estrogen tests, performed on urine or milk samples, provide information about the cow's estrus activity, as estrogen levels increase during this period. Additionally, Gonadotropin-Releasing Hormone (GnRH) tests detect hormone levels related to the ovulation process, helping farmers identify the optimal timing for artificial insemination or natural breeding. By relying on hormonal changes, these tests offer valuable insights into the cow's reproductive health, aiding in the timely detection of estrus and optimizing breeding decisions for improved reproductive efficiency in dairy farming.

### **Reticulo-rumen bolus devices**

Reticulo-rumen bolus devices, such as those offered by SmaXtec sensor ([www.smxtec.net](http://www.smxtec.net)), are at the forefront of estrus detection in dairy cattle. These innovative devices utilize radiofrequency, thermistor, electrode, SMS, and 3-axis accelerometers to monitor the activity, temperature, and drinking behavior of dairy animals. The reticulo-rumen bolus is ingested by the cow and remains inside the stomach, continuously collecting real-time data. The bolus employs radiofrequency technology for wireless communication, allowing seamless data transfer to a receiver. The thermistor measures the cow's body temperature, crucial for identifying heat events. The electrode monitors rumen pH levels, helping to understand the cow's digestive health and potential hormonal changes during estrus. Meanwhile, the 3-axis accelerometers track the cow's movement, aiding in detecting increased activity associated with estrus behavior.

The bolus devices send alerts and data summaries via SMS, empowering farmers to take immediate action and ensure the best possible reproductive outcomes for their dairy herd. This seamless integration of technology revolutionizes estrus detection, ultimately contributing to improved herd productivity and health.

### **Conclusion**

Estrus detection aids, from simple tail paint to advanced automated systems, hold great potential to enhance herd's reproductive efficiency and productivity. Automation in estrus detection has shown promising results, enabling timely breeding decisions and improving conception rates. Embracing advanced estrus detection aids in dairy cattle management can significantly improve reproductive efficiency and overall herd

productivity. Utilizing technologies like heat detection patches, tail paint, pedometers, and automated systems empowers farmers to make timely breeding decisions, leading to higher conception rates. However, it is essential to consider the limitations of these aids, such as potential false positives or negatives, the need for proper calibration, and their reliance on specific behavioral indicators. Integrating multiple detection methods and maintaining a proper sex ratio in the herds are key factors for maximizing the effectiveness of these aids.

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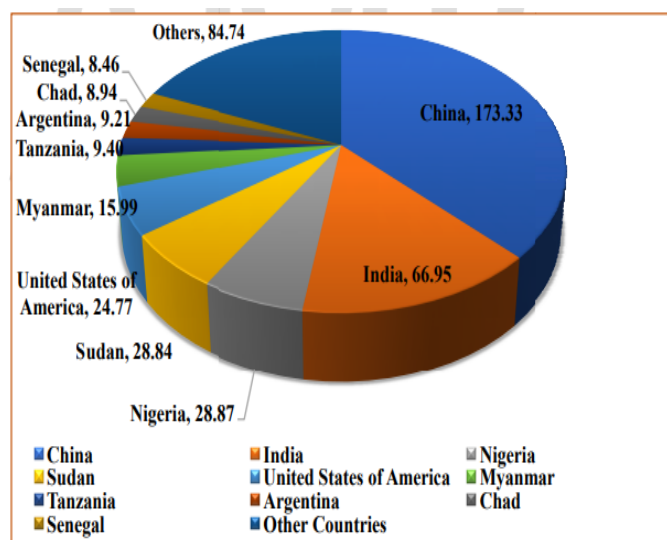
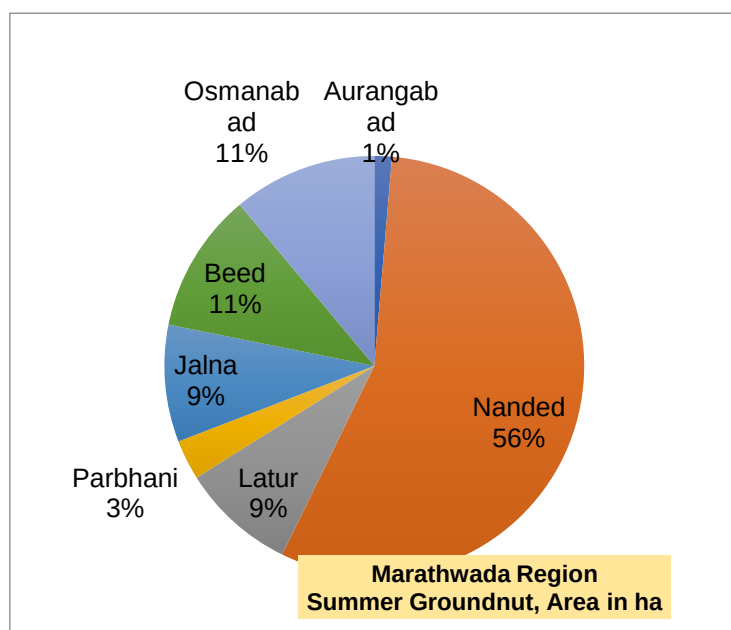
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# Performance evaluation of Turmeric Digger modified for Groundnut Digging Operation

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India is one among the top three groundnut producing countries of ranks second next to China. Nearly 15 percent of Groundnut production is contributed by India to the world production during 2018(1). Agriculture is the main sector in the economy of the Marathwada region of Maharashtra that is mainly dependent on monsoon rainfall. Among the oilseed crops grown in Marathwada, groundnut holds the first place. The annual production of groundnuts of Marathwada region is around 30858 tons approximately and 7 districts of Marathwada. Among the all district from Marathwada region, Nanded holds first place in groundnut production and area of cultivation both. Nanded are considered to contribute more than



16413 tons a year. In spite of the large-scale mechanization of agriculture in Maharashtra. Most of the agricultural operations are carried on by human hand using simple and conventional tools and implements like groundnut digging operation which is laborious and time-consuming operation.

## Groundnut digging with conventional method

- The groundnut digging operation is time consuming and laborious operation leads to increase the digging cost.
- Manually about 20-30 women are required to dig and strip an acre of groundnut.
- Additionally, labors required to collect harvested crop at one place
- Manually digging operation is Drudgeries, required bending, squatting and standing posture alternately which is not ergonomically desirable.
- Groundnut Harvesting should be done on time. If you harvest before maturity lowers the yield due to shrinkage of seeds when they dried.
- Delaying in harvesting germinate the seeds in the field it self due to dormancy



- Delaying in harvesting, more pods remain in soil due to broken of roots, which reduce yield and increase labour cost form picking up the pods from the soil.
- Usually, the pods are left in the ground. The losses may be upto 10– 30 per cent depending upon the conditions.

### Plan, Implement and Support

Keeping in view the above problems, value addition in the existing turmeric digger was done at Custom Hiring Centre, KVK Sagroli. The necessary modifications were incorporated to improve the existing turmeric digger for groundnut digging operation. The machine is converted into a tractor-driven groundnut pod digger.



**Fig.1 Making necessary modifications to the turmeric harvester machine**

### Modification

During field testing, the existing machine for groundnut digging was found unsatisfactory performance. Because the soil volume blocking the inlet of conveyor and dug soil along with the Groundnut plants was obstructing the conveyor inlet due to low clearance between upper frame bars and existing curved iron pipes (of 10 cm length) of the conveyor. To minimize the above problem, existing iron pipes were removed. Also, during experiment, the action of the blade performance was found poor.

The modifications were made to adjust the digging blade according to the requirement for the satisfactory performance of digging blade simultaneously did the Proper adjustment of multi V shape blade of the digger with maintain the blade angle between 10 to 25 Degree.

**Table.1 Performance Evaluation of the Modified Machine compared with manual method**

| Sr. No | Particular                                | Tractor-driven groundnut pod digger | Manual method of Groundnut digging |
|--------|-------------------------------------------|-------------------------------------|------------------------------------|
| 1.     | Digging Efficiency, %                     | 100                                 | 95 %                               |
|        | Undug Pod Percentage                      | 0                                   | 4.5%                               |
| 2.     | Pod Damage Percentage                     | 0                                   | 0.5%                               |
| 3.     | Working Width, m                          | 1.8                                 | 0.3                                |
| 4.     | Forward speed, km/h                       | 2                                   | -                                  |
| 5.     | Field capacity, ha/h                      | 0.36                                | -                                  |
| 6.     | Fuel Consumption, l/h                     | 2                                   | -                                  |
| 7.     | Labour requirement                        | -                                   | 20                                 |
| 8.     | Total cost required for groundnut digging | 2000                                | 5000                               |

### Output

Finally, the field test was conducted at the farmer's field in sagroli Nanded for the machine evaluation. Field performance of the digger was observed and evaluated at 2km/h forward speed of tractor. The

machine performance data regarding fuel consumption, groundnut digging depth, digging efficiency, pod breakage/damage percentage etc were recorded. The experimental results showed the



**Fig. 2 Groundnut digging operation in field using the modified machine**

digging efficiency (i.e. 100%) and pod damage percentage (i.e. 0%) were observed at 2 km/h forward speed of tractor the depth. Not a single pod remains in the soil, 100% pods were harvested from

the black cotton soil. The field capacity of modified digger was recorded as 0.3 ha per hour.

### Outcome

The value-added groundnut digger was tested in black cotton soil. The machine can be used to harvest root crops other than groundnut and turmeric. The drudgery of field work will be reduced and labor shortage problem in the district will be overcome by the machine.



**Fig. 3 Conducted Demonstration at Farmer's Field**

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# Rootstock and Its Importance in Fruit Crops

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Rootstock is the lower portion of the graft which develops into the root system of the grafted plant. A rootstock may be seedling, a rooted cutting or layered plant. It is also described a plant which already has an established healthy root system on to which a cutting or bud from another plant is grafted. The plant part grafted on to the rootstock is usually called scion. Rootstocks are being used in plant propagation for more than 20 centuries. It's may be a same or different species from the scion (Singh *et al.*, 2021).

## Types of rootstock

### 1. Seedling rootstock

These types of rootstock are developed from the seed. These rootstocks are relatively simple and economical to produce. Root systems of seedling rootstocks are deeper. These are mostly used for tropical and sub-tropical fruit crops. Seedling rootstocks have an advantage that the plant doesn't retain viruses occurring in their parent plant. Seedling rootstocks have a disadvantage of genetic variation which may lead to variation in performance of scion (Goswami, 2017).

### 2. Clonal rootstock

Rootstocks propagated by vegetatively are known as clonal rootstocks. These also include those fruit crops which have azygotic seeds Viz., parthenogenetic, polyembryonic and apomitic seed. Each clonal rootstock is genetically same and has identical growth characteristics in given environment. Major disadvantage of clonal rootstock is that, they retain the viruses occurring in the parent

plants. Clonal rootstocks commonly used in temperate region fruit crops (Hartmann *et al.*, 2002).

## Characteristics of an ideal rootstock

- It should exhibit a high degree of compatibility with scion cultivars and give maximum life to trees.
- It should be well adapted to climatic conditions of the particular region like frost, cold and heat.
- Should be resistant to disease and pest prevalent in the concerned area.
- Should be tolerant to adverse soil conditions like salt and drought.
- Must exhibit favourable and positive influence on the performance, bearing and quality of scion variety.
- Should possess good nursery characteristics like germination, high degree of polyembryony, ability to attain graft-able size in short period and free from excessive branching.

## Importance of rootstocks in fruit crops

### 1. Tolerance against biotic stress

Losses due to insect pest and diseases can be minimized by using tolerant rootstocks which are well known in crops like citrus and grape. Rough lemon and Cleopatra mandarin have been found tolerant against tristeza, exocortis and xyloporosis. Nematodes are limiting factor in citrus production, which can be overcome by using trifoliate orange as rootstock. Several *Vitis* species show good resistance against nematodes. Freedom, Harmony and Dog



Ridge are rootstock root knot nematode resistance. Different *Vitis* species are known for their ability to tolerate soil infestation of phylloxera and nematodes. In breeding new rootstock, the aim is to combine resistance to these pests along with other key traits. It is important to test new rootstocks for resistance to different races or biotypes of the pests before they are selected for use as rootstocks in evaluation.

### 2. Improved fruit quality

Rootstocks are sometimes important in the improvement of the fruit quality for crops like, grapes and citrus. There are several report which emphasized their influence on the improvement in quality through TSS, reducing sugar and acidity content of the fruits, Granulation in citrus is also indirectly influenced by the vigour imparted by the rootstock. Higher degree of the granulate in Jaffa sweet orange on Jatti Khatti as a rootstock.

### 3. Increased scion yield efficiency

Rootstocks influence the scion vegetative growth directly or indirectly and thus are decisive in manipulating yield efficiency. In several of the fruit crops, fruit yield per unit area has been found to be influenced by the rootstock. In citrus, the role of the Rangpur lime, Dogridge in grapes and Vellai Kolumban in Alphonso mango has proved the importance of rootstock in increasing scion yield efficiency. The vigour imparted to scion has direct relationship with the fruit yield because of more fruiting area. However, productivity index may vary with the rootstock efficiency to produce fruit per unit area.

### 4. Wider adaptability

Wider adaptability is one of the important characteristic of the rootstock for the successful adoption by the farmers. Rootstock with low multiplication rate and adaptation in limited

geographical area may restrict the usefulness. There is a need of rootstocks for different crops with successful performance under biotic and abiotic stresses, beside adaptively to wide range of soils and climatic conditions.

**Table 1: Rootstocks for different fruit crops**

| Crops      | Rootstocks                             | Grafting method    | Month                     |
|------------|----------------------------------------|--------------------|---------------------------|
| Mango      | Velliacolamban                         | soft wood grafting | July-September            |
| Grape      | Ramsey and Dogrees                     | Whip grafting      | September - October       |
| Sapota     | Khirmi or Rayan ( <i>M. hexandra</i> ) | soft wood grafting | August-September          |
| Cashew     | Local cashew                           | Soft wood grafting | March-September           |
| Ber        | Local / Desi red ber seedling          | Patch budding      | July-August end           |
| Aonla      | Local Aona seedling as stock           | T budding          | June-September , February |
| Jack fruit | Local Jack fruit                       | Soft wood grafting | December                  |
| Tamarind   | Local tamarind seedlings.              | Soft wood grafting | March-April               |
| Apple      | Crabapple, malling IX stocks.          | Tongue grafting    | February-March            |

(Sources: Chadha, 2019)

### 5. Improve salt tolerant

The indiscriminate use of heavy quality of chemical fertilizer and the over exploitation of aquifers has dramatically multiplied of surface area affect by salinity. It is commonly accepted that growth inhibition by salt stress is associated with alteration in the water relationship within the plant ,



caused by osmotic effects with specific ionic consequences or energy availability related to carbohydrate concentration. Walker demonstrated that the rootstocks 'cleopatra mandarin' excludes  $\text{Cl}^-$  but not  $\text{Na}^+$ . this suggests that the ability to exclude these two ions stems from different mechanisms. In India, grape rootstocks such as Dogridze and 110 R are presently being employed mainly to overcome the adverse effects of abiotic stresses like drought and soil salinity and to manipulate vigor of vine to some extent . Mango rootstocks '13/1' has relative high salt tolerance under field condition and makes mango cultivation possible under saline stress conditions also. It is a polyembryonic rootstocks commercially used in Israel and Egypt and has been tested in various regions of the world for tolerance in calcareous soils and saline condition.

### Conclusion

From the foregoing discussion it can be concluded that, rootstock play vital role in

propagation of fruit crop. It protects the fruit crops from adverse effects of drought and salt stress. It helps to improve nutrient uptake from the soil and yield as well as quality of fruit. In fruit crops, rootstocks also give the tolerance against different biotic stresses.

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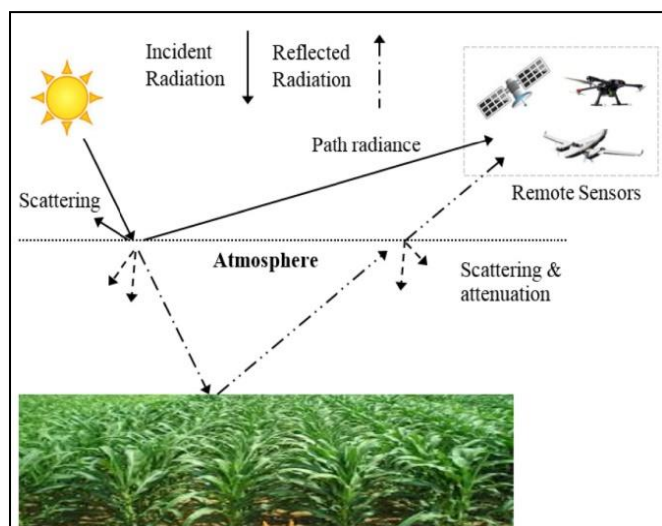
# Use of Remote Sensing in Agriculture

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Remote sensing is gathering information through analysis based on energy of electromagnetic radiations reflected, absorbed or transmitted from the earth's surface. The rays of sun arrive on earth are in the form of electromagnetic radiation. These electromagnetic radiations can be visible light, infrared or microwave radiation and can be passed through any layer depends on the characteristics of that layer. These rays are detected by remote sensing technology. It utilizes various devices and sensors such as aeroplane, drones, and satellites. It enables scientist to gather information about earth's features and processes. Sensors collect data in the form of digital image or measurements.



**Fig. 1: Process of remote sensing**

## Types of remote sensing in agriculture

Remote sensing techniques possess various methods for data collection and analysis of crops and agricultural landscapes. Some common types are:

**a) Optical sensing:** Here sensors detect EM radiations in visible, near-infrared (NIR), thermal

infrared (TIR) region of EM spectrum. Optical sensing data is obtained through satellite imagery or aerial photography. It can provide information about crop health, land cover or vegetation indices.

**b) Hyperspectral sensing:** Here sensor captures data in number of narrow and contiguous spectral bands across EM spectrum. High resolution allows thorough analysis and identification like disease detection, detailed crop classification and nutrient assessment.

**c) Multispectral sensing:** Here sensor captures the data in several discrete bands within EM spectrum. It allows the detection of specific wavelength related to vegetation health and crop monitoring. It is used to calculate vegetation indices viz. EVI (Enhanced vegetation index) or NDVI (Normalized difference vegetation index).

**d) Thermal sensing:** Here sensors capture data in the TIR region of EM spectrum. They measure the emitted radiation from objects, including crops and soil, which is related to their temperature. Thermal sensing is useful for assessing water stress, detecting irrigation efficiency, and monitoring crop health based on temperature variations.

**e) Radar sensing:** Here sensors utilize microwave radiation to penetrate cloud cover, vegetation, and soil, allowing for data acquisition regardless of weather conditions. They measure the backscattered signal, which provides information about the structure and moisture content of crops and the terrain. It is used for mapping topography, monitoring soil moisture, and assessing crop growth stages.

**f) LiDAR sensing:** LiDAR (Light Detection and Ranging) sensors emit laser pulses and measure the time it takes for the reflected light to return. LiDAR data provides highly accurate three-dimensional information about crop height, canopy structure, and terrain elevation. It is useful for precision agriculture applications, including crop height estimation, terrain modeling, and canopy characterization.

**g) Unmanned Aerial Vehicles (UAVs):** UAVs equipped with various sensors, such as RGB cameras, multispectral sensors, or thermal sensors, enable high-resolution and flexible data collection at a localized scale. UAVs provide detailed and timely information for crop monitoring, disease detection, and precision agriculture practices.

### Application in Agriculture

#### Horticulture, agricultural cropping system analysis

Remote sensing technology is become evident in the analysis of different cropping system.

This technology is mainly utilized for horticultural crops where growth of flower analysis can be carried out and can be forecasted.

#### Crop condition assessment and stress analysis

Remote sensing allows monitoring and analysing health condition of every crop and extent of stress particular crop passed through. This data can be utilized to decide the quality of crop produce.

#### Estimation of crop produce

Remote sensing can also be used to estimate crop yields by analysing factors such as plant height, biomass, and chlorophyll content. This information

can help farmers plan their harvests and manage their crops more effectively.

The remotely sensed data used in conjunction with historical and current crop data, weather data, and field reports provide an overall assessment of the crop and food supply situation and integration of these data with digital maps of administrative boundaries, recent price and market conditions on food stocks and consumption rates can be used to predict the prospects of current crops.

#### Identification of different crops

It can be utilized to identify different crops especially those crops which are not easily identified as well as those crops which looks almost similar.

#### Pathogens and disease identification

Remote sensing allows recognition of contaminations and pest attacks in crops over huge areas at starting stages. This gives producers an adequate opportunity to apply any counter means to safeguard the harvests from any tremendous losses.



**Fig.2 GIS, GPS remote sensing and identification of contaminants and disease**

#### Nutrient management

It can assist in assessing nutrient deficiencies and managing fertilization practices. By analysing spectral reflectance patterns, farmers can identify areas of the field with varying nutrient levels. This allows for targeted application of fertilizers, minimizing excess use and potential environmental contamination while maximizing crop nutrient uptake and productivity.

### **Assessment of soil moisture and irrigation management**

It is very necessary to maintain adequate soil moisture condition. Soil moisture condition can be predicted through remote sensing and detailed information about humidity level can be predicted. Through this information we can predict about possibility of cultivation of different crops. By assessing vegetation moisture levels and evapotranspiration rates, it helps farmers determine the precise water requirements of their crops. This information enables them to implement efficient irrigation strategies, reducing water waste, and ensuring that crops receive adequate moisture for optimal growth.

### **Assessment of environmental changes**

It allows monitoring environmental impact on agricultural practices like soil erosion, hotspot polluted area, evaluation of effective conservation measures which support implementation of sustainable farming practices, reducing negative environmental effects and improving long-term agricultural sustainability.

### **Assessment of flood and drought**

Through satellite-based sensors and the data assembled through ground sensors, it can help with

giving a ton of definite information to decide an accurate loss assessment. In case of flooding due to excess rainfall, the areas of land with poor drainage frameworks are at risk of waterlogging which causes basic loss of harvests and yield. The loss assessment can help with further planning for the damage control and countermeasures for keeping losses to a minimum.

### **Land use and land cover changes**

Land use land cover change refers to the conversion of a piece of land's use by humans, from one purpose to another. For example, land may be converted from cropland to grassland. The land cover indicates physical land type such as forest or open water whereas land use documents how people are using the land. By comparing land cover data and maps over a period of time, coastal managers can document land use trends and changes. Using remote sensing techniques, we can keep track of the long-term natural changes in climate conditions, geomorphological and ecological processes, human-induced alterations of vegetation cover and landscapes, inter-annual climate variability, and the human-induced greenhouse effect and make the right decisions at times. Knowing the land use and land cover trend, one can have a better understanding of how and where to plan agricultural practices and get benefits likewise.

Overall, remote sensing has the potential to increase agricultural productivity and sustainability while assisting farmers in producing enough food to fulfil the rising demand in a changing climate condition.

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# Chemical Properties and Nitrogen Transformations in Submerged Soils

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Rice is the staple food crop of the nation spreading over an area of 45 m.ha with a total production of 130 m.tonnes. But rice ecosystem is fragile and grows in wide range of moisture regimes starting with submerged lowland to water deficit upland system. Thus, several physical, physico chemical and biochemical changes occur under submergence and are important in determining the suitability of soil for rice production.

## Depletion of oxygen

The immediate effect of submergence is creation of anaerobic condition due to replacement of air in the capillary pores. Within few hours after submergence, most soil layers turn virtually oxygen free. Soil microorganisms utilize oxidized soil constituents and organic metabolites instead of molecular oxygen for the respiration process causing reduction in soil. Anaerobic condition influences the availability of several plant nutrients and the production of toxic substances in the soil. Rice is able to manage submergence as its roots receive oxygen through aerenchyma in the shoot system and lysigenous chemicals in the roots. Under anaerobic conditions, facultative and true anaerobic organisms become active. Organic matter decomposition is slower and less complete in anaerobic than in aerobic soils.

## Decrease in redox potential

Whenever an aerobic soil is submerged, it undergoes reduction and its redox potential (Eh) drops to a fairly stable value of +0.2 to -0.3 V depending on the soil, but the redox potential in the surface water and the first few millimeters of top soil

remains at +0.3 to + 0.5 V (Ponnamperuma, 1972). Major portion of the root zone of submerged soil is reduced but the subsoil and spots in the reduced matrix as well as streaks may be oxidized. The reduction in Eh has twin benefits on rice growth. The benefits include increase in supply of nitrogen, phosphorus, potassium, iron, manganese, molybdenum and silicon. The disadvantages include loss of nitrogen by denitrification, decrease in availability of sulphur, copper and zinc.

## Changes in pH

The prime effect of submergence is increase in pH of acid soils and decrease in pH of sodic and calcareous soils. Within a few weeks of submergence, pH of acid and alkaline soils converges to neutrality. The change in pH can be attributed to conversion of ferric to ferrous iron, accumulation of ammonium, change of sulphate to sulphide and change of CO<sub>2</sub> to methane under reducing conditions. However, this strategy is not true for acid sulphate soils as they may not attain a pH of 6.0 even several months after submergence (De Datta, 1933).

## Changes in Electrical Conductivity

Electrical conductivity of the soil solution in most of the soils increases after submergence. Organic matter decomposition products' bicarbonate and organic ions and serve as energy source for the reduction of insoluble inorganic compounds to soluble ionic forms. Fe (III) oxide hydrates are reduced to Fe (II) compounds and consequently the colour changes from brown to gray and large amounts of Fe (II) enter into solution

phase. The concentration of water-soluble iron may vary from 0.1 ppm shortly after submergence and shoot upto as high as 600 ppm. In acid sulphate soils, the concentration may be as high as 5000 ppm within few weeks after submergence (Ponnamperuma, 1976). In flooded soils, reduction of higher oxides of manganese (Mn (IV)) takes place with denitrification. Manganese is more readily reduced and rendered soluble than iron. Availability of nitrogen in flooded soils is higher than in non-flooded soils. Availability of phosphorus, silicon and molybdenum in soil increases after flooding. However a decrease in concentration of water soluble zinc and copper is the major disadvantage of flooding. Increased availability of phosphorus could be attributed to the reduction of ferric phosphate to ferrous phosphate, hydrolysis of aluminium phosphate and the dissolution of calcium phosphate resulting from the accumulation of carbon di oxide.

### Production of Toxins

Due to sulphate reduction and anaerobic decomposition of organic matter, accumulation of hydrogen sulphide occurs in flooded soils. In normal soils, hydrogen sulphide is rendered harmless due to precipitation as ferrous sulphide but in soils high in sulphate and organic matter and low in iron, it may harm rice plants. Organic acids like acetic acid, butyric acid, formic acid, propionic acid and lactic acids are formed and the organic reduction products produced in anaerobic soils harm rice plants.

### Nitrogen Transformations

Nitrogen is the King pin of nutrients and the most crucial element in flooded ecosystem. About 95 % of the nitrogen in soil is present in organic form and the inorganic nitrogen constitutes only a portion of the total nitrogen. Most of the inorganic nitrogen present in the reduced soils is water soluble or

adsorbed on the exchange complex. In flooded rice soils, accumulation of ammonia is common as mineralization of organic nitrogen does not proceed beyond the ammonium stage in the absence of oxygen as oxygen is required for microbial conversion of ammonium to nitrate. Nitrite form of nitrogen may accumulate which is mainly attributed to the oxidation of ammonium to nitrite by microorganisms *Nitrosomonas* and *Nitrococcus*. Nitrite is an intermediate product of nitrification process. In submerged ecosystem, nitrate rapidly disappears through denitrification, leaching and plant uptake. Ammonium is fixed in the lattice structures of silicate minerals which is neither water soluble nor readily exchanged.

Nitrous oxide and elemental nitrogen are formed in flooded soils.

Mineralization of nitrogen include hydrolysis of proteins into polypeptides and aminoacids with subsequent deamination in the form of ammonia. Majority of the nitrogen containing compounds that are present in the submerged ecosystem is finally converted to ammonia. Apart from plant uptake nitrogen losses in the soil occur mainly from denitrification, ammonia volatilization, leaching and surface run off. Immobilization and ammonium fixation make nitrogen temporarily unavailable to the rice crop but donot cause loss of nitrogen from the soil system.

Severe nitrogen losses occur in soils subjected to alternate wetting and drying. Soil microorganisms mediating denitrification functions best near pH 7. Ammonia volatilization loss occurs from flood water on a soil moderately to slightly acidic, although losses are usually high on alkaline soils. When pH of the soil solution rises above 7.4, ammonia volatilization losses may be appreciable.

Soil pH may influence ammonia volatilization and at higher soil pH, the losses are high. Up to a pH 9.0, ammonia concentration increases by a factor of 10 per cent for unit increase in pH. The high temperatures and solar radiation that prevail in the dry season increases ammonia losses through volatilization. Leaching of nitrate and ammonium nitrogen also contributes substantially to the loss of nitrogen. Nitrate produced in the oxidized surface layer of a flooded soil moves easily by diffusion and percolation to the underlying reduced layer, where it is rapidly denitrified. Leaching loss of nitrate is higher compared to ammonium fixation especially in coarse textured soil.

Urea nitrogen is taken up by the rice crop after urea is hydrolysed to  $(\text{NH}_4)_2\text{CO}_3$ . The hydrolysis site is soil rather than flood water. Unlike ammonium urea is only weakly adsorbed by soil colloids. Hence losses by leaching and run off is high if hydrolysis of urea is slow. Urease activity is the

highest in alkaline conditions than in acidic conditions.

Biological nitrogen fixation is the most prominent phenomena in submerged ecosystem. The principal agents of biological nitrogen fixation are the water fern, azolla in association with blue-green algae, non-symbiotic nitrogen fixation around the plant's root zone and in anaerobic soil. Thus, the flooded rice ecosystem is a fragile system with numerous nutrient transformations and meticulous nutrient management is warranted to achieve the full potential of the system.

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# Bio-Rational Management of Fruit Fly (Tephritidae) Using Pheromone Traps

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Tephritids are among the most studied group of fruit flies with ~ 4,000 well known species which are distributed worldwide. Out of these 200 species are economically important as they spoiling not only to fruits but also to a number of vegetable crops. In India, eight species of genus *Bactrocera* are identified among quarantine pests with the oriental fruit fly *B. dorsalis* Hendel being the most destructive fruit fly of mango, followed by Peach fruit fly *B. zonata* Saunders and Guava fruit fly *B. correcta* Bezzi. The

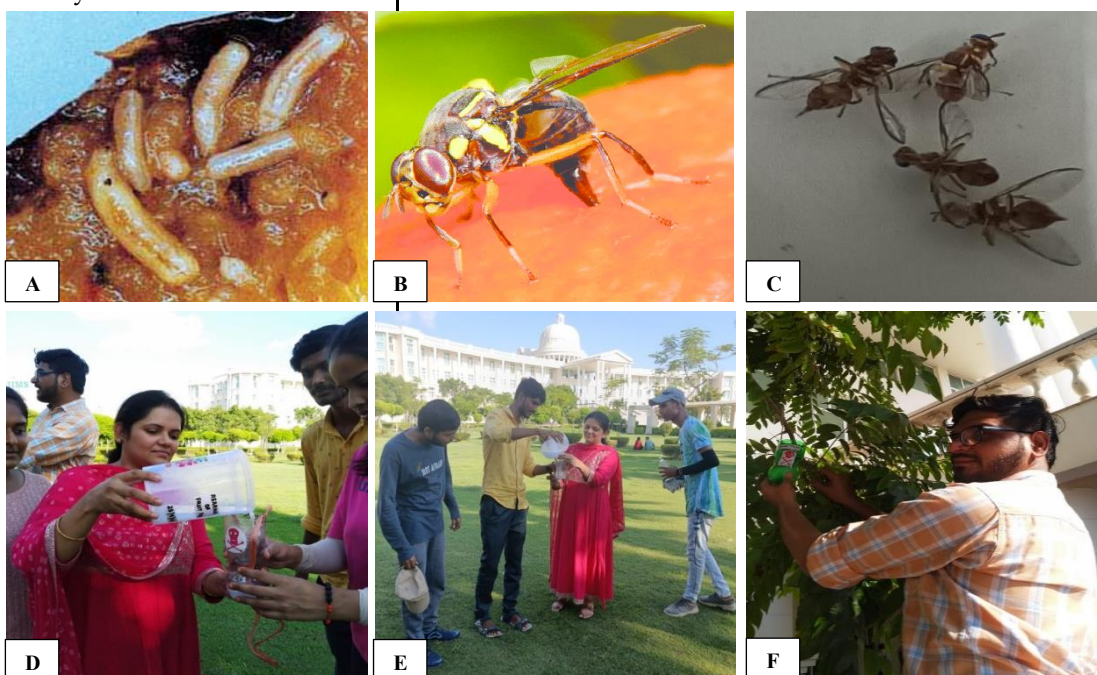
flies attack fruits at different stages of maturity but damage is more obvious at harvest period (Ansari *et al.*, 2012). Due to the increasing concern of damage done by tephritids fruit flies, local area management at field or crop or village level is important to keep the population of fruit flies under

control. Under this management option, a number of methods such as bagging of fruits, field sanitation, protein baits and cue-lure traps, host plant resistance, biological control, and safer insecticides, can be employed to keep the pest population below the economic threshold in a particular crop over a period of time to avoid the crop losses without health

and environmental hazards, which is the immediate concern of the farmers.

## Identification of pest

Creamish yellow apodous maggots with a black tooth-like feeding mouthpart (Fig. 1A). Pupa – ranges in color from dull red or brownish yellow. Adult – Reddish brown with transparent wing and with prominent yellow and dark brown to black markings on the thorax (Fig. 1B & C).



**Fig. 1. (A) Creamish yellow apodous maggots of fruit fly on rotted fruit of mango, (B) Fruit fly ovipositing and puncturing the fruit skin, laying eggs, (C) Newly emerged fruit fly adults from laboratory, (D & E) Scientist (Dr. Archana Singh) preparing Methyl Eugenol based fruit fly traps as device to early monitor the population and (F) Scientist (Dr. Fazil Hasan) hanging the fruit fly traps 7 feet above the ground level.**



## Nature of Damage

Sting marks and bruising to the fruit skin constitute the external damage that later turn to brownish rotten patches (Bana *et al.*, 2015). Injury to fruit occurs through oviposition punctures by females and subsequent larval tunneling (Fig. 1B). Ripening fruits are more likely to be attacked.

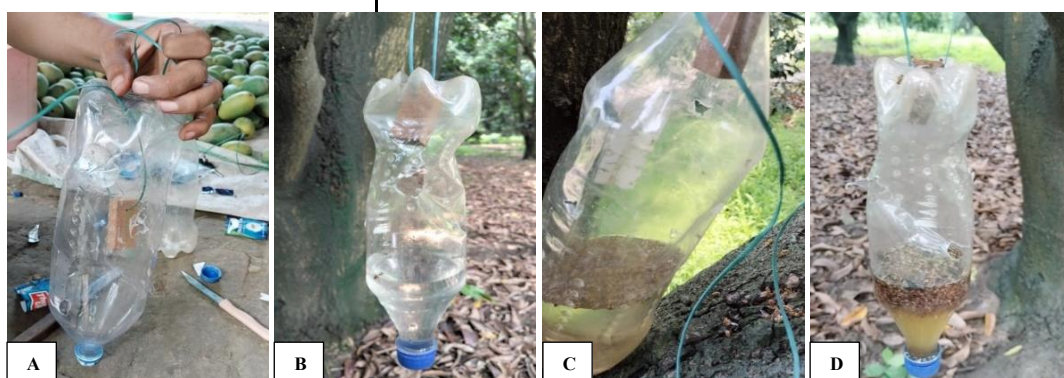
## Bionomics of pest

Females lay clusters of 6–10 eggs just under the skin of the fruit. After 1–2 days larvae hatch from the eggs and take 6–8 days to mature. Larvae feed upon the pulp of fruit. The mature larva emerges from the fruit, drops to the ground (5–10 cm), and forms a tan to dark brown puparium (Dhillon *et al.*, 2005). Flies start emerging from April onwards with maximum population during May to July which coincides with fruit maturity. About nine days are required for attainment of sexual maturity after the adult fly emerges.

## Management practices

Affected fruits should be collected and destroyed. Rake up the soil below the tree and drench with chlorpyrifos 20 EC @ 2.5 ml/ L. Setting up of methyl eugenol traps to lure the males in the orchard @ 10/Ha (Fig. 1.10D, E & F). Cue-lure traps have been used for monitoring and mass trapping of the fruit flies. A number of commercially produced attractants (Flycide® with 85% cue-lure content; Eugelure® 20%; Eugelure® 8%; Cue-lure® 85% + naled; Cue-lure® 85% + diazinon; Cue-lure® 95% + naled) are available in the market, and have been found to be effective in

controlling this pest. Hasan *et al.*, 2023 (Unpublished) have captured 4.25 to 7.85 flies per trap per day in poison bait traps containing methyl eugenol + melathion in mango orchard during May and June, 2023 at Amroha region of U.P. India. Similarly, the same practice was done at the mango production belt of Gr. Noida U.P. where average fruit flies catch per traps was 3.28 to 6.67 (Hasan *et al.*, 2023 Unpublished) (Fig 1D-F). More over local area management of fruit fly was initiated by Dr. Hasan at the premises of Noida International University, Gr. Noida. In this method mass trapping of fruit fly was done by using commercially available cue-lure soaked in wooden board. These pheromone soaked wooden board was fixed in waste plastic bottles, walls of which having exit holes allowing moaning fruit flies to enter inside the bottle and trapped (Fig. 2A – 2D). Mau *et al.* (2003) reported that the use of male lure cearlure B1 (Ethylcis-5-Iodo-trans-2 methylcyclohexane-1- carboxylate) have been found to be 4 - 9 times more potent than trimedlure for attracting medfly, *C. capitata* males and thus could be tried for male annihilation strategies of melon fruit



fly areawide control programs.

**Fig. 2. Local area management of fruit flies using commercially available fruit fly traps.**

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# Nutrition Garden: A Sustainable Model for Nutritional Security and Diversity

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Food security continues to be a matter of grave concern for India. Despite being the second largest producer of food, India is home to the world's second largest undernourished population (195.9 million). A review of studies examining the link between food security and malnutrition in children suggests a direct association with under nutrition in children in middle-income countries. Another study concludes that under nutrition/stunting is a consequence of household food insecurity.

Fruits and vegetables based nutri garden are not only rich in minerals and vitamins but also; contribute in a big way in maintaining health, overcoming hunger and malnutrition. The nutri-garden ensures access to healthy diet with adequate macro and micronutrients at doorstep. Nutri-garden is playing an active role in eradicating under-nutrition and it is advanced form of kitchen garden in which vegetables are grown as a source of food and income in a more scientific way. For small and marginal farmers, nutri-garden can contribute to the

family diet and provide several other benefits, particularly for women.

Nutri- gardens as they show a Medical Research (ICMR, 2010) recommendation for vegetable consumption can be fulfilled i.e. 300 gm of vegetable per person per day in which 50 g leafy

vegetable; 50 g root vegetables and 200 g other vegetables.

## What is a nutri-garden?

The concept of nutri-gardens builds on the optimal utilization of land to grow vegetables and fruits that can support the nutritional needs of the community and address the gaps in access, quality, and availability of diverse and nutritious diets. It represents an exemplar practice which addresses multiple goals of nutrition security, agri-food diversity, livelihood generation and environmental sustainability. Also, known as integrated homestead food production (IHFP), this concept entails cultivation of small scale plots often adjacent to households for enhanced food security and nutrition with a focus on "nutrition-sensitive, pro-poor & women-controlled approach to household food production". Moreover, homestead gardening can be coupled with promotion of backyard livestock, beehives and/or fish ponds. Research shows that IHFP can be used as a model for



increasing dietary intake (in particular, of micronutrients) and increased income for resource-poor households.

**Table 1: The contribution of nutrition-garden to the sustainable model and nutrition security**

| SL. No. | Goal                                   | Role of Nutri-Garden                                                                                                                                 |
|---------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.      | No poverty                             | Generate small but constant source of income, especially for women                                                                                   |
| 2.      | Zero hunger                            | Constant and cheapest source of nutritive food                                                                                                       |
| 3.      | Good health and well being             | Ensuring good health of whole family and source of balanced diet for women of reproductive age and young children                                    |
| 4.      | Quality Education                      | Provide nutrition rich vegetable, which improves brain development in younger age and supplement family income, which help to get quality education. |
| 5.      | Gender Equality                        | Selling surplus produce from Nutri-garden generate source of income for women.                                                                       |
| 6.      | Decent Work and Economic Growth        | Provide opportunities for entrepreneurship development in rural area especially for women                                                            |
| 7.      | Sustainable Cities and Communities     | Contributes in greening rural and urban areas and help in enhancing resilience from climate and disaster.                                            |
| 8.      | Sustainable Consumption And Production | Nutri-garden helps in providing continuous supply of vegetables to households and help to complete nutrient cycle                                    |
| 9.      | Climate Action                         | Strengthen family-level resilience and adaptive capacity to climate related risks and natural calamities.                                            |

### The objective of Nutrition Garden

- ✚ By recycling home trash, grey water, and other resources, the front yard, backyard, and space around the living space can be used to grow nutrient-dense vegetables and fruits.
- ✚ The goal is for all family members, particularly women and children, to consume at least 150-200gm of green vegetables and fresh fruits per person per day throughout the year.
- ✚ Integrate backyard poultry and goat farming for improved soil nutrient availability and increased income.

### Principles of Nutrition Garden

- ✚ Fruit vegetables, leafy vegetables, legumes, tuber crops, spices and some medicinal herb along with trees like banana, lemon.
- ✚ Own seed, own input can be used.
- ✚ Integrate livestock and recycle waste through composting.



### Benefits of Nutrition Garden

- ✚ It provides nutritional security
- ✚ Clean environment- Less disease- Better nutrition
- ✚ Organic farming- safe food, low cost, less time involvement (more resilient crops) and improved organic waste management



- ✚ Multiple and mixed cropping - increases dietary diversity and soil nutrition
  - ✚ Increase the biodiversity i.e. improves sources of food for both animals and human
  - ✚ Reduced the cost of production - supports consumption of nutritious food on regular basis, more profits from sale, scope to buy food that is essential but cannot be grown on own farm
  - ✚ Recycling of the waste water
  - ✚ Preservation of natural resources like forests and water bodies
  - ✚ Good source of uncultivated foods- allows growth of wild foods – weeds, small insects, local fishes and wild fruit.
- Select vegetables liked by the family members, particularly women and children.
  - Select a diverse range of vegetables, because all have different properties
  - Select vegetables that are hardy, easy to grow, adapted to the local climate and soil.
  - Select vegetables varieties tolerant to common pests and diseases.
  - Quality planting materials (Seed, cutting, seedling and tubers) of the selected vegetables must be locally available and easily accessible by the family members.
  - Include improved varieties but also traditional varieties to maintain agro-biodiversity and cultural heritage.
  - New nutritive crop species or varieties can be introduced and tested for acceptability, and this can create enthusiasm for gardening.

### Important component of Nutri-garden

#### a. Nutri-Garden produce

- ✚ A diverse range of nutrient-rich vegetable crop, combining traditional and improved varieties, suited to prevailing environmental conditions
- ✚ Garden management based on good agricultural practices (GAP) to overcome production constraints.

#### b. Nutrition

- ✚ Knowledge about the importance of vegetables for nutrition and health and knowledge about good food practices which enhance the uptake and utilization of micronutrients. e.g. Food synergy.

#### C. Sustainability

Supply of high quality nutritional rich vegetables seeds to farming community from an incessant source.

#### Selection criteria for vegetable crop

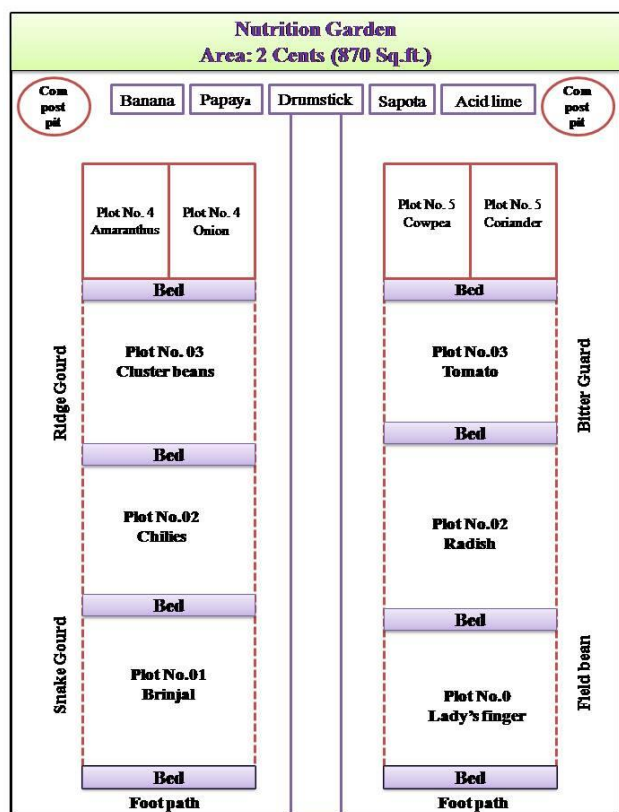
### Layout of Nutrition Garden

The size of a garden is not defined because it depends on the space available at the backyard of an individual house. As far as the shape is concerned a rectangular garden is preferred to a square one. Normally for a family of 5-6 people, 2 cents (870 sq ft) may be adequate to get vegetables throughout the year.

### Layout

The main purpose of planning a layout for a vegetables garden is to obtain maximum output and a continuous supply of vegetables. The principles that are to be followed are as given below.

- ✚ Perennial plants such as drumstick, banana, papaya, curry leaf, gooseberry mango, guava, custard, sapota etc., should be planted at the rear end of the garden, so that they may not shade other crops.



- ✚ The adjacent space near the central footpath can be utilized for growing different short duration varieties such as coriander, amaranths, fenugreek, mint etc. these crops can be cultivated in different seasons.
- ✚ The fence surrounding the garden can be utilized for growing creepers and gourds

such as sponge gourd, bitter gourd, snake guard etc.,

- ✚ The compost pits should be placed in the corner of the garden.
- ✚ The garden should be divided into small plots with raised bunds. In the bunds one can grow root crops such as onion, turmeric, ginger etc.

### Conclusion

Nutri-gardens are cornerstone in traditional farming systems, since time immemorial but with time, it has lost its importance. Myriad colored vegetables into the daily diet will enhance the individual's ability to fight diseases and improve immunity. Also innumerable phyto-chemicals in a range of fresh fruits and vegetables act as anti-oxidant, anti-allergic, anti-carcinogenic, anti-inflammatory, anti-viral and anti-proliferative. Nutri-gardens are also very much essential in places and villages which are isolated and far from the local market. Awareness campaign regarding the proper nutrition, nutri-gardening, dietary habits, should be demonstrated in the rural and remote areas. Nutri-gardening is one of the advantageous ways to improve nutrition level in community with minimum investment.

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# Mango Leaf Webber and Mango Gummosis: latest culprits of mango production at Amroha District, Uttar Pradesh, India

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The mango, *Mangifera indica* (Anacardiaceae) is widely known as the king of fruits and considered as the apples of tropical regions worldwide. It is an important fruit crop grown extensively under tropical and subtropical climate and it may vary in shape, size, and colours depending upon region and varieties. The area under mango cultivation in India is around 2263 ha, the production is 19687 MT and the productivity is 8.7 MT/ha (2016-17) (Indian horticulture database, 2021). In India the leading producer states of mango are Uttar Pradesh, Andhra Pradesh and Karnataka. The major mango producing districts of Uttar Pradesh are Lucknow, Amroha, Sambhal, Muzaffarnagar and Saharanpur where mangoes are grown over about 2.5 lakh hectares in different areas. The most popularly grown varieties of mango are Dussehri, Chowsa, Langda, Fazali, Mallika, Gulab khas and Amrapali.

Amroha has more than 100 types of described and non-described varieties of mangoes, so its diversity is very high which make Amroha unique place for mangoes. The mango production in Amroha was about 22 lakh tonnes in 2021 (Nadeem Siddiqui said to TOI). However, this production is still low and several factors contributing towards its low productivity including, insect pests, diseases, physiological and environmental factors. Mango plants are attacked by 492 species of insects, 17 species of mites and around 26 species of nematodes and out of these scale insect, mealy bug, fruit fly, and mango hopper are considered as the major one.

However, mango leaf webber (*Orthaga* Spp.) was considered as the minor pest but in recent year its increasing incidence in mango orchard brings the focus on its incidence and potential damage. Similarly, mango tree is also exposed to number of diseases out of this gummosis or die back is creating threats to mango orchards in recent years. The purpose of this article is to focus on the latest culprits in the mango orchards like leaf webber and mango gummosis/dieback with specific management practices, so that the early control of this pest and disease can be achieved to increase the productivity of mango especially in Amroha District, Uttar Pradesh, India.

## Mango Leaf Webber (*Orthaga* spp.; Lepidoptera: Noctuidae)

There are many species of leaf webber observed on mango in India of which *Orthaga euadrusalis* (Walker), *Orthaga exuvinaeae* (Hampson) and *Orthaga mangiferae* (Mishra) are considered as major species. The incidence of leaf webber is more prevalent in old and neglected orchards. Leaf webber is a phytophagous insect that scrapes leaf surfaces and web leaves of mango. Upon hatching the caterpillar feed gregariously on the chlorophyll contents of the leaves by scrapping the surface of leaf lamina. At the initial stage of larval development the young caterpillar webbed together two or three leaves to build a resting site where they hide and feed on the internal portion of leaves from edges towards the midrib, thereby doing so they are



leaving behind the network of veins. As soon as the larva reaches to the maturity, the caterpillar feeds voraciously and webs the shoots and leaves together. Damaged leaves are detached from the stalk but remain entangled in webs on the tree. Numerous dried bunches of shoots and leaves are clearly visible from a distance on severely attacked mango tree. The webbed leaves appear like a small tent so it is also generally termed as the Tent caterpillar. The interwoven pouch houses a mass of several caterpillars inside it (Fig 1A-C). The activity of mango leaf Webber in the mango orchards start in July and it creates havoc up to December (ICAR, 2014).

of the webs is difficult and may incur further management costs. So, the older orchards should be restored with dwarf-resistant varieties of mango which are easier to manage the pest if persists.

- ✓ Chemical control method is advised if the infestation and damage are economical. Botanicals like nemactine, nimbecidine, etc. can be used to manage the pest without much collateral damages. Although, there is a wide range of pesticides that can be used against the pest, insecticides like cypermethrin, chlorpyrifos, acephate are easily available in the market.



**Fig. 1. Incidence of Leaf Webber in mango orchard at Amroha District, Uttar Pradesh, India.**

#### Management practices

- ✓ The incidence of mango leaf Webber is persistent in old and unmanaged orchards with weak and huge trees where the management is not convenient. In these orchards, scraping out

#### Gummosis or Die Back

(*Lasiodiplodia*)

(Syn: *Botryodiplodia*)

*theobromae* (Pat.) Griffiths & Maubl.; Botryosphaerales: Botryosphaeriaceae)

The disease is observed all year round but is most evident during June, July and August and low during cool months from November to February. The disease is more prevalent after rainy season before the onset of winters. Disease is accompanied by damage

caused by trunk borers resembling *Batocera reformaculata*. It is a common soil-borne saprophyte or wound parasite, distributed throughout the tropics and subtropics. Die back or drying of plant from top downwards is prevalent in mango growing states of the country and is one of the serious diseases of mango. The disease is characterized by



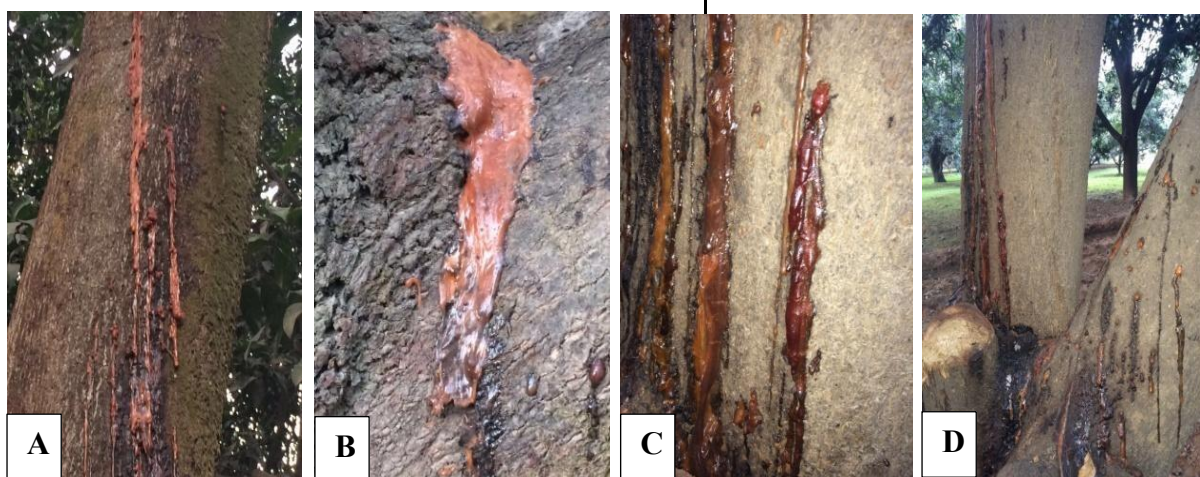


Fig 2. Disease symptoms of Dieback or Gummosis in mango trees. (A - D) exudation of gummy material from the tree trunk.

drying of twigs and branches followed by complete defoliation, which gives the tree an appearance of scorching by fire.

Initially die back is evident by discoloration and darkening of the bark. The dark area advances and extends outward along the veins of leaves. The affected leaf turns brown and its margins roll upwards. At this stage, the twig or branch dies, shrivels and leaf falls. This may be accompanied by exudation of yellowish-brown gum (Fig 2A-D).

#### Management practices

- ✓ Use of disease free propagating material.
- ✓ Avoid planting alternate host trees in the vicinity of orchards.
- ✓ Remove and destroy the infected tree parts immediately and prune some of the healthy

branches to ensure the complete eradication of pathogen.

- ✓ Proper disposal and burning of affected branches.
- ✓ After pruning apply Copper Oxychloride at the concentration of 0.3% on the wounds.
- ✓ Apply Bordeaux mixture twice a year to reduce the infection rate on trees and monitor the orchard regularly to identify possible infections at early stage.
- ✓ Two foliar sprays with topsin-M (Thiophanate-methyl) @1 g/ L or foliar spray with carbendazim @ 0.1%, or chlorothalonil @ 0.2% at fortnightly interval.

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# Zero Tillage Potato Cultivation (ZTPC): A Sustainable Approach for Coastal Farming System

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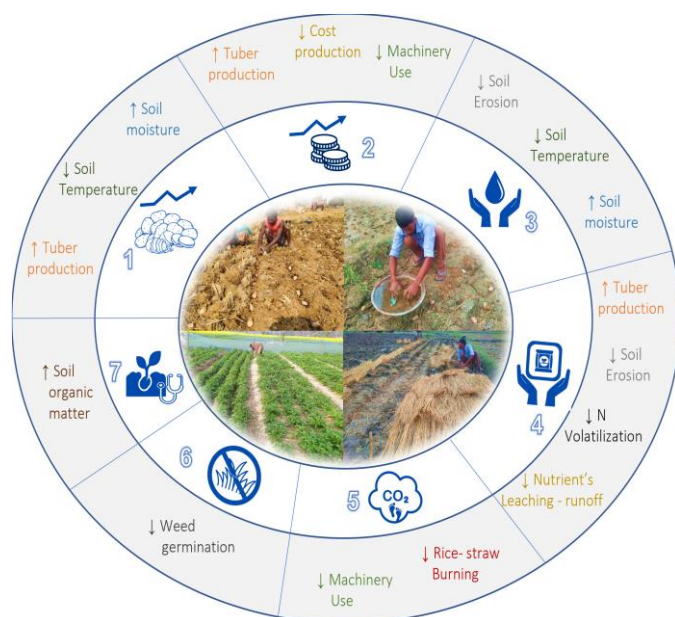
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One of the main challenges of Sustainable Intensification (SI) is to raise the productivity of existing lands while minimising environmental effects. It calls for proper legislation, conservation agriculture, integrated pest management, agroforestry, etc. Future agricultural productivity is threatened by the sharp rise in agricultural production per person, severe rural poverty and environmental degradation, as well as the rise in extreme climatic events linked to water risk, particularly in Asia, where SI will be essential. In fallow regions between rice cultivation or rice and other crops (wheat), potato has been regarded a crucial alternative for increasing rice-based systems (Ramirez et al., 2022). In places where rice is the main crop, intensification with potatoes could diversify diets and generate additional income. Potato cultivation has been a significant contributor to global food security, but traditional farming practices often lead to soil degradation, increased water consumption, and reduced yields. In recent years, Zero Tillage Potato Cultivation (ZTPC) has emerged as a sustainable approach to address these challenges, especially in coastal farming systems. ZTPC involves minimal soil disturbance and promotes sustainable soil health management, leading to increased crop productivity and enhanced environmental preservation.

## About ZTPC

Zero-tillage potato cultivation involves timely sowing of potatoes immediately after harvesting the preceding monsoon or kharif rice in

wet fields. This practice efficiently utilizes residual soil moisture and protects tubers with paddy straw, serving as a thick mulch to conserve irrigation water and prevent soil salinity. The early sowing and harvesting facilitate the subsequent cultivation of another rabi pulse crop, such as green gram. By adopting this method, farmers can significantly enhance cropping intensity, yield, and profitability. This practice aims to preserve soil structure, moisture, and microbial diversity, promoting natural nutrient cycling and reducing soil erosion.



**Fig 1. - The main processes triggered by zero/minimum-tillage and/or mulching under potato cultivation reported by the literature that improve crop yield (1), profitability (2), nutrient-use efficiency (3), water productivity (4), C footprint (5), weed control (6) and soil organic carbon (soil health) (7). (Source - Ramirez et al., 2022)**

### Advantages

- **Increasing Crop Productivity:** ZTPC has shown promising results in increasing crop productivity. The undisturbed soil allows for better water retention and nutrient availability, leading to healthier potato plants with higher yields.
- **Environmental Benefits:** By reducing the need for ploughing, ZTPC minimizes greenhouse gas emissions and fuel consumption, contributing to lower carbon footprints. This environmentally-friendly approach supports sustainable agriculture and mitigates climate change impacts.
- **Time Efficiency:** Early sowing and harvesting reduce the time between cropping cycles, allowing farmers to utilize their land more efficiently and potentially generate more income within a given agricultural season.
- **Soil Moisture Conservation:** By sowing potatoes immediately after the harvest of the preceding crop, residual soil moisture is effectively utilized, reducing the need for excessive irrigation and conserving water resources.
- **Reduced Soil Erosion:** Zero tillage minimizes soil disturbance, which helps in preserving the soil structure and reducing erosion, thereby promoting better soil health and fertility.
- **Weed Suppression:** The use of thick mulch, such as paddy straw, helps in suppressing weed growth, reducing the competition for nutrients and sunlight with the potato plants.
- **Cost Savings:** Zero tillage reduces the need for conventional tillage operations, leading to

cost savings in terms of labour, fuel, and machinery.

- **Soil Health Improvement:** The practice of zero tillage encourages the build-up of organic matter in the soil, enhancing microbial activity and overall soil health.
- **Sustainable Farming:** Zero tillage promotes sustainable agricultural practices by reducing the negative impacts on the environment, promoting soil conservation, and conserving water resources.

**Fig 2. Zero Tillage Potato Cultivation (Source: AI -**



**Generated)**

### Adoption and Challenges

Despite the numerous benefits offered by Zero Tillage Potato Cultivation (ZTPC), its widespread adoption faces several challenges:

- **Pest Attacks:** Pest attacks, such as those caused by rats, can lead to severe damage to potato production. The resulting yield losses impose significant economic burdens on farmers.



- **Need for Proper Training:** Successful cultivation of zero tillage potatoes requires farmers to undergo comprehensive training in this technology. Insufficient training can lead to a significant decline in the adoption of ZTPC.

**Market Access:** Farmers need access to a proper market or appropriate marketing channels, such as Farmer Producer Organizations (FPOs) or others, to efficiently sell their produce. A lack of adequate market access can have adverse effects on the adoption of ZTPC.

**High Initial Costing:** The initial investment required for cultivating Zero Tillage Potatoes can be substantial, which may deter farmers from readily adopting this technology due to lower motivation.

Addressing these challenges is crucial to promote the widespread adoption of ZTPC and to fully harness its potential benefits in potato cultivation. Measures such as providing training and technical support, facilitating market linkages, and exploring avenues for cost reduction could play vital roles in overcoming these obstacles.

### Prominent Example

A prominent example is included from an article by Bengali Newspaper named 'Anandabazar Patrika'. Which says,

Despite the unique challenges posed by its environment, characterized by unconventional irrigation patterns and distinct climatic conditions, the women of the Sundarbans have forged a pioneering path in agriculture. By embracing the concept of zero tillage, they have transformed potato cultivation into a sustainable and efficient practice. This innovative technique involves directly sowing

potato seeds into the soil without the traditional ploughing or tractor usage. Intriguingly, this approach is accompanied by strategic applications of organic fertilizers, ensuring optimal growth and yield. By sidestepping the need for mechanical tilling, these farmers not only conserve water and preserve soil structure but also mitigate the costs and labour associated with conventional methods. The result is a remarkable increase in potato production, even in the face of the region's unique challenges. The significance of their achievement resonates beyond local boundaries. Esteemed institutions like the Australian National Science Agency have taken note of their success, highlighting the Sundarbans' women farmers as a model for sustainable agriculture. This showcases the power of innovation to transcend geographical and cultural barriers, offering insights that can inspire agricultural practices around the world.

Ultimately, the story of zero tillage potato cultivation in the Sundarbans encapsulates the resilience, resourcefulness, and determination of these women farmers. Their ability to adapt and thrive under adverse conditions underscores the potential for sustainable practices to create meaningful change, paving the way for a more secure and prosperous future for communities worldwide.



Fig 3. - Newspaper article of 'Anandabazar Patrika'. (Source - [www.anandabazar.com](http://www.anandabazar.com))



## Conclusion

Zero Tillage Potato Cultivation (ZTPC) is a viable approach for crop intensification in rainfed lowlands in coastal saline regions since it uses less irrigation water, requires less labour, and produces higher yields. In comparison to the traditional ridge and furrow style of potato production, this approach also produced better net returns and BCR. With the application of this technique, cropping intensity can be increased by 300% (Sarangi et al., 2018), and carryover soil moisture and rice crop residue can be used more effectively. As a result, this method is

sustainable and improves the standard of living for farming people in India's coastal regions.

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**Table 1: Zero Tillage Potato Cultivation Vs Conventional Potato Cultivation:**

| Aspect              | Zero Tillage Potato Cultivation                                                                     | Conventional/Traditional Potato Cultivation                                                |
|---------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Soil disturbance    | No soil disturbance by ploughing, harrowing, or ridging                                             | Frequent soil disturbance by ploughing, harrowing, and ridging                             |
| Soil cover          | Soil surface covered with paddy straw mulch                                                         | Soil surface exposed without mulch cover                                                   |
| Cost of cultivation | Reduced by about 27%                                                                                | Higher due to more labour, fuel, and machinery requirements                                |
| Tuber yield         | Tuber yield varies from 12.4 to 32.1 tonne/ha (mean: 20.17 tonne/ha) (Sarangi et al., 2018)         | Tuber yield varied from 7.5 to 26.9 tonne/ha (mean: 19.02 tonne/ha) (Sarangi et al., 2018) |
| Tuber quality       | Improved in terms of crude protein, fat, crude fibre, and carbohydrate content                      | Inferior in terms of nutritional value                                                     |
| Soil health         | Enhanced by reducing soil salinity, improving soil bulk density, and increasing soil organic carbon | Degraded by causing soil erosion, runoff, and nutrient losses                              |
| Irrigation water    | Saved by about 200 mm                                                                               | Wasted due to higher evaporation and runoff                                                |

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# Types and Status of Rainfall Distribution in India

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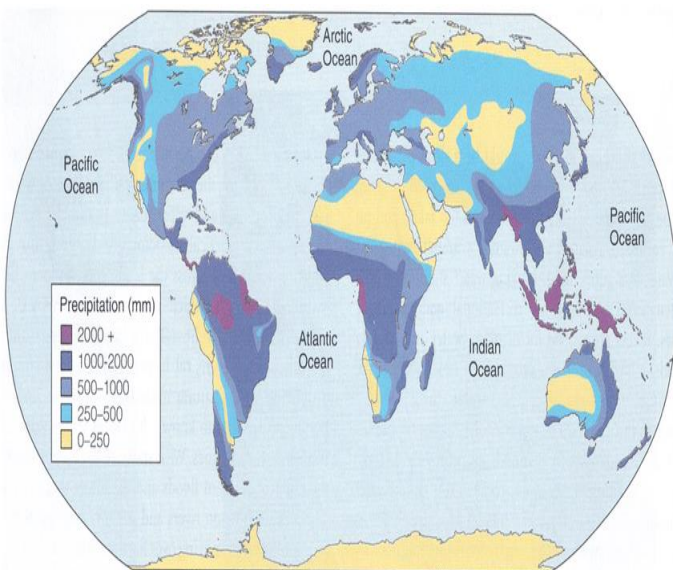
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Precipitation is the process where the local air becomes saturated with water vapour and it starts to pour, as it no longer can maintain the water vapour in the gaseous form. There are various types of precipitation – liquid, freezing and frozen.

**Liquid:** Precipitation comes down to the earth in the form of liquid it is called as liquid precipitation

**Freezing:** Freezing rain occurs when the layer of freezing air is so thin that the raindrops do not have enough time to freeze before reaching the ground.

**Frozen:** The form of precipitation that reaches the ground in frozen form. Example: snow, snow pellets, snow grains, ice crystals, ice pellets, and hail.



The rainfall distribution in India is impacted by the Thar desert and the Himalayas. Temperature and pressure changes over the Indian ocean, the Arabian sea, the Bay of Bengal and the southern part of the Pacific Ocean which play a significant role in the intensity and distribution of monsoon rains over the country.

Precipitation in India is irregular over the course of a year, with a well-defined rainy season.

South west monsoon over most part of the country starts from June and ends in September; North east monsoon starts from October and ends in December and Pre-monsoon rains starts from march and ends in May. The average annual rainfall in India is 118 cm according to India Meteorological Department.

## Precipitation regions in India

The India is divided in to 5 different regions based on their amount of rain fall distribution

- **Extreme Precipitation regions:** North eastern regions and the windward side of the western ghats recives 400 cm of annual rainfall. The states like Assam, Meghalaya, Arunachal Pradesh and hilly tracts of the western ghats are host to tropical rainforests. The highest rainfall in India and the world is recorded at Mawsynram village of Meghalaya.
- **Heavy Precipitation regions:** The regions experiencing 200-300 cm rainfall belong to this zone. Most of eastern India is covered under this zone. These regions are also home to tropical rainforests. States such as West Bengal, Tripura, Nagaland, Manipur, Odisha and Bihar are included in this zone. Most of the areas in the sub-Himalayan belt also fall under this zone.
- **Moderate Precipitation regions:** Areas which experience 100 to 200 cm of rainfall include parts of West Bengal, Bihar, Odisha, Madhya Pradesh, Andhra Pradesh and the leeward side of the Western Ghats. Wet Deciduous forests comprise the most common natural vegetation of these regions.
- **Scanty Precipitation regions:** Areas having 50 to 100 cm of rainfall consisting of parts of Maharashtra, Gujarat, Karnataka, Tamil Nadu,

Andhra Pradesh, Madhya Pradesh, Punjab, Haryana and Western Uttar Pradesh. Tropical grasslands, savannah and dry deciduous forests are commonly found in these areas.

- **Desert and Semi-desert Regions:** These are the areas that receive below 50 cm of rainfall. The states of Rajasthan, Gujarat and adjacent areas are classified as desert or semi-desert based on the amount of rainfall they receive. Some parts of Jammu & Kashmir such as the Ladakh plateau are also included in this zone as cold deserts. The vegetation consists of hardy species which can withstand extended droughts. Some areas like parts of Gujarat have savannah vegetation in the wetter regions. The lowest rainfall in India has been recorded in Ruyli village, Rajasthan.

### Factors affecting rainfall distribution

Factors controlling the distribution of rainfall over the earth's surface are the belts of converging-ascending air flow (see doldrums; polar front), air temperature, moisture-bearing winds, ocean currents, distance of inland from the coast and mountain ranges. Ascending air is cooled by expansion, which results in the formation of clouds and the production of rain. Conversely, in the broad belts of descending air (see horse latitudes) are found the great desert regions of the earth, descending air being warmed by compression and consequently absorbs moisture instead of releasing moisture. If the temperature is low, the air has a small moisture capacity and is able to produce little precipitation. When wind blows over the ocean, especially over areas of warm water (where evaporation of moisture into the air is active) towards a given coastal area, that area receives more rainfall than a similar area where the winds blow from the interior toward the oceans. Areas near the sea receive more rain than inland regions, since the wind constantly lose

moisture and may be quite dry by the time they reach the interior of a continent.

### Various Types of Rainfall

Rainfall has been classified into three main types based on their origin

- Convictional rainfall
- Orographic or relief rainfall
- Cyclonic or frontal rainfall

### Major Characteristics of Convictional Rainfall –

The air on getting heated becomes light and rises in convection currents.

- As the air rises, it expands and drops the temperature and subsequently, condensation takes place and cumulus clouds are formed.
- Heavy rainfall with lightning and thunder takes place which does not last long.
- Such rain is usually occurs in the summer or the hotter part of the day.
- This type of rainfall generally takes place in the equatorial regions and internal parts of the continents, predominantly in the northern hemisphere.
- This rainfall is usually associated with hail and graupel.

### Major Characteristics of Orographic Rainfall

- When the saturated air mass come across a mountain, it is forced to rise.
- The rising air expands, eventually the temperature falls and the moisture gets condensed.
- The principal characteristic of this type of rain is that the windward slopes get more rainfall.
- After giving rain on the windward side when these wind reach the other slope, they drop

away, and their temperature increases. Then their ability to absorb moisture increases and hence, these leeward slopes remain dry and rainless.

- The region situated on the leeward side is known as the rain-shadow area.
- The windward slopes of mountain ranges generally receive heavy rainfall; the leeward slopes receive almost no rain.

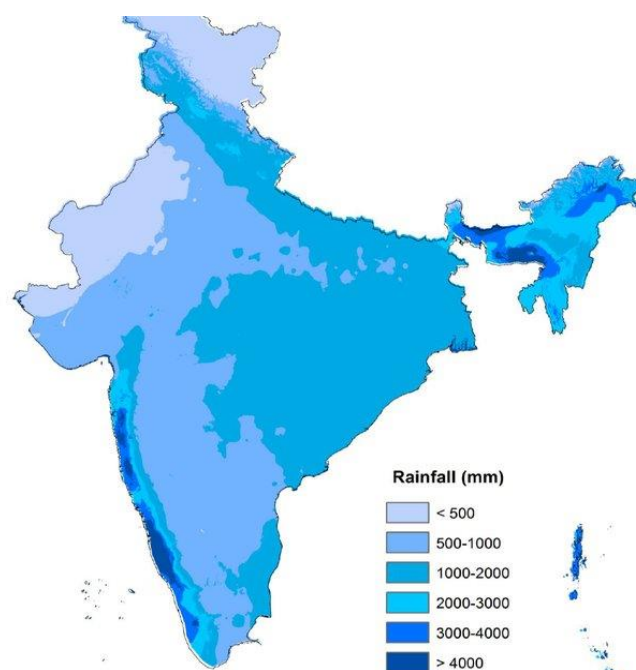
### Major Characteristics of Cyclonic Rainfall

- Cyclonic activity causes cyclonic rains and it occurs along the fronts of the cyclone.
- When two air masses of different density, temperature, and humidity meet, then cyclones are formed.
- The layer that separates them is known as the fronts of the cyclone.
- A warm front and the cold front are the two parts of the cyclone.
- At the warm front the warm lighter wind increases slightly over the heavier cold air.
- As the warm air rises, it cools and the moisture present in it condenses to form clouds.
- This rain falls gradually for a few hours to a few days and is called as cyclonic rains.

### Impact of rainfall distribution over the years in India

The temperature and moisture distribution over the Indian subcontinent are changing in recent decades with the accelerated global temperature rise. These changes in distribution result in shifting wet/dry and warm/cold zones within India. The differential warming rate over land and surrounding ocean determine intricate dynamics of the Indian summer monsoon (ISM) and make the Indian region

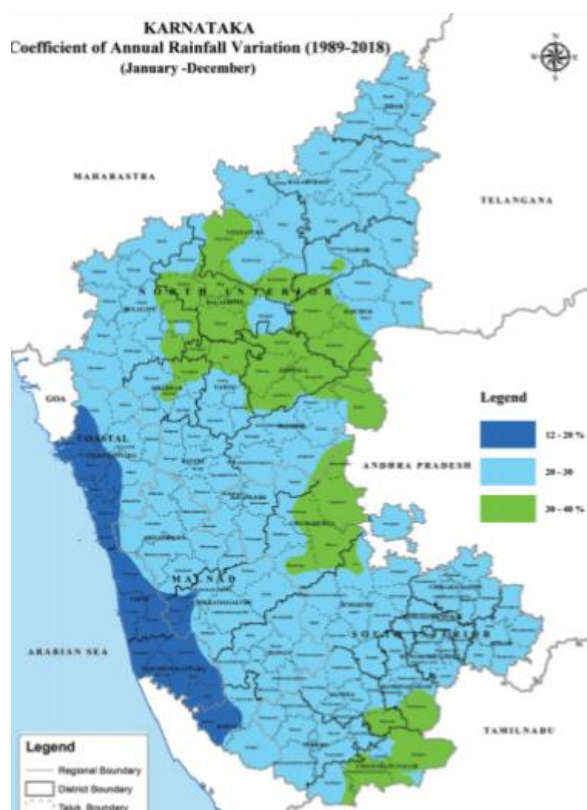
a more susceptible towards drought and flood events. In recent time, the frequent flooding over northwest India viz., over Gujarat and southern Rajasthan is attributed to the weakening of prevailing heat-trough circulation (northerly wind) and gradual increase in the convective activity (enhanced moist static energy).



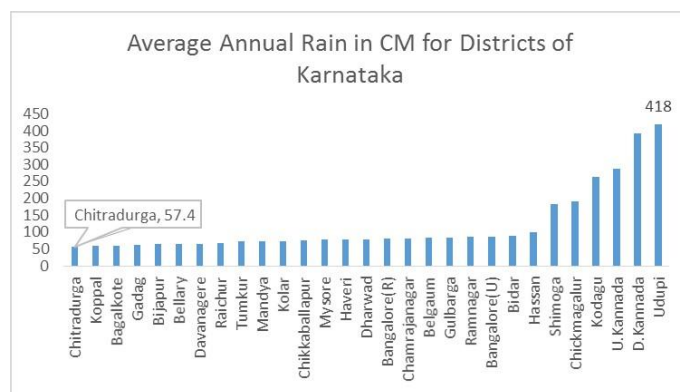
The recent weakening of the southwesterly reduced transport of moisture leading to reduced rainfall over Indo-Gangetic Plain (IGP) and northeast India; while the strengthening of the same enhanced the moisture transport and hence the rainfall over northwest India. In addition, northward shift of the sinking airmass over equatorial region, in recent time, leads to the decrease of the rainfall over the southern Indian region. The recent changes in rainfall pattern have shifted the climate of IGP and northeast India towards the relatively arid regime and that of western India towards a relatively moist regime, which supports the possible greening of the Thar region. The recent change in rainfall distribution in the form of wet and dry zones across the country will impact the water resource, food security as well as the fragile local ecosystem.



### Status of rainfall distribution over the years in Karnataka



The average annual rainfall in Karnataka is 124 cm. The state is divided into three meteorological zones viz. North Interior Karnataka, South Interior Karnataka and Coastal Karnataka. Coastal Karnataka receives an average annual rainfall of 345 cm is one of the most rainy regions in the country. Contrasting this, the region of South Interior Karnataka and North Interior Karnataka receive only 128 and 73 cm of average annual rainfall respectively. In Karnataka the lowest annual rainfall



of 41 cm is observed in Parshurampura chitradurga district and highest annual rainfall of 411 cm is observed in udupi district.

Karnataka state is having the second largest rainfed agricultural area in the Country and food production is mainly depending on the south-west monsoon. The State's mean annual rainfall is found to be in decreasing trend along with its sixteen years cyclic periodicity. The normal sowing season rains are being delayed due to the shift of July rains to the August month and September peak rainfall is being shifted to October month. The maximum water available period for the grand growth period is shifting towards the end of September and beginning of October in many districts. Major portion of the annual rainfall received during monsoon season and majority of the farmers depends on rainfed agriculture, this failure of rains can have a crippling effect on the economy of the state.

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# Climate Change Impacts and The Need for Adaptation

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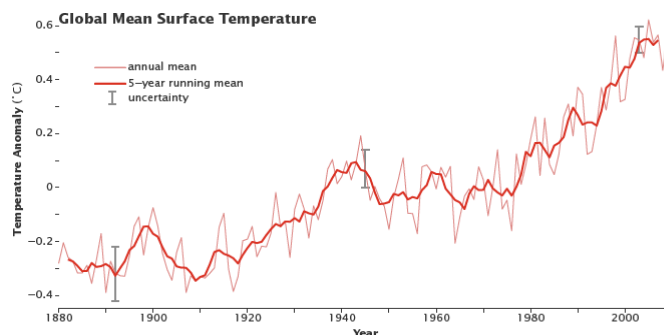
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As increased greenhouse gas concentrations drive temperature increases, and subsequent sea level rise, the frequency and intensity of extreme weather events is projected to increase – from heat waves, droughts and forest fires to floods, storms and heavy precipitation. These changes will in turn impact wildlife and flora, with natural habitats changing faster than species can adapt, leading to the extinction of certain species and/or the spread of invasive alien species<sup>13</sup>. The physical impacts of climate change will greatly vary from one region to another, depending on the existing local geographical conditions such as coasts, forests, mountains or urban areas. Some regions of Europe will experience more rapid changes than others and each region will be faced with different types of extreme weather events. Provides an overview of the different impacts of climate change by type of region in Europe. Broadly speaking, the main climate hazards and physical impacts associated with climate change are

## Temperature increases

Average global temperatures have increased since the 19th century around the globe, raising the number of warm days and nights per year. This in turn brings more extreme weather events such as heat waves, extreme heat and even more frequent wild and forest fires the survey conducted among the LRAs for this study highlighted temperature increases as the most frequently physical impact of climate change already being experienced at local level.



## Changes in Precipitation

One of the consequences from higher temperatures is that patterns in precipitation are changing. This translates in more frequent occurrence of extreme events such as droughts, floods, storms and heavy rainfall/ extreme precipitation or even landslides. LRAs responding to the survey indicated that changes in precipitation, extreme rainfalls, coastal storms and flooding are the second most frequently experienced phenomena. North-Western and Central European regions are expected to experience more frequent heavy precipitations and floods, as Southern regions will face more droughts. However, these impacts may also vary within the regions or over time, with periods of heavy precipitation followed by periods of water scarcity within the same region.

## Melting ice cover

As a result of higher average temperatures, ice sheets, glaciers and permafrost are losing mass globally. In Europe, this translates in negative impacts primarily for the Arctic and mountainous regions. The latter will be hit particularly hard by climate change, as they are expected to experience a much higher increase in temperatures than the global average. This is projected to lead to very specific issues linked to decreasing snow levels and

mountain permafrost areas along with the extinction of local species (especially in the Alpine regions)

### Rising sea levels

As a result of thermal expansion and glacier loss, sea level has risen since the beginning of the century, with higher average levels observed since the increases the risks of coastal erosion and flooding putting in danger coastal regions in particular. Most Coastal European regions are expected to experience more frequent coastal flooding and coastal erosion, linked to the rise in sea level and storm surges.



### Indirect impacts

The above-mentioned climate change impacts could be heightened in urban areas as the built environment and high soil sealing create unique microclimates. This can affect air temperatures, wind direction and precipitation worsening the risks of, for example, heat waves and urban floods. In addition, the combination of changes, especially to temperature and precipitation, could alter the life cycles of different species and facilitate the spread of invasive alien species, pests, vector-borne diseases (i.e. those spread by insects, ticks, parasites etc.) or disease pathogens to new geographical areas. This in turn poses significant risks to plant, animal and human health

### Socio-economic impacts

The physical impacts of climate change have very diverse socio-economic consequences that

differ by sector and region. Even within the same local area or region the same climate change impacts can be experienced very differently across sectors and social groups. Although, it is difficult to provide an exact mapping of all possible socio-economic impacts of climate change, examples of impacts in key sectors relevant for European LRAs include:

### Health and social vulnerability

One of the main pathways through which climate change is going to affect economic systems is through impacts on human health and social vulnerability. In particular, climate change is likely to cause various health and safety risks such as: illnesses and mortality due to heat waves or cold spells; mortality, chemical hazards and poisoning due to extreme weather events, floods or wild fires; new illnesses and spread of communicable diseases due to changing patterns in the activity of pathogens, viruses and parasites.

Pathways through which climate change can contribute to the spread of diseases include:

- Air-borne diseases: Increased humidity could increase the risks of lower respiratory tract infections;
- Food-borne diseases: Higher ambient temperatures increase the replication cycles of pathogens for food-poisoning
- Water-borne diseases: Extreme precipitation can increase the risk and the amount of pollutants entering recreational coastal waters as well as overwhelm urban water treatment plants and raise the risk of disease outbreaks in the drinking water distribution systems;
- Vector-borne diseases and pathogens: Climate change can alter the life cycles of vectors and the reproduction rate of parasites

and viruses, reducing incubation periods and increasing transmission risks. Long-term seasonal changes can influence vector, animal and human activity and further affect the spatial-temporal distribution of diseases.

### **Agriculture, forestry and aquaculture**

In the agriculture, forestry and aquaculture sectors, climate change is likely to affect crop yields, species reproduction and growth, water availability and the pathways for invasive alien species, diseases and pathogens. While these changes could bring about positive outcomes in some regions by allowing the growth of new species or extending crop periods, they could reduce productivity in other areas. The economic consequences of these changes include fluctuations in food prices, farm incomes and overall food security at regional, national or even global level. In line with this, the survey found that losses stemming from impacts on agriculture is the second most frequently mentioned socio-economic impact of climate change.

### **Energy**

In the energy sector, a changing demand for energy is likely to be one of the main impacts of climate change. Temperature extremes can affect both the amount and periods for heating and cooling energy demand. Reduced water availability could affect the amount of power produced by thermal power generation (for example, fossil fuel, biomass or nuclear power plants rely on large quantities of water for cooling and their production could be interrupted due to water shortages). Combined, these shifting patterns for energy demand and supply can create risks for the overall stability of electricity networks during peak demand periods. Moreover, extreme weather events could cause physical damage to energy infrastructure resulting

in power cuts or safety hazards that can in turn jeopardise operations in other sectors of the economy.

### **Transport**

Physical damages to infrastructure following extreme events are also a likely impact in the transport sector. Other impacts stemming from rising temperatures and heat waves would be problems of rail buckling and pavement deterioration. Such damage to the road, rail, water and air transport infrastructure could in turn disrupt the flow of goods and passengers with corresponding economic consequences across sectors and regions, especially if international transport networks are affected.

### **Tourism**

Tourism is highly likely to be impacted by climate change. Rising temperatures, heat waves, sea level rise and coastal erosion could reduce the size of beach tourism in traditional European destinations (for example, Mediterranean). Similarly, changes in snow availability and higher temperatures could cause shrinkages in the size of ski tourism in traditional destinations (for example, the Alps). These impacts could result in the shift of these types of tourism to new locations or different periods of the years or give way to new types of tourism<sup>37</sup>. For instance, mountainous areas at lower altitudes that experience shorter ski seasons are expanding the opportunities available for other touristic activities such as camping, mountain climbing or hiking.

### **Construction, housing and infrastructure**

Some of the main competences of LRAs relate to the development of local infrastructure and land use. As a result of climate change construction is likely to see delays and increased costs following fluctuating weather conditions and extreme events



such as floods or landslides. Furthermore, building material requirements and construction codes are likely to evolve to address the changing weather conditions as rebuilding and repair demand might grow.

### Water management and services

Although the impacts of climate change on sectors such as manufacturing or services

(particularly those other than tourism or health services) are less studied, they are likely to be the consequences of changes in primary economic activities such as labour productivity and energy demand or disruptions to transport networks. These changes could result in fluctuations of prices and qualities for manufacturing inputs, higher production costs as well as disrupted supply chains or interruption of services.

## Adaptation measures

**Table 1: Examples of the main climate hazards and potential adaptation measures**

| Climate Hazard                        | Potential adaptation measures                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increased temperatures and heat waves | <b>Grey measures:</b> <ul style="list-style-type: none"> <li>- Cooling of indoor public spaces: improving thermal insulation, vertical greenery, shading of transparent openings, windows and displays, green/reflecting roofs.</li> </ul> <b>Green measures:</b> <ul style="list-style-type: none"> <li>- Increase and revitalization of green areas, parks and fountains in cities, notably to increase shade</li> </ul> <b>Soft measures:</b> <ul style="list-style-type: none"> <li>- Assessments of vulnerability to high temperatures</li> <li>- Heat-wave action plans (such as toll-free information and assistance numbers, meal delivery and home care)</li> </ul> |
| Forest and wildfires                  | <b>Green measures:</b> <ul style="list-style-type: none"> <li>- Agroforestry (a combination of trees and crop cultivation) can help reduce forest fires as it removes the dry vegetation most prone to fire at ground level.</li> </ul> <b>Soft measures:</b> <ul style="list-style-type: none"> <li>- Vulnerability assessments</li> <li>- Early warning systems</li> </ul>                                                                                                                                                                                                                                                                                                 |
| Droughts                              | <b>Grey measures:</b> <ul style="list-style-type: none"> <li>- Improve irrigation systems in agriculture</li> </ul> <b>Green measures:</b> <ul style="list-style-type: none"> <li>- Water retention spaces in the form of decentralized lakes and ponds</li> <li>- Increase green areas in cities, which absorb and retain water</li> </ul> <b>Soft measures:</b> <ul style="list-style-type: none"> <li>- Early warning systems</li> <li>- Awareness raising on water consumption</li> </ul>                                                                                                                                                                                |
| Extreme precipitation and floods      | <b>Grey measures:</b> <ul style="list-style-type: none"> <li>- Sustainable drainage systems</li> <li>- Dikes and dams</li> <li>- Widen roadside ditches</li> <li>- Reduce and open sealed surfaces (i.e. artificial, impenetrable surfaces like tar)</li> </ul> <b>Green measures:</b>                                                                                                                                                                                                                                                                                                                                                                                       |

|                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                     | <ul style="list-style-type: none"> <li>- Green areas, green roofs, to help absorb excess water</li> <li>- Floodplain and wetland restoration</li> </ul> <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Early warning systems (assessing vulnerability and predicting floods)</li> </ul>                                                                                                                                                                                                                                                                                                              |
| Landslides                          | <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Vulnerability assessments</li> <li>- Early warning systems</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Permafrost and ice melting          | <p><b>Grey measures:</b></p> <ul style="list-style-type: none"> <li>- Maintenance and restoration of mountain cliffs</li> </ul> <p><b>Green measures:</b></p> <ul style="list-style-type: none"> <li>- Increase pastures and green spaces, which help regulate temperatures</li> </ul> <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Permafrost and glacier monitoring</li> <li>- Vulnerability assessments</li> <li>- Early warning systems</li> <li>- Promotion of insurance for inhabitants of risk-prone areas</li> <li>- Car free tourism / sustainable tourism</li> </ul>                     |
| Coastal erosion                     | <p><b>Grey measures:</b></p> <ul style="list-style-type: none"> <li>- Artificial dunes &amp; dune rehabilitation</li> <li>- Seawalls</li> <li>- Sea dikes</li> <li>- Beach nourishment</li> </ul> <p><b>Green measures:</b></p> <ul style="list-style-type: none"> <li>- Wetland restoration</li> </ul> <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Assessment/ mapping of future erosion</li> </ul>                                                                                                                                                                                              |
| Sea level rise and coastal flooding | <p><b>Grey measures:</b></p> <ul style="list-style-type: none"> <li>- Flood barriers</li> <li>- Relocation of infrastructure to higher altitudes</li> </ul> <p><b>Green measures:</b></p> <ul style="list-style-type: none"> <li>- Restore and maintain wetlands, which can act as buffers</li> </ul> <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Vulnerability assessments</li> <li>- Include rising sea levels in future urban planning</li> </ul>                                                                                                                                              |
| Invasive alien species              | <p><b>Grey measures:</b></p> <ul style="list-style-type: none"> <li>- Underwater suction devices (to absorb invasive algae)</li> </ul> <p><b>Green measures:</b></p> <ul style="list-style-type: none"> <li>- Crop rotations to revitalize soils and prevent pest infection</li> <li>- Introduction of natural predators (like mollusks for algae), with caution on potential unwanted negative consequences</li> </ul> <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Identify the most problematic species</li> <li>- Track movements of species and put in place early warning systems</li> </ul> |
| Diseases and pathogens              | <p><b>Soft measures:</b></p> <ul style="list-style-type: none"> <li>- Identify the most problematic vectors and pathogens</li> <li>- Track movement of vectors and pathogens and put in place early warning systems</li> <li>- Raise awareness and provide information on prevention measures</li> </ul>                                                                                                                                                                                                                                                                                                                    |

**Table 2: Effect of climate changes on climatological variables**

|                                                                  |                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Higher maximum temperature, more hot days and heat waves         | <ul style="list-style-type: none"> <li>• Increased incidence of serious illness among elderly, children, the poor</li> <li>• Increased heat stress in livestock</li> <li>• Increased risk of damage to both monsoon and dry season crops</li> <li>• Increased crop pest and diseases</li> <li>• Increased energy demand and reduced energy supply reliability</li> </ul> |
| Higher minimum temperature, fewer cold days, and cold waves      | <ul style="list-style-type: none"> <li>• Decreased cold-related human mortality</li> <li>• Decreased risk of damage to a number of crops</li> <li>• Increased risk to crops such as wheat and chickpea</li> <li>• Increased activity of some pest and diseases vectors</li> </ul>                                                                                        |
| More intensive precipitation events                              | <ul style="list-style-type: none"> <li>• Increased chances of local flood</li> <li>• Increased soil erosion</li> <li>• Increased loss of topsoil and nutrients</li> <li>• Increased pressure on relief</li> </ul>                                                                                                                                                        |
| Increased monsoon precipitation variability                      | <ul style="list-style-type: none"> <li>• Frequent dry spells during monsoon season</li> <li>• Extended dry spells and drought</li> </ul>                                                                                                                                                                                                                                 |
| Increased summer drying and associated droughts                  | <ul style="list-style-type: none"> <li>• Decreased crop yields</li> <li>• Decreased water resources (quantity and quality)</li> <li>• Decreased surface water resources in rivers, tanks, ponds, etc.</li> <li>• Declining groundwater resources due to over exploitation</li> </ul>                                                                                     |
| Increase in nor'westers during summers and peak wind intensities | <ul style="list-style-type: none"> <li>• Increased risk to human life</li> <li>• Risk of infectious disease epidemics</li> <li>• Increased risk of wind-related damage</li> </ul>                                                                                                                                                                                        |
| Increased incidence of events such as hail storms and whirlwinds | <ul style="list-style-type: none"> <li>• Wind-related damage</li> <li>• Damage to irrigated summer crops</li> <li>• Damage to fruit trees such as mango and jack fruit</li> </ul>                                                                                                                                                                                        |

\* \* \* \* \*

# Guava Anthracnose Disease: Diagnosis & Control

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Anthracnose is the most commonly observed disease that affects both pre- and postharvest management of guava. Guava anthracnose was found more prevalent during the main season (April-September) than in offseason (November-February). The causal organisms of guava anthracnose is *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae*. Among the tree fruit plants guava starts bearing within the shortest possible time and produce abundant fruits. A total of 10 diseases have been reported on guava of which anthracnose is recognized as the second most important disease. High prevalence of the disease has been reported. The disease becomes a serious obstacle to guava cultivation, food values and market price are falling and cause a great threat to germplasm preservation. The farmers think to avoid the cultivation of guava owing to a great loss by this disease. So, work is necessary to protect the nutritious and highly productive guava fruits from anthracnose.

## What is Anthracnose in Guava?

Anthracnose is the most commonly observed disease that affects both pre- and postharvest management of guava. This disease can cause considerable postharvest losses and can affect young developing flowers and fruit. It has been reported in all guava-growing areas around the world where high rainfall and humidity are present.

## What does guava plant look like in Anthracnose?

Anthracnose is manifested in symptoms as die-back, twig blight, wither tip and fruit spot. On the unripe fruits small, dark brown, sunken and small spots of pin head size are observed. These

spots gradually enlarge to 5 – 6 mm in diameter; coalesce to form a corky hard lesion having cracks. The ripe fruits become soft and at times drop off. Unopened buds and flowers are also shed. Foliage develops necrotic gray lesion at tips and margins. Tender branches dry from tip downward exhibiting 'die back'. The growing tips of the branches die and necrotic and dead areas spread downwards. The leaves, flowers and fruits are unripe fruits remained mummified. Fruits carry the incipient infection from the field that manifests itself in storage causing rotting of fruits.

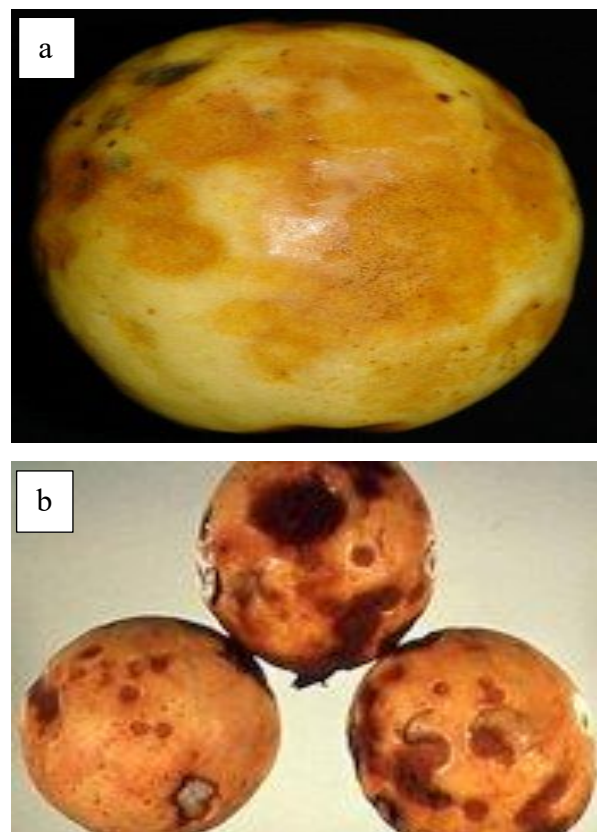


Fig 1: (a) Initial symptom of disease *Colletotrichum psidii*. (b) Circular black spots on fruit

## How this Diseases is spread in orchard?

Anthracnose infection commonly occurs in the fields during the flowering and fruiting stages.

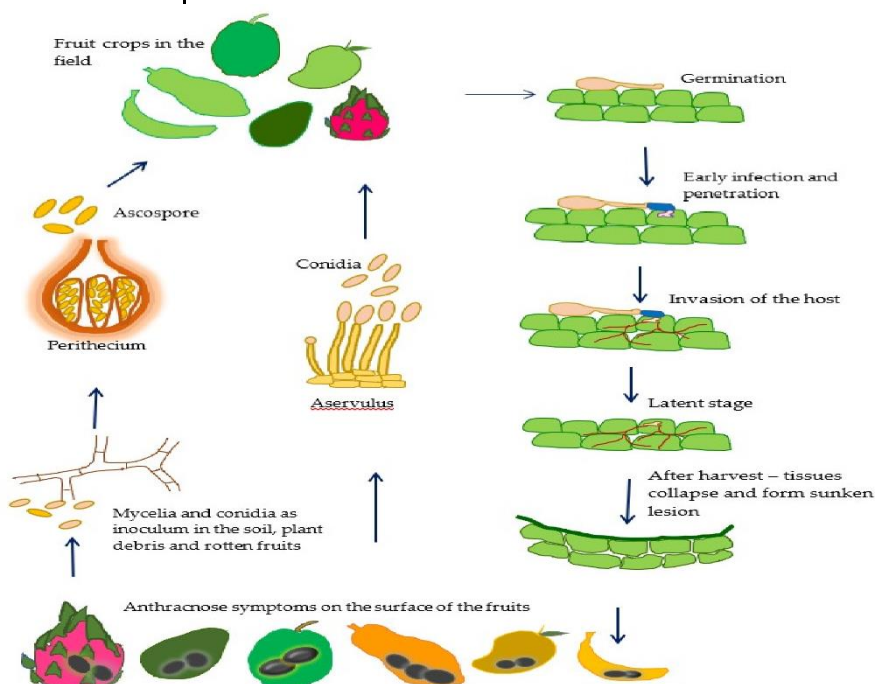


Different factors may affect *Colletotrichum* infection, including humidity, temperature, fruit condition, and inoculum concentration. Host infection generally begins with conidial germination and is followed by the formation of appressoria and penetration pegs, which are fungal structures that assist in the penetration into host tissues. In some cases, direct penetration occurs through wounds or natural openings. Anthracnose pathogens infect not only fruits, but also other plant organs, including the leaves, flowers, twigs, and branches. The conidia and spores formed in these infected tissues are subsequently released and dispersed during rainy days through water splashes or during high humidity periods, thus becoming the primary inoculum for fruit infection at the preharvest stage. The most visible anthracnose symptoms are black or dark brown sunken lesions containing conidial masses on the surface of infected fruits. Small individual lesions may merge to produce larger lesions. These black or dark brown lesions on the surface appear unattractive to consumers and significantly reduce the market value of such fruits

After infection, many anthracnose pathogens adopt quiescence or latency, which is common in pathogens causing postharvest diseases, including *Colletotrichum*. During the latent period, anthracnose pathogens remain dormant within the host tissues until environmental conditions, and the host physiology are conducive for their reactivation and further development. Reactivation occurs particularly when fruits ripen. Anthracnose

symptoms often develop after harvest, during storage, transportation, and marketing.

The spread of the disease is by air-borne conidia and numerous insects and birds which frequently visit banana flowers also spread the disease. The disease is favoured by high atmospheric temperature and humidity, wounds and bruises caused in the fruit and susceptibility of the variety.



**Fig 2: Anthracnose disease cycle of Guava crop.**  
(Image source: Latiffah Zakaria)

**How can I protect our farm from this disease?**

**These are the simple steps you can take to protect your farm**

In order to control and manage anthracnose diseases treatment of fruits at harvest with biofungicides based on Arabic gum together with 1% chitosan and mixture of different plant variety has been used with some success to avoid the growth of pathogen including citric extracts, *Zingiber officinale*, rhizome extract, *Acacia albida* and during cultivation of spraying of Chlorothanlonil (0.2%) and Bavistin (1%) four times at 15 days interval is recommended, banana bunches can be sprayed with

mancozeb(0.25%) and benzimidazoles(0.05%) Minimising bruising; proper sanitation of handling and prompt cooling to 14°C are essential in minimising the disease in cold storage. The Sprayings of Bordeaux mixture (3:3:50) or Copper oxychloride (Blitox 0.2%) at weekly intervals starting from the month of July manage the disease. Among systemic fungicides Carbendazim (Bavistin 0.1%) or Thiophanate methyl (Topsin M or Roko 0.1%) provide effective disease control of Anthracnose.

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# An overview of Minimum Support Price (MSP) in India

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The Minimum Support Price (MSP) is a government-initiated measure designed to ensure that farmers receive a fair and guaranteed price for certain agricultural products, regardless of market fluctuations. It serves as a protective mechanism, safeguarding farmers from potential losses in situations where the open market price falls below the cost of production. In India, the government sets the MSP for 24 commodities twice a year.

The primary objective of MSP is to shield farmers from abrupt price drops, especially during years of bumper crops when market prices may decline significantly. By announcing the MSP before the planting season, the government aims to provide farmers with clarity regarding the expected price for their produce, offering income stability and preventing distress sales. Under the MSP system, if the market price falls below the declared MSP, the government commits to purchasing the entire quantity of the commodity directly from the farmers. This mechanism ensures that farmers are not compelled to sell their produce at unfairly low prices and helps maintain a stable income for them. However, the MSP policy has received both support and criticism. Advocates argue that it offers necessary security to farmers and contributes to food security, while critics point out potential challenges, such as market distortions and surplus stocks. Striking the right balance between supporting farmers and ensuring market efficiency remains an ongoing topic of debate and policy refinement.

## Back ground of MSP

The concept of Minimum Support Price (MSP) in India has its origins in the 1960s when the country faced food shortages due to droughts and

conflicts, such as the Bihar famine of 1966-1967. At that time, India was undergoing the Green Revolution, a period marked by efforts to increase agricultural productivity through the adoption of high-yield varieties, improved tools, and the use of fertilizers. In pursuit of this objective, various agriculture policy strategies were proposed, including a government price policy for food grains that aimed to support land productivity. To implement these policies effectively, the Agricultural Price Commission (APC) was established in 1965. The APC's role involved the implementation of pricing policies, such as predetermined procurement price, minimum support prices, and the establishment of a food distribution system, including procurement at pre-decided prices and the distribution of food grains at subsidized rates.

In March 1985, the Commission for Agricultural Costs and Prices (CACP) was formed, replacing the APC with a broader set of responsibilities. In addition to the CACP, other institutions, both at the central and state levels, are involved in the MSP implementation process. Notable examples include the National Agricultural Cooperative Marketing Federation (NAFED) and the Food Corporation of India (FCI). These policy changes and the introduction of MSP played a significant role in boosting the production of grains like wheat and rice. As a result, the country transformed from facing grain shortages to achieving grain surpluses.

## CACP - Commission for Agricultural Costs and Prices

The Commission for Agricultural Costs and Prices (CACP), formerly known as the Agricultural

Prices Commission, underwent a name change in 1985 and now operates as a statutory panel under the Ministry of Agriculture & Farmers Welfare, Government of India. It plays a vital role in the agricultural sector by providing recommendations on Minimum Support Prices (MSPs) for the notified Kharif and Rabi crops to the Cabinet Committee on Economic Affairs (CCEA).

The primary objective behind the establishment of the CACP is to suggest appropriate MSPs that can serve as a motivating factor for farmers and cultivators to adopt modern agricultural practices, employ the latest technologies, and increase productivity while minimizing the use of resources. However, it's important to note that the government is not bound by the recommendations put forth by the CACP and holds the discretion to make the final decisions regarding MSPs. It decides the minimum support price taking into account the following factors such as:

1. The entire structure of the economy of a particular commodity or group of commodities.
2. Cost of production.
3. Changes in input prices.
4. Input-output price parity.
5. Trends in market prices.
6. Demand and supply.
7. Inter-crop price parity.
8. Effect on industrial cost structure.
9. Effect on the cost of living.
10. Effect on the general price level.
11. International price situation.
12. Parity between prices paid and prices received by the farmers.

13. Effect on issue prices and implications for subsidy.

### Importance of MSP to the farmers

- Minimum Support Price (MSP) is a market intervention mechanism employed by the Government of India to protect agricultural producers from significant drops in farm prices.
- It is typically announced at the beginning of the sowing season and serves the purpose of shielding farmers against price declines, especially during years of bumper production.
- The government guarantees minimum support prices for various agricultural commodities, providing assurance to farmers for their produce.
- This support is essential to safeguard farmers from distress sales and to ensure a steady supply of food grains for public distribution.
- During times of abundant production and market oversupply, if the market price for a commodity falls below the announced minimum support price, government agencies step in to purchase the entire quantity offered by the farmers at the declared MSP.
- This action helps stabilize prices and prevents farmers from incurring losses due to lower market prices.

### Latest Minimum Support Price - Kharif (2023-24); Rabi (2023-24)

The sowing season of crops in India varies across states, and the harvesting timeline is influenced by the crop variety. As a result, crops sown during the Kharif season may reach the market even before October. The Minimum Support Price



(MSP) for Kharif crops for the year 2023-24 will be applicable from 1st September 2023. On the other hand, the MSP for all mandated Rabi crops will be for the Rabi Marketing Season (RMS) 2023-24.

The increase in MSP for Kharif crops in the Marketing Season 2023-24 aligns with the announcement made in the Union Budget 2018-19. The government aims to fix the MSP at a level of at least 1.5 times the All-India weighted average Cost of Production to ensure reasonable and fair remuneration for farmers. Among the Kharif crops, the expected margin to farmers over their cost of production is estimated to be the highest for bajra at 82 per cent, followed by tur at 58 per cent, soybean at 52 per cent, and urad at 51 per cent. For the remaining crops, the margin to farmers over their cost of production is estimated to be at least 50 per cent.

The Minimum Support Price (MSP) increase for Rabi Crops during the Marketing Season 2023-24 is in accordance with the announcement made in the Union Budget 2018-19. The government aims to set the MSP at a level of at least 1.5 times the All-India weighted average Cost of Production to ensure fair and reasonable remuneration for farmers. Among the Rabi crops, the maximum rate of return is projected to be 104 per cent for rapeseed & mustard, followed by 100 per cent for wheat, 85 per cent for lentil, 66 per cent for gram, 60 per cent for barley, and 50 per cent for safflower.

### Latest News about MSP

The All-India Kisan Sabha has expressed dissatisfaction with the Minimum Support Price (MSP), asserting that it is unfair and fails to meet the farmers' expectations, resulting in substantial income losses. According to Ashok Dhawale, the president of AIKS, the rising input costs combined

with the inadequate MSP will push many farmers, especially small, marginal, and medium-level farmers, as well as tenants, into indebtedness. The Bharatiya Janata Party had promised in 2014 that the MSP would be set according to the Swaminathan Commission's recommendation of  $C_2+50\%$  ( $C_2$  being the comprehensive cost of production). However, this promise remains unfulfilled, as stated by Ashok Dhawale.

The Bharatiya Kisan Union (Ekta-Ugrahan), a prominent farmer union in Punjab and a member of the Samyukta Kisan Morcha (SKM), which is an umbrella organization of approximately 500 farmer groups, has also dismissed the recent MSP hike. They argue that the government's approach of ensuring 1.5 times the cost of production on crops fails to address the farmers' predicament adequately and does not provide them with a remunerative price. The outfit's leader, Sukhdev Singh Korikalan, labels it as mere eyewash and demands that the MSP should be based on the Swaminathan Commission's formula of  $C_2+50\%$ . Additionally, the government should make MSP a legally binding right for farmers, ensuring that their crops are purchased at MSP to sustain them in the otherwise economically challenging agricultural sector.

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**Table 1: Latest Minimum Support Price - Kharif (2023-24)**

| Commodity             | Variety       | MSP for 2022-2023<br>(Rs/ quintal) | MSP for 2023-2024<br>(Rs/quintal) | Increase over<br>previous year<br>(Rs/quintal) |
|-----------------------|---------------|------------------------------------|-----------------------------------|------------------------------------------------|
| <b>KHARIF CROPS</b>   |               |                                    |                                   |                                                |
| Paddy                 | Common        | 2040                               | 2183                              | 143                                            |
|                       | Grade 'A'     | 2060                               | 2203                              | 143                                            |
| Jowar                 | Hybrid        | 2970                               | 3180                              | 210                                            |
|                       | Maldandi      | 2990                               | 3225                              | 235                                            |
| Bajra                 |               | 2350                               | 2500                              | 150                                            |
| Maize                 |               | 1962                               | 2090                              | 128                                            |
| Ragi                  |               | 3578                               | 3846                              | 268                                            |
| Arhar (Tur)           |               | 6600                               | 7000                              | 400                                            |
| Moong                 |               | 7755                               | 8558                              | 803                                            |
| Urad                  |               | 6600                               | 6950                              | 350                                            |
| Cotton                | Medium Staple | 6080                               | 6620                              | 540                                            |
|                       | Long Staple   | 6380                               | 7020                              | 640                                            |
| Groundnut in<br>shell |               | 5850                               | 6377                              | 527                                            |
| Sunflower<br>seed     |               | 6400                               | 6760                              | 360                                            |
| Soyabean              | Yellow        | 4300                               | 4600                              | 300                                            |
| Sesamum               | -             | 7830                               | 8635                              | 805                                            |
| Niger seed            | -             | 7287                               | 7734                              | 447                                            |

**Table 1: Latest Minimum Support Price - Rabi (2023-24)**

| <b>RABI CROPS (Rabi Marketing Season (RMS) 2023-24)</b> |                |                                           |                                           |                                                     |
|---------------------------------------------------------|----------------|-------------------------------------------|-------------------------------------------|-----------------------------------------------------|
| <b>Commodity</b>                                        | <b>Variety</b> | <b>MSP for 2022-2023<br/>(Rs/quintal)</b> | <b>MSP for 2023-2024<br/>(Rs/quintal)</b> | <b>Increase over previous<br/>year (Rs/quintal)</b> |
| Wheat                                                   |                | 2015                                      | 2125                                      | 110                                                 |
| Barley                                                  |                | 1635                                      | 1735                                      | 100                                                 |
| Gram                                                    |                | 5230                                      | 5335                                      | 105                                                 |
| Masur (Lentil)                                          |                | 5500                                      | 6000                                      | 500                                                 |
| Rapeseed & Mustard                                      |                | 5050                                      | 5450                                      | 400                                                 |
| Safflower                                               |                | 5441                                      | 5650                                      | 209                                                 |
| Toria                                                   |                | 5050                                      | 5450                                      | 400                                                 |
| Copra (2022 crop season)                                | Milling        | 10,335                                    | 10,590                                    | 255                                                 |
|                                                         | Ball           | 10,600                                    | 11,000                                    | 400                                                 |
| De-husked coconut (2022 crop season)                    |                | 2800                                      | 2860                                      | 60                                                  |
| Raw Jute (for 2023 -24 season)                          |                | 4750                                      | 5050                                      | 300                                                 |

\* \* \* \* \*

# Organic Dairy Farming – Opportunity and Challenges

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Organic dairy farming concept is a relative newcomer. Interestingly it is showing a rising trend with time due to its beneficial effects in human life, to environment and mainly awareness among people. Lot more people lack the knowledge of organic farming and its uses. Therefore, this article gives much information about organic dairy farming, to enlighten the lives of human kind.

Organic dairy farming is a method of raising dairy cattle that highlights natural and sustainable practices while avoiding the use of chemical products, antibiotics and genetically modified organisms. Organic dairy surged into the organic marketplace in the 1990s, establishing itself as a major category. In organic farming animals are raised on pastures cultivated organically without using fertilizers and pesticides and there is restricted usage of antibiotics and hormones. The products obtained from Organic dairy farm are the organic dairy products. The primary aim of the organic dairy farming is to produce good quality milk and dairy products along with promoting the health and wellbeing of human, animals and environment.

The main principle of organic movement is healthy soils lead to healthy crops, healthy animals, healthy humans leading to healthy planet. Organic farming aims in increasing soil organic matter and biology in order to provide a long-term, dynamic environment for generating nutritious food and feed.

## Key features of organic dairy farming

**Organic feed:** Cows and calves are fed with 100% organic feed. Organic feed is one which is grown without the use of synthetic chemicals, fertilizers, pesticides and genetically modified organisms. Organic crops must be grown on land that has been free of all prohibited elements for at least three years prior to the first organic harvest.

The use of non-natural feed additives and supplements, like vitamins and minerals, is also approved for use. Organic dairy animals should have access to pasture and graze outdoors. Prohibition of slaughter by-products is followed in organic dairy farming.

## Restriction of synthetic chemicals

Synthetic chemicals such as antibiotics, hormones and synthetic growth factors etc should be prohibited. Antibiotics usage is restricted and are used only when cows are ill. Approved health care products can be used.

Additionally, calf should not be fed with synthetic milk replacers. Instead of usage synthetic chemicals natural remedies should be used and calves must be fed organic milk only.

**Animal welfare:** Organic dairy farming gives more importance to humane treatment and welfare of animals. Certain harmful procedures such as tail docking should be prohibited. Whereas, activities such as grazing animals outdoors, providing proper shelter, dehorning to minimize stress and meeting



proper feed and water to animals are given importance.

**Genetically modified organisms:** Use of genetically modified organisms is prohibited strictly.

**Impact on environment:** Organic dairy farming aims at minimizing environmental impacts by reducing chemical input, water conservation and promoting sustainable soil health through practices such as cover cropping, crop rotation and usage of organic fertilizers.

**Record maintenance:** farming who is maintaining organic dairy farming should keep all records to verify his/her compliance with the standards. Organic farms are inspected and audited every year.

**Certification:** Organic dairy farms are required to abide by stringent requirements for organic certification set by the government or independent certifying agencies. These criteria guarantee that farms adhere to the established organic best practices and regulations.



### Advantages of organic dairy farming

Organic dairy products are strictly from animals that are maintained under organic management. The milk and milk products obtained

from this system of rearing are superior in quality of products.

Organic milk is better for health. Whereas, conventional milk may contain residues of antibiotics, pesticides, hormones etc which have serious impact on health of animals as well as humans. Conventional milk is inferior in its quality. Its consumption may cause hormonal imbalance, early puberty, hypersensitivity and certain types of diseases such as cancer in humans. Therefore, organic dairy products are having superior quality and health benefits and its usage helps in good health status.

### Limitations of organic dairy farming

Agriculture and dairy farming is mostly occupied by small and marginal farmers. Because so many small farms supply milk and other products, traceability is a challenging alternative.

In organic production system animals are most vulnerable to incidences of diseases because they are raised outdoors and preventative treatment is not allowed. Therefore, parasite infection in organic dairy systems is the biggest problem for animal health and, subsequently, for consumer product quality. Production concern and cost drop is also a major drawback of organic dairy production. Additionally, lack of knowledge and training among farmers and people is causing fall in production and utilisation of organic dairy products.

### Conclusion

Organic dairy farming is expanding quickly and strictly prohibits the usage of synthetic chemicals, hormones, pesticides and other harmful chemical which cause hazardous health issues. Additionally, the organic dairy farming is strictly monitored by regular inspection, certification and verification of organic practices to protect consumers

who choose organic product. In general, organic dairy farming represents an effort to develop a more holistic and sustainable method of producing dairy products that puts the health of animals, consumers, and the environment first.

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# Potential Technology of Rice cultivation with limited Water resources

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Rice is the staple food for nearly half of the world's population, most of whom live in developing countries. The crop occupies one-third of the world's total area planted to cereals and provides 35-60% of the calories consumed by 2.7 billion people. More than 90% of the world's rice is produced and consumed in Asia (Barker and Herdt 1985 and IRRI, 1989). Rice is the most widely grown of all crops under irrigation. More than 80% of the developed fresh water resources in Asia are used for irrigation purposes and more than 90% of the total irrigation water is used for rice production (Bhuiyan 1992). But, water is becoming increasingly scarce. Per capita availability of water resource declined by 40-60% in many Asian countries between 1955 to 1990. For various reasons such as diminishing rainfall, depletion of ground water resources and increasing demand from other sectors, the availability of water for agriculture will diminish both in quantity and quality in the years to come. Yet, more rice needs to be produced with less and less water to feed the ever increasing population.

Of all the crops grown under irrigation, more than 50-60% of the irrigation water is used for rice, the staple food for nearly half the world's population. Since more than 90% of the world's rice is produced and consumed in Asia, water scarcity will be a threat to food security in this region. Success and sustenance of future rice production will therefore depend primarily on developing and adopting strategies that will use water more efficiently.

## Aerobic Rice

Rice is the unique plant that grows well both under aerobic and anaerobic conditions. When it is grown under aerated conditions without standing water it is called aerobic rice as against the usual transplanted rice which is grown under unaerated flooded conditions. Aerobic rice is an alternative and contingent rice production system (Sreedevi *et al.*, 2014), wherein rice crop is cultivated under nonpuddled and non-saturated soil conditions. This concept is mainly targeted for irrigated lowlands, less water available areas and uplands facilitating water saving and increasing water productivity by reducing its use during land preparation and limiting seepage, percolation and evaporation (Peng *et al.*, 2012). Aerobic rice is characterized by the presence of air in the soil medium and its limited water requirement as compared to the irrigated rice. The term aerobic rice became popular after the development of rice varieties with high yields (close to the irrigated lowlands) for cultivation in Latin American countries, particularly in Brazil, where rice is grown on non-puddled soils with irrigation water as high external input.

The cultivation of aerobic rice aims to minimize the water requirements of rice, but at the same time retaining the high yielding ability and input responsive characteristics of irrigated lowland varieties. The yields of aerobic rice are close to those irrigated lowlands, but with water savings of 40-50%. Early experiments suggested that only half the amount of water is needed for aerobic rice, aerobic



**Aerobic field after sowing and irrigation**



**Aerobic Rice seedling stage**



**Aerobic Rice Tillering stage**



**Unweeded aerobic rice plot**

varieties can be grown on water limited environments of irrigated lowlands. Since, they are able to root deeply and maintain leaf area development under non-saturated soil conditions. The aerobic rice varieties are considered to be more promising under both aerobic and flooded conditions.

Since 'aerobic rice' is a water saving technology, it provides enormous scope to sustain the rice production even during the limited water situations.

Under this changing scenario, water saving technologies that were investigated in the early 1970's such as saturated soil culture, and Alternate Wetting and Drying (AWD) are receiving renewed

attention from researchers. Generally, the water saving irrigation practices shift away from continuous anaerobic conditions to alternate anaerobic-aerobic and continuous aerobic conditions. Aerobic rice cultivation has been a successful market integrated system in Brazil and it is also being grown in northern China with yield levels reported to be close to irrigated levels.

### **Expected problems associated with aerobic rice cultivation**

The greatest benefit derived from flooding in lowland systems is that standing water acts as most efficient non-toxic weed killer. So, if farmers switch to growing aerobic rice, management of weeds will become an important issue. Another problem which is popularly called as 'yield collapse' may also occur



in aerobic rice cultivation. This is characterized by good yields in the first season, which may slump by about 20% in the following season and continued further. But it is reported that with suitable cropping patterns (management techniques) it could be averted.

### Package of practices developed at Indian Institute of Rice Research

**Land Preparation:** Well ploughed, and no or very little clods/clumps in field is required

like any dry land crops. Any type of organic manure, composted crop residues / vermi manure / green leaf manuring @ 5 t/ha. is strongly recommended.

**Suitable Cultivars:** Hybrids or High Yielding Varieties of mid early, medium duration, drought tolerance & weed competitiveness are suitable. e.g. : IR64, DRRDhan44, MTU1010, PMK3, PHB71, PA6444, DRRH3, JKRH3333, DRRH2, KRH2, GK5003, Rasi, Naveen, IET 20653, Vandana, Apo, Kalinga3 and Shabagidhan.

**Seed rate:** 25-30 kg/ha

**Time of sowing:** It has been observed that dry seeding one week before the onset of monsoon has performed similar to that of with the onset of / immediately after the onset of monsoon. The time of sowing had profound influence on grain yield and water requirement of the crop.

**Method of sowing and Spacing:** Seeding can be done manually or by seed drill in shallow furrows of 2-3 cm depth, at a spacing of 20X10cm for HYVs and 20X15 cm for Hybrids. 2-3 seedlings can be maintained per hill to maintain optimum plant stand and also to avoid thinning and wastage of seed and other resources. Care should be taken to avoid excess use of seed and thinning at later stage. The Irrigation channels, should be made along the slope, and light irrigation has to be given if there is no rain.

**Fertilizer Management:** Nutrition is the critical input in yield realization of aerobic rice ecosystem as availability of required nutrients is low. Iron deficiency is one of the serious nutritional disorders in aerobically grown rice on upland alkaline and calcareous soils leading to decline in productivity. Optimum fertilizer schedule for hybrids is 150:50:50 NPK and 120:50:50 for HYVs. Entire dose of fertilizer phosphorus and 75% potassium should be applied at sowing and first dose of Nitrogen i.e., 50%N should be applied after the seedlings reach 2-3 leaf stage. Top dressing of 25% nitrogen at maximum vegetative stage (45 DAS), 25% N, 25% K at 50% flowering stage is recommended. If Iron deficiency is noticed, spraying of ferrous sulphate @2.0% ferrous sulphate 3 to 4 times at weekly interval. Weekly irrigation with high Nitrogen fertilization resulted in high yields

**Table 1. Interaction influence of different Nitrogen & Water Schedules on Hybrid Rice PA 6444**

| Irrigation regime             | Grain yield kg/ha                                                     |                                                  |                                                  | Water requirement hamm |
|-------------------------------|-----------------------------------------------------------------------|--------------------------------------------------|--------------------------------------------------|------------------------|
|                               | Fertilizer schedule<br>N <sub>0</sub> P <sub>50</sub> K <sub>50</sub> | N <sub>100</sub> P <sub>50</sub> K <sub>50</sub> | N <sub>150</sub> P <sub>50</sub> K <sub>50</sub> |                        |
| Need based irrigation         | 2553                                                                  | 3233                                             | 4293                                             | ~ 1000                 |
| Weekly irrigation             | 2565                                                                  | 3518                                             | 4835                                             | ~ 1200                 |
| Continues water level of 5 cm | 3069                                                                  | 4621                                             | 5010                                             | ~ 1500                 |

**Biofertilizers:** Biofertilizers are cost effective, eco-friendly and can act as a partial supplement chemical fertilizers and they also play a vital role in maintaining long term soil fertility and

sustainability. Azospirillum and phosphorus solubilizing bacteria (PSB) inoculants @5 kg/ha mixed with gruel for seed coating and remaining quantity was broadcasted in the field by mixing with 200 kg Farm Yard Manure and 200 kg of soil just before sowing of rice. Combination of Azospirillum and PSB were found to save 15-25% fertilizer N and P.

**Irrigation:** Soil must to be kept aerated to get the advantage of aerobic cultivation. Need based irrigation (5-7 days interval) is needed to maintain moist situation upon noticing visible symptoms of hairline cracks on soil surface. Maintenance of saturated condition at critical stages of Active Tillering, Panicle Initiation, Flowering to grain filling stage is essential.

The irrigation scheduling at 150mm cumulative pan evaporation (CPE) resulted in significant crop growth, yield attributes and grain yield (Table)

**Table: Mean Grain yield and yield attributes of aerobic rice under different irrigation schedule**

| Irrigation schedules | Grain yield (t/ha) | Panicle/m <sup>2</sup> (No.) | Panicle weight (g) |
|----------------------|--------------------|------------------------------|--------------------|
| I1 (150 mmCPE)       | 3.89               | 243                          | 2.65               |
| I2 (100 mmCPE)       | 3.64               | 233                          | 2.53               |
| I3 (75mm CPE)        | 3.42               | 222                          | 2.44               |
| C.D.(0.05)           | 0.08               | 4                            | 0.04               |

**Weed Management:** Weeds are one of the major constraints to aerobic rice production system, as dry-tillage, alternate wetting & drying conditions are conducive to germination, growth of weeds

causing grain yield losses of 50-91%. Sequential application of Pendimethalin 30 EC @1.5 kg a.i./ha. application as pre-emergence 1-2 days after sowing, followed by Bispyribacsodium 10%SC @ 20 g a.i./ha at 3-4 leaf stage of weeds is recommended.

**Inter-cultivation:** Soil between the rows can be disturbed and added to the base of the rice plants so as to aerate the soil and also strengthen the base of the plants.

**Plant Protection:** Prophylactic sprays of one dose of any systemic insecticide needs to be sprayed as required. Carbofuron. soil application in case of the nematode incidence is necessary.

**Harvesting:** The crop will flower in 75 - 80 days and attain maturity in 118 - 120 days.

#### **Aerobic rice based cropping systems:**

Location specific Pulse crop or Oil seed crop in rotation with aerobic rice in *kharif*.

#### **Prospects of Aerobic Rice in India**

Although it is difficult to quantify the exact area that would be suitable for aerobic rice cultivation, one would expect that most of the irrigated rice grown in command area, particularly in southern India and under tube well irrigation is the potential area for growing aerobic rice. On the other hand, about 1.0 m ha of area under uplands is characterized as favourable due to higher precipitation received during wet season. Similarly, about 2.0 m ha of rainfed lowlands remains non-flooded for most part of the crop growth making it most suitable for aerobic rice cultivation. Large area under rice-wheat system in northern India could be most potential area for aerobic rice cultivation.

#### **Conclusions**

The adoption of water saving technologies in general and aerobic rice in particular at the farm level will contribute to increasing water productivity, safe

guarding food security and alleviating poverty. Assuming an average farm size of 1 hectare, some 17 million farmers who face physical water scarcity and 22 million farmers who face economic water scarcity in 2025 will benefit from water saving technologies.

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# Unveiling the Green Beneath: A Comprehensive Review of Microbial Contributions in Agriculture

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Agriculture is a diverse network of plant-microorganism interactions. There is an increasing demand for ecologically compatible, environmentally friendly agricultural techniques that may provide a plentiful supply of nutrients for the growing human population through better quality and quantity of agricultural products and services. Although soil is the primary source of plant nutrients, soil quality is required for agricultural production. Soil microorganisms (bacteria, fungus and protists) present in the soil system can improve soil quality and maintenance. Farmers commonly think of bacteria as pests that ruin their crops, although many microbes are beneficial. Soil microorganisms, particularly bacteria and fungus are essential for decomposing organic matter, recycling old plant material and forming interactions with plant roots that deliver critical nutrients such as nitrogen and phosphorus. Fungi can colonize the higher sections of plants and provide numerous benefits such as drought endurance, heat tolerance, insect resistance and plant disease resistance. Microbes are major catalysts of global carbon and nitrogen cycles in terrestrial ecosystems including the generation and consumption of greenhouse gases in soil. While decomposing organic matter in soil, some bacteria produce the greenhouse gases carbon dioxide (CO<sub>2</sub>) and nitrous oxide (N<sub>2</sub>O). Others consume methane (CH<sub>4</sub>) from the atmosphere, so contributing to climate change mitigation. Each of these processes is influenced by

human activity and has an impact on the warming potential.

## Soil microbes

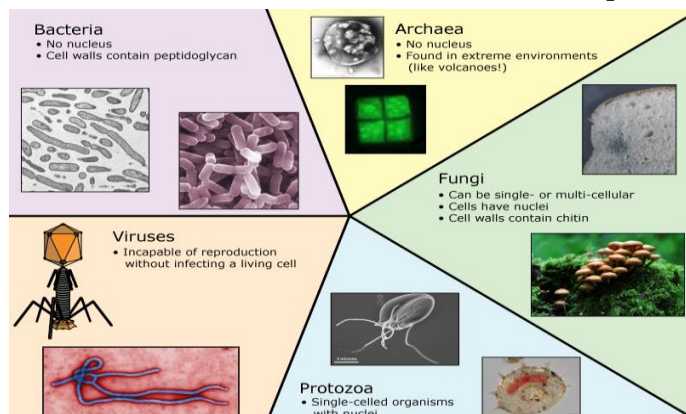
Microbes are the most ancient form of life on Earth, accounting for a huge portion of the planet's living material. They are microscopic organisms that are too small to be seen with the naked eye. Soil bacteria perform critical roles in ecosystems, influencing a wide range of critical ecosystem processes such as nutrient absorption, nitrogen cycling, carbon cycling, and soil formation. Efficient and potential soil microorganisms including all five major groups i.e. bacteria, viruses, fungi, algae and protozoa can significantly benefit the Agricultural practices (Bagyaraj and Rangaswami, 2007)

**Bacteria:** Bacteria are small, single-celled organisms that flourish in a wide range of settings. They can be found in animals' digestive systems, the ocean and fresh water, compost piles (even at temperatures above 130°F), and soils. Their number per gram of soil reaches from 100,000 to several hundred millions. *Arthrobacter*, *Bacillus*, *Pseudomonas*, *Clostridium* and *Micrococcus* are common soil microorganisms.

**Fungi:** Fungi are eukaryotic organisms, which means that their cells include membrane-bound organelles and clearly defined nuclei. They are more abundant in the surface layers of well-aerated and cultivated soils, and they predominate in acidic soils. The physical structure of soil is improved by the accumulation of mold mycelium within it. Soil fungi



include *Aspergillus*, *Mucor*, *Penicillium*, *Trichoderma*, *Alternaria*, *Fusarium* and *Rhizopus*.



**Figure 1: The different types of microbes**

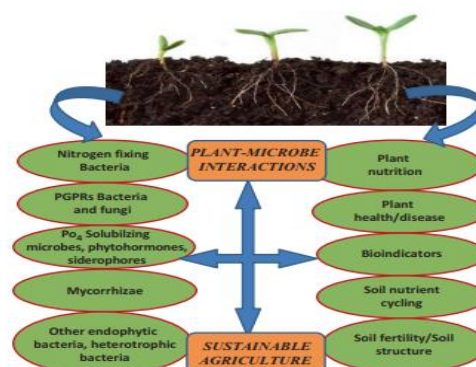
**Algae:** They have a lower population density than bacteria and fungus. They exist on the soil's surface or subsurface. Algae may grow in relatively dry soils (100 to 10,000 per gram of soil) and develop mutually beneficial interactions with other creatures. Lichens on rocks are a combination of a fungus and an alga. Green algae and diatoms are the most common.

**Protozoa:** Protozoa are unicellular organisms with populations ranging from 10,000 to 100,000 per gram of soil. They are mostly secondary organic material consumers, feeding on bacteria, fungi, other protozoa, and organic molecules dissolved in soil water. Protozoa are thought to be responsible for mineralizing (releasing nutrients from organic molecules) much of the nitrogen in agricultural soils by grazing on nitrogen-rich organisms and excreting waste. The majority of soil forms are flagellates, amoebae, or ciliates. They feed on soil bacteria and are found in abundance in the upper layer of the soil. They maintain the biological balance in the soil.

**Viruses:** Viruses are microscopic parasites that are far smaller than bacteria. They are unable to thrive or multiply outside of a host body. Bacterial, plant, and animal viruses enter soil by the addition of plant and animal wastes.

Microbial diversity and its interaction with plant-soil system

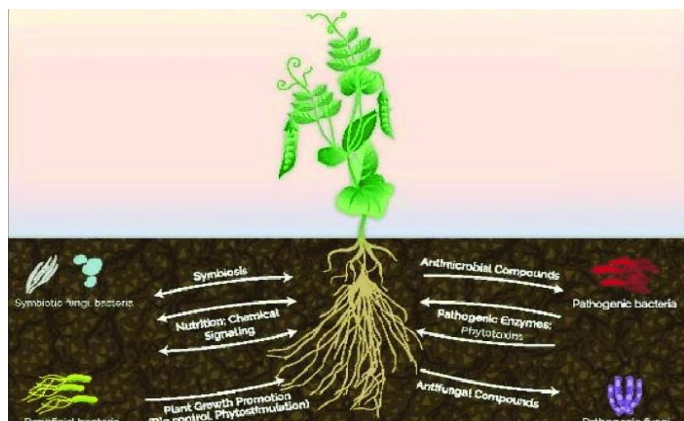
Soil microorganisms such as bacteria, algae, fungus, protozoa, and infective agents such as viruses are the bodies that exist among the vast resources of microscopic diversity. These soil microorganisms have various beneficial roles as well as some negative effects. The impact of soil biota in the soil profile is diverse and challenging since the same action can be destructive or beneficial depending on its position. Plants, on the other hand, exhibit a diverse spectrum of interactions with these soil microbes, extending the complete range of biological possibilities (competitive, exploitative, neutral, commensal and mutualistic).



**Figure 2: Interaction among microbes and plants within the soil system (Source: Toor and Adnan, 2020)**

As the interactions between plant and microscopic communities are influenced by various agronomic managements and biological factors, particularly in the current situation of global revolution, the impact of ecological stress factors must be considered, as they affect proper management of crop-micro biome interactions. The creation of soil with a high level of soil fertility is the consequence of hundreds of years of soil "evolution"; this assertion is not surprising given the complicated interactions between microbes and the plant-soil

system. Figure 2 depicts the interaction of bacteria and plants within the soil system.



**Figure 3: Schematic diagram of plant-soil interaction in rhizosphere (Source: Bramhachari et al., 2015)**

Soil microorganisms (bacteria and fungus) are required for organic matter decomposition and the recycling of old plant material. Some soil bacteria and fungus create interactions with plant roots, supplying essential nutrients such as nitrogen and phosphorus. Fungi can colonize the higher sections of plants and provide numerous benefits such as drought endurance, heat tolerance, insect resistance, and plant disease resistance. Viruses are almost always thought of as disease agents. This is due to the fact that the ones that cause disease have been investigated. Although half of the wild plants have viruses, the majority do not appear to be sick. The viruses appear to be harmlessly living in the plants.

## Importance of soil microbes to plants

Plants cannot acquire nutrients from soil unless bacteria work in the soil. Microbes are alive and require sustenance to survive, which comes from organic stuff. Microbes assimilate numerous components such as nitrogen, carbon, oxygen, hydrogen, phosphorus, potassium, and micronutrients for plants as they consume food. Microbes are responsible for converting NPK and

minerals into a form that plants may use for growth and development. The following are some of the most important roles of soil microorganisms.

## Production of plant growth regulators

Plant growth regulators are synthetic chemicals that are useful in agriculture because they govern plant development. Various soil microorganisms, including bacteria, fungus and algae are responsible for creating physiologically active chemicals such as plant growth regulators, which can influence plant growth and development (Ahemad and Kibret, 2014). Plant growth promoting rhizobacteria (PGPR) can modify root architecture and promote plant growth by producing phytohormones such as indole acetic acid (IAA), gibberellic acid (GA), cytokinins, and important metabolites such as siderophores, HCN, and antibiotics (Kloepper et al., 2007).

Plant growth may be aided by PGPR through the suppression of root pathogens via the production of siderophores (compounds secreted by microorganisms that bind iron, making it less available to pathogens) or the production of antibiotics, nitrogen fixation, and plant hormone production. Plant growth and root colonization are stimulated by PGPR when combined with mycorrhizae. PGPR has had some success in agriculture, and commercial preparations are imminent. Rhizobium symbiosis with legumes and free-living associative rhizosphere soil bacteria Azotobacter and Azospirillum are two of the most important. Rhizobacteria, primarily Pseudomonas, Erwinia, Flavobacterium and Bacilli are another category of beneficial microbes that increase agricultural plant health and productivity through a range of secondary metabolites and are involved in root growth promotion.

**Table 1: Production of plant growth regulators (PGRs) by PGPR (Source: Prasad et al., 2015)**

| PGPR                              | PGRs                 | Plant     | Reference<br>s                       |
|-----------------------------------|----------------------|-----------|--------------------------------------|
| Pseudomonas fluorescens           | Indole-3-acetic acid | Groundnut | Dey et al. (2004)                    |
| Azospirillum lipoferum strains 15 | Indole-3-acetic acid | Wheat     | Muratova et al. (2005)               |
| Bacillus sp.                      | Indole-3-acetic acid | Rice      | Beneduzi Paenibacillus et al. (2008) |

### Nutrient management

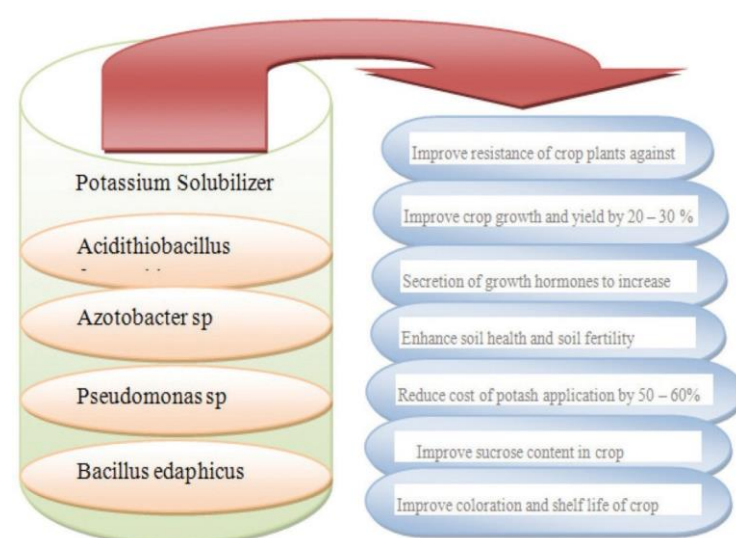
Nutrient management encompasses conservation measures that directly or indirectly aid in the optimization of use in nutrient use efficiency, hence improving plant quality, soil health, and the environment. Microbes in the soil and atmosphere play an important role in nutrient management. Soil microorganisms, notably bacteria and fungi, are shown to be critical in digesting organic materials in the soil and recycling organic leftovers. Many substances are secreted from various sections of the plant root system, which may generate a unique environment in the rhizosphere. These substances are known as root exudates.

Several environmental factors e.g. temperature, light, age and soil type can directly or indirectly affect the nature and timing of root exudation. Potentiality of microbes such as *Aspergillus niger*, *A. chroococcum*, *Azospirillum brasilense*, *Bacillus subtilis*, *Pseudomonas corrugata*, *Rhizobium* sp. and *Streptomyces nojiriensis* in

enhancing plant growth as well as pest and disease suppression has been reported (Bhattacharyya and Jha, 2012).

### P solubilising Biofertilizers (PSB)

The amount of phosphorus available for plant growth is determined not only by the overall amount of phosphorus in the soil, but also by its solubility. The amount of P available to plants is determined by the composition of the soil (soil texture) and its acidity (pH) (Muraleedharan et al., 2010). Inorganic phosphate compounds such as tricalcium phosphate, dicalcium phosphate, hydroxyapatite, and rock phosphate can be solubilized by several bacterial and fungal taxa. Among the bacterial genera with this capacity are *Pseudomonas*, *Bacillus*, *Rhizobium*, *Burkholderia*, *Achromobacter*, *Agrobacterium*, *Micrococcus*, *Aerobacter*, *Flavobacterium* and *Erwinia*.



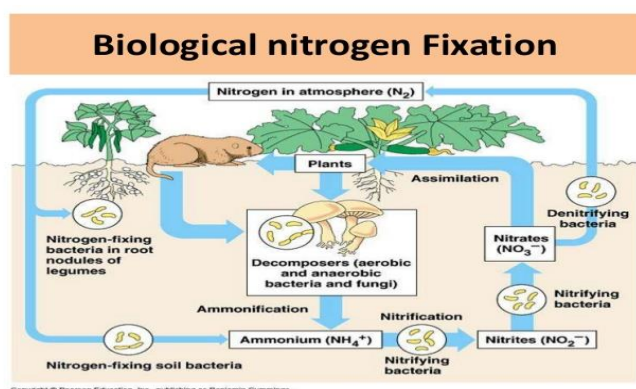
**Figure 4: Role of potassium solubilizers in agriculture (Toor and Adnan, 2020)**

### Nitrogen fixing biofertilizers

Nitrogen is a vital ingredient for all forms of life. It can be present in amino acids, proteins, and many other chemical substances. Nitrogen is a minor mineral nutrient that regulates the strength of organic matter formation. The atmosphere is the



source of soil nitrogen, with nitrogen gas accounting for around 79% of total atmospheric gases. Although nitrogen is abundant in nature, it frequently limits plant productivity because atmospheric nitrogen is only available to a narrower variety of organisms that symbiotically and non-symbiotically associate with higher plants (Franché et al., 2009). Global nitrogen consumption is roughly  $2.6 \times 10^{11}$  kg per year, with biological nitrogen fixation accounting for nearly 70%.



**Figure 6: Biological Nitrogen Fixation**

(Source: <https://socratic.org/questions/how-can-nitrogen-be-fixed-naturally-for-plant-use>)

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# Harnessing the Demographic Dividend of India in Agriculture

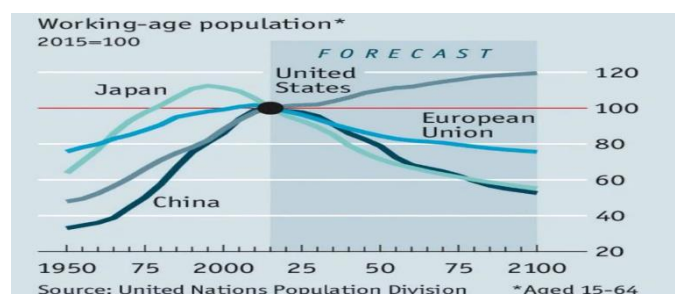
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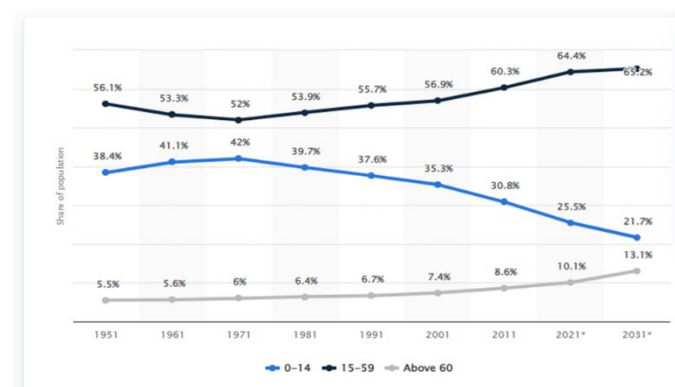
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Demographic dividend means the economic growth potential that can result from shifts in a population's age structure, mainly when the share of the working-age population (15-64 years) is larger than the non-working-age share of the population (14 and younger & 65 and older) (UNFPA 2020). Demographic dividend has historically contributed up to 15 % of the overall growth in advanced economies. With fewer births each year, a country's working-age population grows larger relative to the young dependent population. With more people in the labor force and fewer children to support, a country has a window of opportunity for economic growth if the right social and economic investments and policies are made in health, education, governance, and the economy. These population parameters indicate an availability of demographic dividend in India, which started in 2005-06 and will last till 2055-56.

Harnessing the demographic dividend of India in agriculture can be a key driver for sustainable economic growth and development. The demographic dividend refers to the potential economic benefit a country can achieve when the proportion of its working-age population is relatively larger than the dependent population (children and elderly). India, with a large and growing young population, has the opportunity to leverage this demographic advantage in the agricultural sector.



India has one of the youngest populations in an aging world. In 2020, the median age in India will be just 28, compared to 37 in China and the US, 45 in Western Europe, and 49 in Japan. Since 2018, India's working-age population (people between 15 and 64 years of age) has grown larger than the dependent



population – children aged 14 or below as well as people above 65 years of age. This bulge in the working-age population is going to last till 2055, or 37 years from its beginning. This transition occurs largely because of a decline in the Total Fertility Rate (TFR, which is the number of births per woman) after the increase in life expectancy gets stabilised. According to Economic Survey 2018-2019, the Demographic Dividend of India will be at a peak around 2041, when share of working-age population is expected to hit 59% and thereafter it will start declining.

**Table 1. Status of demographic dividend in india (as per 2021 census data)**

| Indicator                  | Status                                                                             |
|----------------------------|------------------------------------------------------------------------------------|
| Total Population           | Approximately 1.3 billion                                                          |
| Population Growth Rate     | Declining, but still positive                                                      |
| Working-Age Population (%) | Approximately 66%                                                                  |
| Median Age                 | Around 28-30 years                                                                 |
| Dependency Ratio           | Decreasing due to declining birth rates                                            |
| Youth Unemployment Rate    | Varied across states, relatively high                                              |
| Rural-Urban Migration      | Significant rural-to-urban migration                                               |
| Education Levels           | Improving, but disparities exist                                                   |
| Agricultural Workforce     | Still a substantial portion of the labor force                                     |
| Technological Adoption     | Increasing, but disparities in adoption exist                                      |
| Government Initiatives     | Several programs and policies to promote agricultural growth and skill development |

Agriculture continues to be a vital industry in India as of 2021, giving employment and a means of subsistence to a sizeable portion of the population, particularly in rural areas. The proportion of India's labour force employed in agriculture in 2020, as reported by the World Bank, was almost 43%. This suggests that about 50% of India's workforce was employed in agricultural pursuits.

It's important to note as the economy has become more diverse and non-agricultural industries have expanded, the proportion of the labour force employed in agriculture has been steadily declining over time. Employment patterns have shifted away from agriculture as a result of urbanization, increased industrialization, and the expansion of the services sector.

### Constraints And Prospects of Harnessing Demographic Dividend:

#### Constraint

There are several constraints faced for harnessing the demographic dividend:

- **Rural-Urban Migration:** India has been witnessing significant rural-to-urban migration as young people move to cities in search of better economic opportunities. This migration can lead to labour shortages in the agricultural sector, making it challenging to harness the demographic dividend fully.
- **Outdated Agricultural Practices:** A large part of India's agricultural sector still relies on traditional and outdated farming methods. To harness the demographic dividend, there is a need to modernize agriculture through technological advancements, improved irrigation systems, and the adoption of best practices.
- **Land Fragmentation:** In India, land holdings are often small and fragmented due to inheritance laws. This fragmentation can hinder economies of scale and modernization efforts, making it difficult to optimize agricultural productivity.
- **Climate Change and Water Scarcity:** Agriculture is highly dependent on climate and water resources. Climate change and water scarcity issues can negatively impact agricultural productivity and pose challenges for harnessing the demographic dividend.
- **Lack of Skills and Training:** Many young people in rural areas lack the necessary skills and training to participate in modern agricultural practices. Proper training and

skill development programmes are essential to leverage their potential effectively.

### Prospects

There are several constraints faced for harnessing the demographic dividend:

- **Youthful Workforce:** India's youthful workforce can be a significant asset in the agricultural sector. By providing the right incentives and training, young people can bring innovation, energy, and enthusiasm to agriculture.
- **Technological Advancements:** Embracing technology and innovation in agriculture can revolutionize the sector. From precision farming and use of drones to IoT devices for better monitoring, technology can enhance efficiency and productivity.
- **Diversification and Value Addition:** Encouraging farmers to diversify their crops and engage in value addition can open new markets and increase their income levels.
- **Rural Entrepreneurship:** Supporting and promoting rural entrepreneurship can lead to the development of agribusinesses, food processing units, and other related industries, creating more job opportunities and contributing to economic growth.
- **Investment in Infrastructure:** Improving rural infrastructure, such as irrigation facilities, transportation networks, and storage facilities, can boost agricultural productivity and reduce post-harvest losses.

- **Government Initiatives:** The Indian government plays a crucial role in promoting agricultural growth. By implementing policies that encourage investment, research, and development in agriculture, the government can create an enabling environment for harnessing the demographic dividend.

### Conclusion

The growing population and its significance on nation's growth is a two-way phenomenon. The increase in population adds to growth and development of a country by supplying workforce, but at the same time adding up to the count of number of dependent individuals to the economy. India's demographic dividend will prove to be advantageous if the huge potential of the working age human resources are channelized rightly, which implies gainful employment of the available workforce. The Govt. of India also formulates numerous schemes for qualitative development of different domains of targeted livelihood. Till date, plans have been developed for sectoral domains, but no comprehensive strategy has been devised to integrate the natural resources with human resources. The NITI AAYOG and policy makers should take into consideration a comprehensive planning for capacity building from the grass-root to national level which will lead to an effective transformation. This will establish India as a leading economy globally.



**Table 2. AGRICULTURAL LABOUR FORCE IN INDIA-HISTORICAL DATA**

| Year | Total Labor Force (Millions) | Agricultural Labor Force (Millions) | Percentage of Agricultural Labor Force in Total Labor Force (%) | Source               |
|------|------------------------------|-------------------------------------|-----------------------------------------------------------------|----------------------|
| 2000 | 391.2                        | 241.1                               | 61.6                                                            | ILO, Census of India |
| 2005 | 446.5                        | 224.5                               | 50.3                                                            | ILO, Census of India |
| 2010 | 480.2                        | 209.4                               | 43.6                                                            | ILO, Census of India |
| 2015 | 517.6                        | 195.6                               | 37.7                                                            | ILO, Census of India |
| 2020 | 541.3                        | 186.4                               | 34.4                                                            | ILO, Census of India |

**Source:** International Labour Organization (ILO), Census of India data.

**Table 3: How demographic dividend will promote national economy of India**

| Aspect                              | Explanation                                                                                                                                                             | Source                                                                                      |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Increased Labor Force Participation | A large working-age population can lead to more people actively participating in the labor market, contributing to economic productivity and growth.                    | World Bank - India Development Update, 2021                                                 |
| Higher Savings and Investment       | With a growing working-age population, higher savings rates are expected, which can lead to increased domestic investment, supporting economic development.             | IMF - India: 2020 Article IV Consultation                                                   |
| Increased Consumer Demand           | A youthful population means an expanding consumer base, driving domestic demand for goods and services, boosting economic activity.                                     | India Brand Equity Foundation (IBEF) - Demographics                                         |
| Urbanization and Industrialization  | A youthful population can fuel urbanization and industrial growth as young people migrate to cities for better job opportunities.                                       | McKinsey Global Institute - India's Turning Point                                           |
| Technological Innovation            | Younger populations are often more tech-savvy and can drive technological innovation, enhancing productivity and economic competitiveness.                              | PwC India - India's Demographic Dividend                                                    |
| Entrepreneurship and Startups       | The demographic dividend can foster entrepreneurship, leading to the creation of startups and innovative businesses, driving job creation and economic diversification. | NITI Aayog - India Innovation Index 2020                                                    |
| Skilled Workforce                   | Investments in education and skill development can create a more skilled and adaptable workforce, attracting foreign investment and boosting productivity.              | International Journal of Advanced Research and Publications - Demographic Dividend: A Study |

**Table 4. Government schemes for harnessing demographic dividend India**

| Scheme name                                     | Objective                                                                     | Source                                                                                  |
|-------------------------------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Pradhan Mantri Kaushal Vikas Yojana (PMKVY)     | Skill development and vocational training for youth to enhance employability  | <a href="https://www.pmkvyofficial.org/">https://www.pmkvyofficial.org/</a>             |
| National Apprenticeship Promotion Scheme (NAPS) | Encouraging industries to engage apprentices and provide skill-based training | <a href="https://apprenticeshipindia.org/">https://apprenticeshipindia.org/</a>         |
| Pradhan Mantri Mudra Yojana (PMMY)              | Providing financial support to small and micro-enterprises                    | <a href="https://www.mudra.org.in/">https://www.mudra.org.in/</a>                       |
| National Skill Development Mission (NSDM)       | Enhancing the employability of the workforce through skill development        | <a href="https://www.skilldevelopment.gov.in/">https://www.skilldevelopment.gov.in/</a> |
| Skill India Mission                             | Focused on providing training and skill development to the Indian workforce   | <a href="https://www.skillindia.gov.in/">https://www.skillindia.gov.in/</a>             |

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# Farm Pond: A Sustainable Source of Income for Farmers

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Water is a part of the larger ecosystem in which the reproduction of the bio diversity depends. Fresh water shortage is not limited to the arid climate regions only, but in areas with good supply the access of safe water is becoming serious problem. Lack of water is caused by low water storage capacity, low infiltration, larger inter annual and annual fluctuations of precipitation (due to monsoonic rains) and high evaporation demand. The available water resources are under severe pressure due to increasing demands and the time is not far when water, which we have always thought to be available in abundance and free gift of nature, will become a inadequate commodity. Conservation and preservation of water resources is urgently required to be done. Water management has always been practiced in our communities since ancient times, but today this has to be done on priority basis. Due to population explosion, our country faces a serious threat to the management of water resources as the gap between demand and supply widens. Thus it is

the responsibility of all to conserve our precious water resources. Harvesting of rainwater is of utmost important. A judicious mix of primeval knowledge, modern technology, farmer's involvement and above all, peoples' participation will go a long way in revitalizing and amplification of water harvesting practices throughout the country.

## Need for Rainwater Harvesting

Water is a becoming a limited commodity and it is considered as a liquid gold in many parts of the country. The demand of water is also increasing day by day not only for Agriculture, but also for household and industrial purposes. It is estimated that water need for drinking and other municipal uses will be increased from 3.3 Mhm to 7.00 Mhm in 2020/25. Similarly the demand of water for industries will be increased by 4 fold i.e. from 3.0 Mhm to 12.00 Mhm during this period. At the same time more area should be brought under irrigation to feed the escalating population of the country, which also needs more water. But we are not going to get one litre more water than we get at present though the demand is alarming. The perennial rivers are becoming dry and ground water table is depleting in most of the areas. In some areas the depletion is about 30-50m in the last 30-40 years (Sivanappan,

2006). Country is facing floods and drought in the same year in many states. This is because, not adequate action was taken to conserve, harvest and manage the rainwater efficiently. The Theme paper on Water vision 2050 of India, prepared by Indian Water Resources Society (IWRS) has indicated that a storage of 60 Mhm is necessary to meet the demand of water for irrigation, drinking and other purposes. But the present live storage of all reservoirs put together is equivalent of about 17.5 Mhm which is less than 10% of the annual flow in the rivers in the country. The projects under construction (7.5 Mhm) and those contemplated (13 Mhm) are added, it comes only 37.50 Mhm and hence we have to go a long way in water harvesting to build up storage structures in order to store about 60 Mhm. Therefore there is an urgent need to take up the artificial recharge of the rain for which water harvesting and water conservation structures are to be build up in large scale.

### Objective of Rainwater Harvesting

1. Restore supplies from the aquifers depleted due to over exploitation.
2. Improve supplies from aquifers lacking adequate recharge.
3. Store excess water for use at subsequent times.
4. Improve physical and chemical quality of ground water.
5. Reduced storm water run off and soil erosion.
6. Prevent salinity ingress in coastal areas.
7. Increase hydrostatic pressure to prevent/stop land subsidence.
8. Recycle urban and industrial wastewater etc.

9. Rehabilitate the existing traditional water harvesting structure like village ponds, percolation tanks, etc.
10. With minor scientific modifications and redesigning, convert the traditional water harvesting structure into ground water recharge facilities.

### Benefits of Rainwater Harvesting

- Rise in ground water levels in water
- Increased availability of water from wells
- Prevent decline in water levels
- Reduction in the use of energy for pumping water and consequently the costs.
- Reduction in flood hazard and soil erosion
- Benefiting in the water quality
- Arresting sea water ingress
- Mitigating the effect of droughts and achieving drought proofing
- Reviving the dying traditional water harvesting structures and their rehabilitation as recharge structures.
- Effective use of lack of defunct wells and tubwells as recharge structure
- Up gradation of social and environmental status etc.

### Types of Farm Pond

The ponds are mainly of two types. One is embankment type and other is dug out type. The embankment type pond is constructed across streams/ravines and big gullies in order to impound certain quantity of runoff water which will otherwise find its way to rivers. The impounded water infiltrated into subsoil and recharges the groundwater table. The excess runoff is collected in dug out farm pond and the stored water can be used as a supplementary irrigation to the crops grown in adjoining areas.



### Dimensions of farm ponds for different catchments at AICRPDA, Akola centre

Based on the runoff from different catchments, the capacity of the farm pond has been decided at AICRPDA, Akola. Accordingly, the location for construction of the farm pond had been chosen and the dimensions were decided and construction of three farm ponds for three different catchments was done and the details are given in Table 1 and 2.

### Availability of water in the farm pond

Depending upon the amount of rainfall and the intensity of rainfall, the runoff from the catchments can be accumulated in the farm ponds. On the basis of availability of water in the farm ponds and as per need the protective irrigation can be given to the crops in *Kharif* as well as *Rabi* season. The expected area coverage depending upon the availability of the water in the farm pond is given below in Table 3.

### Results

In Vidarbha region of Maharashtra State and most part of the country, occurrence of high intensity rainfall events may results in floods. In these areas dry spell even within the monsoon periods are not uncommon, resulting in fluctuation in crop production. In these areas it would be wise to harvest the runoff water, store it and recycle it for using to different agronomical crops by constructing farm ponds and other water storing structures. Farm ponds hold great promise as a life saving device for rainfed crops in area characterized by low and erratic rainfall. In view to have sustainability in rainfed agriculture and development of water resources the experiment on rain water management through farm pond technology has been undertaken and results for the year 2018-19 are presented here.

### Productivity (*Rabi*):

During the *Rabi* season 2018-19, the storage was there in the farm ponds. The sowing of chickpea was done in the month of October. The germination in treatment T<sub>3</sub> (without irrigation) was very poor due to less residual moisture in the soil. However, the protective irrigations of 50mm depth were given to chickpea and the recorded yield of chickpea with protective irrigations is given in Table 4. The highest yield and B:C ratio (1560kg ha<sup>-1</sup> and 2.24) was recorded in the treatment two protective irrigations of 50mm depths each with sprinkler set from stored pond water (T<sub>2</sub>).

The stored farm pond water was also used for supplemental irrigation to different vegetables by using micro-irrigation systems. The details of vegetables along with irrigation system used, yields and water used is given in Table 5. It was observed that in the vegetable crops like Coriander, Fenugreek, Radish, Spinach, Dolichus bean (wal), Brinjal and Cow pea the water use efficiency was in the range of 2.25 – 6.00kg/m<sup>3</sup>. The total income from these small vegetables plots during the season 2018-19 is Rs. 9710.

### Conclusion

Rainwater harvesting through farm pond had increases the yield level in the range of 45 to 46% during *rabi* season and water use efficiency was increased in the range of 2.25 to 6. 00 kg/m<sup>3</sup> for vegetables. It will be possible for the farmers to go for the vegetable crops during *rabi*. The water was also available for the cattle and for other agricultural operations. The farmers having availability of farm pond water can have sustainable income due to vegetables.

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**Table 1. Dimensions of farm pond**

| Farm pond no. | Catchment area (ha) | Capacity (cum) | Top dimensions (m x m) | Bottom dimensions (m x m) | Depth (m) | Side slopes |
|---------------|---------------------|----------------|------------------------|---------------------------|-----------|-------------|
| 1             | 5.0                 | 2753           | 45 x 27                | 36 x 18                   | 3.0       | 1.5:1       |
| 2             | 5.0                 | 4265           | 60 x 30                | 51 x 21                   | 3.0       | 1.5:1       |
| 3             | 2.0                 | 370            | 18 x 11                | 12 x 5                    | 3.0       | 1:1         |

**Table 2. Cost estimation of farm pond**

| Farm pond no. | Capacity (cum) | Cost of Earthwork (Rs.) |
|---------------|----------------|-------------------------|
| 1             | 2753           | 1,70,000                |
| 2             | 4265           | 2,63,500                |
| 3             | 370            | 22,900                  |

Cost of portable pump set, 3HP with discharge of 1000 lpm : Rs. 34700/-

Cost of Sprinkler set (30pipes of 75mm dia, 3.2 Kg/cm<sup>2</sup> and 8 nozzles) : Rs. 35000/-

**Table 3. Expected area which can be provided protective irrigation from the available pond water (ha)**

| Depth of water in the farm pond (m) | Availability of water in the farm ponds (cu m) |             |             | Expected area which can be provided protective irrigation from the available pond water considering 10 % losses (ha) |             |             |
|-------------------------------------|------------------------------------------------|-------------|-------------|----------------------------------------------------------------------------------------------------------------------|-------------|-------------|
|                                     | Farm pond 1                                    | Farm pond 2 | Farm pond 3 | Farm pond 1                                                                                                          | Farm pond 2 | Farm pond 3 |
| Full                                | 2753                                           | 4265        | 370         | 4.95                                                                                                                 | 7.68        | 0.66        |
| 2.5                                 | 2294                                           | 3554        | 307         | 4.13                                                                                                                 | 6.40        | 0.55        |
| 2.0                                 | 1836                                           | 2844        | 246         | 3.30                                                                                                                 | 5.12        | 0.44        |
| 1.5                                 | 1377                                           | 2133        | 184         | 2.48                                                                                                                 | 3.84        | 0.33        |
| 1.0                                 | 918                                            | 1422        | 123         | 1.65                                                                                                                 | 2.56        | 0.22        |
| 0.5                                 | 459                                            | 711         | 61.5        | 0.83                                                                                                                 | 1.28        | 0.11        |

**Table 4. Yield of chickpea**

| Treatments                                                                    | Yield (kg ha <sup>-1</sup> ) | % increase in yield over T <sub>1</sub> | Net returns (Rs. ha <sup>-1</sup> ) | B:C ratio |
|-------------------------------------------------------------------------------|------------------------------|-----------------------------------------|-------------------------------------|-----------|
| T <sub>1</sub> - One protective irrigation<br>(After sowing )                 | 1067                         | -                                       | 14201                               | 1.58      |
| T <sub>2</sub> -Two protective irrigations<br>(After sowing and at flowering) | 1560                         | 46.23                                   | 31333                               | 2.24      |

**Table 5. Irrigation through micro-irrigation system from farm pond for different vegetables**

| Vegetables          | Irrigation system | Water applied (m <sup>3</sup> ) | Plot Area (m <sup>2</sup> ) | Yield (kg plot <sup>-1</sup> ) | Net Income (Rs plot <sup>-1</sup> ) | B:C ratio | Water use efficiency, Kg/m <sup>3</sup> |
|---------------------|-------------------|---------------------------------|-----------------------------|--------------------------------|-------------------------------------|-----------|-----------------------------------------|
| Coriander           | In-line Drip      | 6                               | 32                          | 24                             | 960                                 | 2.80      | 4.00                                    |
| Fenugreek           | In-line Drip      | 12                              | 96                          | 71                             | 2130                                | 3.54      | 5.91                                    |
| Radish              | In-line Drip      | 12                              | 64                          | 72                             | 1080                                | 2.43      | 6.00                                    |
| Spinach             | In-line Drip      | 12                              | 96                          | 72                             | 2160                                | 3.28      | 6.00                                    |
| Dolichus bean (Wal) | In-line Drip      | 8                               | 32                          | 18                             | 540                                 | 1.78      | 2.25                                    |
| Brinjal             | Micro-Sprinkler   | 18                              | 60                          | 82                             | 1640                                | 2.73      | 4.55                                    |
| Cowpea              | Micro-Sprinkler   | 10                              | 30                          | 40                             | 1200                                | 2.52      | 4.00                                    |
| <b>Total</b>        |                   | 78                              | 410                         | -                              | <b>9710</b>                         | -         | -                                       |

\* \* \* \* \*

# Applications and Potential of Oilseed Crops

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Oilseeds have proven to be the backbone of agricultural economy in India as they are the second most important crop, after cereals within the segment of field crops (Parmar et al. 2013). Edible oilseeds crops are obtained from various primary and secondary sources. Among these, the nine primary crops includes, soybean (glycine max), groundnut (*Arachis hypogaea*), rapeseed & mustard (*Brassica*) contributes to more than 88% of total oilseeds production (Yadav et al. 2018). More than 80% of vegetable oil is contributed by mustard (35%), soybean (23%) and groundnut (25%) crop itself. In addition to these crops, oil harnessed from secondary sources like cottonseed, rice bran, coconut, Tree Borne Oilseeds (TBOs) and Oil Palm is also popular in India (Singh et al. 2017). Lipids are the main reserved form of energy in the embryo of oilseeds, which is most efficient compound in terms of energy in comparison to carbohydrates or proteins. Quality of oil seeds is determined by its fatty acid composition, antioxidants (tocopherols, carotenoids and phenolic compounds) etc (Izquierdo et al. 2017). Also, the genetic constituent and growing conditions have strong impact on the quality parameters of the seeds and thereby influencing their commercial value (Mailer and Beckingham 2006). Some oilseeds crops have high oil concentration (sunflower, mustard) while for other crops oil is a co-product (cotton, maize, rice).

The revolution launched in 1986-1987 to achieve self-reliance in edible oils, with special emphasis on four crops (mustard, groundnut, soybean and sunflower). The revolution led to doubling of the India's oil production (from 12 million to 24 million tonnes)

within ten years. This increase in the production may be attributed to processing facilities (hybrid seeds, irrigation, fertilizers, pesticides, transportation facility, minimum support price and warehousing) provided to the farmers (Kumar and Tiwari 2020). However, the self-sufficiency attained through yellow revolution was for a short period. Despite being one of the largest oilseed crop producing country in the world, India is not able to meet the spurt in vegetable oil consumption and industrial usages (Rani and Singh 2022). India accounts for 10% of the global oilseed production with 20.8% of the area under cultivation (Renjini and Girish 2019). Oilseed production through the years increased from 108.3 (in 1985-86) to 365.65 (in 2020-21) lakh tonnes with major contribution from Rajasthan, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Haryana and Andhra Pradesh. India is also one of the major oilseed exporter (mustard, soybean, cotton seed, sunflower, sesame and groundnut). The oil is being exported to USA, Netherlands, China, Australia, Singapore, Belgium, Germany, Indonesia, Hong Kong, Nepal, Saudi Arabia and Italy (Thappa et al. 2019).

Oilseeds are among the five essential ingredients of human diet other than protein, carbohydrates, minerals and vitamins (Chandrasekaran and Shine 2012). The major components of vegetable oils comprise of triacylglycerols and other minor components includes phospholipids, sterols, antioxidants, mono and diacylglycerols (Abiodun 2017). The oils consist of long-chain fatty acids [C-14 to C-24] that may be saturated, monounsaturated or polyunsaturated.



Recently, human diet has witnessed increment in unsaturated fatty acids (C18:1; C18:2 and C18:3) due to their health benefits (Mailer, 2004). Therefore, altering the fatty acids composition of traditional oilseed crops has been area of interest for plant breeders.

### Applications of oilseed crops

A wide variety of bioactive compounds have been obtained from oilseeds. Apart from their role in human diet, oilseeds have several industrial applications in biodiesel, fertilizer, medicine, soaps, skin products, animal feeds, fibers, candles, perfumes, paint, button etc (Zhang et al. 2023). Due to the nutrient enriched by products (hull, meal and oil) of oilseed crops had also been integrated into animal diet.

1. **Fuel:** Agro waste from oilseed crops has the potential to be used as source of renewable energy hence supporting the evergreen biofuel industry (Neupane 2022). Oilseed crops are characterized as source of biodiesel, an alternative fuel in the industry. Positively the production of biofuels is feasible at low price, however the disadvantage is the prevalence of fuel over food (Balat 2011). Hence, over the past few years, non-edible oilseed crops have been emphasised upon for biofuel production (Lu et al. 2011). The highest biodiesel yield is given by palm oil followed by coconut, rapeseed, peanut, sunflower and soyabean oil. Genetic engineering has been applied to transform the traditional plants for desired oil content (Waseem et al. 2017).
2. **Fertilizer:** Oilseed meals are used as organic nitrogen fertilizer and weed control agents for example, Brassica species have higher nutrient quality in comparison to sunflower seed meal (Mazzoncini et al. 2015). Also, the Brassica seeds through enzymatic activity of glucosinolates are effective in controlling weeds, insect pests and other nematodes. The presence of toxic allergen such as ricin in castor meal has proven to be useful as it's toxic for the microorganisms (Nangbes et al., 2013).
3. **Food industries:** Higher concentration of free radicals in the human body are harmful as they initiate unwanted oxidation reactions (Packer and Ong 1998). The easiest way to inhibit these processes is the addition of antioxidants directly into the diet. The major natural antioxidants present in vegetable oil includes tocopherols, tocotrienols, carotenoids, flavonoids and some minute quantities of sterols and lignin (Kamal-Eldin and Appelqvist 1996). Hence, seed oil is being used for baking, as flavouring agent in margarines and salad dressing (Agarwal et al., 2003). Also, the meal of some oilseeds may be used to fortify food items e.g., coconut meal used to fortify food formulations as it has high dietary fibre that aids to the digestion (Madhavan et al. 2010).
4. **Animal feeds:** Oilseed meals although being underrated have proven to be biggest innovation in animal feeding. Oilseed meal is the by-product obtained after the refining and processing of oilseeds that have abundant energy as well as minerals and vitamins (McKevith 2005). The major crops used for this purpose includes soybean, mustard, peanut, sunflower and others (Zhang et al. 2023). In addition to high protein content, soybean meal also contains some antioxidants such as syringic, vanillic, ferulic, salicylic and sinapic acids. Rapeseed meal on the other hand

contains sinapine, benzoic and cinnamic acid derivatives, phenolic acid esters and glycosides (Schmidt and Pokorny 2005).

5. **Enzymes:** In solid state fermentation oilseed meal have been used as substrate for the production of enzymes (Chatterjee 2015). Various enzymes such as tannase, inulinase, lipase, mannase, amylase, L-glutaminase and protease have been produced using several bacterial and fungal strains (*Candida rugosa*, *P. chrysogenum*). Several antibiotics have also been produced from oilseed meals (soybean, sunflower and sesame oil meal) e.g., cephamycin C and clavulanic acid (Usman and Saif 2023).
6. **Other Products:** Some fatty acids in oilseed crops are beneficial for the skin such as linoleic and oleic acids. Linoleic acid prevents the hyperpigmentation caused by ultraviolet rays hence is used for treating dermatomes or sunburns (Lautenschläger 2003). Oleic acid help regulate the percutaneous lipid barrier of the skin hence, helps to fight against redness, itchiness and skin sensitivity (Vermaak et al., 2011). Coconut oil has proved to be good moisturizer for hair and skin as it contains antioxidants as well as antibacterial properties (Madhavan et al. 2010b). Soybean and palm kernel oil for making soaps, detergents and toiletry products. Linseed oil (non-food crop) has found it's way in textile industry as it becomes hard and elastic on drying therefore used for manufacturing of paints, resins or printing inks (Abiodun 2017).

### Conclusion

Oilseed crops have been backbone of agriculture as they provide us edible products, act as

substrate for biofuel production and several other industrial applications. However, the production of oilseed crops is not able to meet the demand of ever rising population in India. So, breeders are focusing to optimize the characteristics of traditional crops to achieve desired levels of production. The changes introduced include higher oil content, changes in fatty acid profiles and the reduction in antinutritional components. Further, there is scope in exploring the oilseed meal benefits in food fortification that can help mitigate the food insecurities.

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# Microalgae for Biodiesel Production

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Growing dependence on petroleum as the main source of energy and chemical-based fuel which is creating a lot of problem to mankind and environment by releasing the harmful gases. The release of carbon in the form of carbondioxide and carbon monoxide has increased the pollution and led to the global warming. The best replacement method for this problem is to shift to renewable energy resource. Biodiesel is an attractive renewable transportation fuel because it is biodegradable and non-toxic. Biodiesel is the most promising biofuel which is produced from the process known as transesterification. Furthermore, less hazardous gases emission due to higher oxygen content as well as zero sulfur and aromatic substances. Fatty acid methyl esters (FAME) are well-known type of biodiesel of vegetable oils and animal fats with short-chain alcohols. Majorly the biomass of high oil content is used for the production of the bio-diesel but the comparison of the emissions from the fuel microalgae shows better results. Microalgae because of high photosynthesis and oil production efficiency, growing ability in non-fresh water and low land area requirement is an affordable feedstock for biodiesel production compared with edible sources.

## Algae cultivation methods

### Open pond system

Open pond systems use shallow ponds, from about one acre to several acres in size, in which the algae are exposed to natural solar radiation which they convert into biomass. Typically, the ponds are called raceway ponds because their shape resembles a race track.



### Enclosed photobioreactor (PBR)

Three major types of photobioreactors are vertical column, tubular and plate types

Due to enclosed structure and relative controllable environment, enclosed PBR can reach high cell density. All the factors like light, oxygen, water and culture are controlled as per the requirement for the optimum growth of micro-algae.

### Vertical-column photobioreactors

The name itself indicates the vertical glass tubes provided in favourable conditions for the growth of microalgae. These are compact, low-cost and easy to operate.



### Flat plate photobioreactors

This type of PBR receives much attention for cultivation of photosynthetic micro-organisms due



large illumination surface area. These are made up of transparent PVC materials for maximum utilization of sunlight

### Tubular photobioreactors:



Large illumination surface area, suitable for outdoor cultures, fairly good biomass productivities. Among the proposed photobioreactors, tubular is one of the most suitable types for outdoor mass cultures.

### Harvesting of algae

**Sedimentation** is the initial phase of separating the algae from water. Once agitation is completed, the algae are allowed to settle and densify

**Membrane separation** is a form of filtration. This method can be used to collect microalgae with low density, but is typically done on a small scale

**Flocculation** is a method where flocculants are added to the mixture of water and algae that causes the algae to “clump” together (or aggregate) and form colloids

**Froth floatation** is a method in which air bubbles are incorporated into the unit. Sometimes an additional

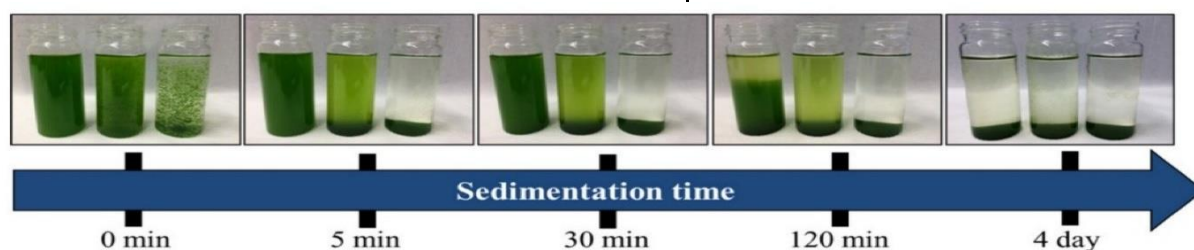


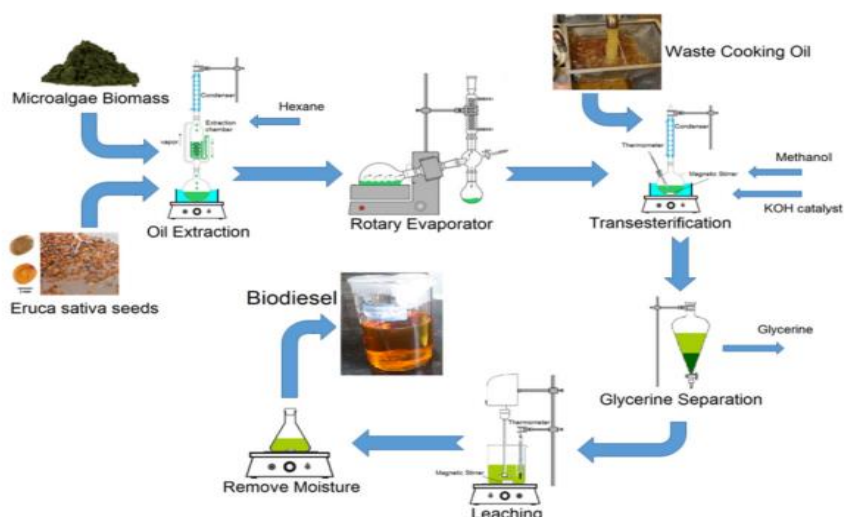
organic chemical or adjustment of pH will enhance separation

### Extraction of biodiesel from micro algae

After the harvesting and separation of algal biomass, the powder form of microalgae is used for the extraction of oil from it. The below flow diagram depicts the procedure of oil extraction and biodiesel

production from the algal biomass through





the process known as transesterification.

In the transesterification process a glyceride reacts with an alcohol (typically methanol or ethanol) in the presence of a catalyst forming fatty acid alkyl esters and an alcohol. The feedstock for transesterification can be any fatty acids from vegetable or animal origin, or used cooking oils (UCO). Typically used vegetable oils originate from sunflower, soy and oil palms. A strong base or a strong acid can be used as a catalyst. At the industrial scale, mostly sodium or potassium hydroxide is used. The end products of the transesterification process are raw biodiesel and raw glycerol. In a further process these raw products undergo a cleaning step. In case of using methanol as alcohol FAME (fatty acid methyl ester) biodiesel is produced. The purified glycerol can be used in the food and cosmetic industries, as well as in the oleochemical industry. The glycerol can also be used as a substrate for anaerobic digestion.

### Conclusions

- The best and most suitable alternative for the costliest and harmful petroleum products.
- All the living organisms can have the better health by reduction in pollution
- This renewable energy source can be produced at a place and need not to be

imported from foreign countries.

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## Success story of a women farmer- Smt. Anuradha

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Women make up 43 percent of the global agricultural labour force, yet they face significant discrimination when it comes to land and livestock ownership, equal pay, participation in decision-making entities and access to credit and financial services. Few women have still succeeded facing all such hardships. Smt. Anuradha S. Amminabhavi



from Marewad village of Dharwad also one such women who was new to agriculture till her marriage but after married to a farming family learnt the skills and excelled in agriculture. She has 14 acres of both

rainfed and irrigated land. Mainly grows Green gram, Black gram, Groundnut and Vegetables. The bunds of the farm are planted with many forest tree species which acts as live fencing. She believes in Organic farming practices and follows them in her farming system. They have tractor for cultivation. Maintain small dairy unit with cows and buffaloes to meet milk requirement of the house and substantiate regular expenses of the family. The agricultural crop residue, dairy waste and other decomposable materials for the preparation of compost. Four pit Vermicompost unit is maintained at the backyard



with locally available materials and the produce is mainly used for farm fertility improvement. She was trained in organic farming and other animal husbandry trainings. She is also training other farm women in those areas. Her family is motivating her for her contribution in the field of Agriculture. Regularly she contacts KVK scientists for technological updates and subscribes agriculture and related magazines to update her knowledge. Department staff also supports her technologically in her new experiments.



### Impact in the area

She is earning an income of nearly 3 lakh rupees per year. Maintained fodder cafeteria for dairy and Nutri farm at the backyard of the house to meet family requirement of fruits and vegetables. Many families in and outside the village also visit

and taking guidance in improved agriculture practices.

### Awards & recognitions

Awarded Shreshta Krishika Mahile of Dharwad Taluk by University of Agricultural Sciences, Dharwad during 2019-20.

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# Ethnoveterinary Practice for Mastitis

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Ethnoveterinary knowledge is acquired via actual experience. Ethnovet practices are important because they are easily available, inexpensive and effective, especially in rural areas where veterinary services are absent or irregular and expensive. In spite of recent initiatives to encourage its use globally, a lot of information is only recorded in field reports and academic journals. With an emphasis on cattle diseases, the goal of this publication is to assist livestock agents and farmers' leaders in integrating and promoting the use of ethnoveterinary medical practises in animal healthcare.

## Mastitis

Mastitis is the inflammation of the mammary gland and udder tissue. It is considered as the most prevalent illness that causes financial loss in the dairy sectors due to decreased yield and poor milk quality. Mastitis can be classified into 3 classes based on the degree of inflammation, namely clinical, sub-clinical, and chronic mastitis

## Causes

- ✓ It typically manifests as an immunological reaction to bacterial invasion of the teat canal by a variety of bacterial sources found on farms (mostly through contaminated bedding or teat dips), but it can also be brought on by chemical, mechanical, or thermal harm to the cow's udder.
- ✓ Pathogen, Host and Environment factors
- ✓ **Pathogen:** A wide range of gram-positive and gram-negative bacteria, some of which are contagious (such as *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma* spp.) and others of which are environmental (such as *Escherichia coli*, *Enterococcus* spp., coagulase-negative *Staphylococcus*, and *Streptococcus uberis*).
- ✓ **Host:** Pure breed or cross breed with high yielding, Cattle with large funnel-shaped teats or pendular-shaped udder, older cows, cows in transition period and lactation period are more susceptible for mastitis.
- ✓ **Environmental:** High stocking density, contaminated floor, wet bedding, poor ventilation, and hot and humid climate all promote growth of mastitis causing pathogens.

## Symptoms

### Subclinical:

- ✓ Cow appears normal, no physical signs of inflammation in udder.

- ✓ Less milk production than expected
- ✓ Somatic cell count of milk can be considered

### Clinical

- ✓ Swelling, redness, inflammation, or a hardness of the udders.
- ✓ Reduced food intake, fever and udders hot to touch.
- ✓ Reduction in mobility due to the pain of a swollen udder
- ✓ Milk discoloured with watery, pus, clots, flakes and thread like substances.



**Mastitis milk with pus, clots and flakes**

### Ethnoveterinary treatment

- ✓ Hygienic milking practices

- ✓ Ingredients required: Gheekumari (Aloe vera ) - 2 or 3 petal, Haldi (Turmeric) powder- 50gm, Chunna powder (Lime stone)- 10 gm
- ✓ Depending on the severity of the ailment, the above components are all thoroughly ground into a paste and applied to the udder three times each day for three to seven days before which the udder and teats should be washed with boiled water for 3 times for 5 days.

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# The New Age of Fertilization: Exploring Nanourea's Paradigm Shift

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Nanourea represents an unprecedented breakthrough at the intersection of nanotechnology and agriculture. This innovative composite, comprising nano-scale urea particles, possesses the potential to reimagine the landscape of fertilizer application, yielding substantial crop amplification while mitigating environmental repercussions. Conventional urea fertilizers, often plagued by inefficiencies that result in nitrogen overflows and ecological degradation, encounter a transformative solution in Nanourea. This innovation leverages nanotechnology to engender particles endowed with calibrated release dynamics, harmonizing nitrogen liberation with the precise demands of plant nutrient assimilation. The diminutive scale of Nanourea particles facilitates enhanced soil permeation, fostering augmented nutrient absorption by plants, thereby nurturing robust vegetative expansion and diminishing overall fertilization necessities. The consequential attenuation of nitrogen runoff fortifies water bodies and averts groundwater pollution. The profound potential of Nanourea to bolster agricultural productivity while concomitantly ameliorating ecological imprints engenders pronounced intrigue amongst scientific scholars, agronomists, and environmental vanguards. As the frontiers of nanotechnology expand, Nanourea emerges as a promising stride towards sustainable resolutions for the imperatives of global food security, propounding a trajectory towards efficacious and eco-friendly agrarian practices.

## Benefits of nanourea

**Enhanced Nutrient Efficiency:** Nanourea's controlled release mechanism ensures that nutrients are gradually released, matching the plant's uptake

needs, thereby minimizing wastage and increasing nutrient use efficiency.

**Increased Crop Yield:** Improved nutrient absorption due to nanoscale particles leads to healthier and more vigorous plant growth, resulting in higher crop yields.

**Reduced Environmental Impact:** Nanourea's controlled release reduces nitrogen runoff, minimizing water pollution and protecting aquatic ecosystems.

**Water Conservation:** By optimizing nutrient delivery, nanourea reduces the need for excessive irrigation, promoting water conservation in agriculture.

**Soil Health Improvement:** Nanourea's smaller particles enhance soil penetration, promoting better nutrient distribution and microbial activity, which contribute to improved soil health.

**Decreased Fertilizer Usage:** Nanourea's efficiency means farmers can use smaller amounts of fertilizer to achieve the same or better results, reducing overall fertilizer application.

**Sustainable Agriculture:** Nanourea aligns with sustainable farming practices by reducing environmental pollution, conserving resources, and promoting long-term agricultural viability.

**Enhanced Nutrient Uptake:** The nanoscale particles facilitate easier uptake of nutrients by plants, reducing nutrient losses and ensuring that crops receive the necessary nutrients for optimal growth.

**Mitigation of Nitrogen Loss:** The controlled release of nitrogen in nanourea helps prevent leaching and volatilization, reducing the emission of harmful greenhouse gases.



**Global Food Security:** By improving crop yields and making agriculture more sustainable, nanourea contributes to addressing the challenges of feeding a growing global population.

### **The scientific principle of nanourea**

Nano urea (liquid) encompasses 4% N within encapsulated nitrogen analogs or organically matrix-embedded forms. With dimensions ranging from 20-50 nm, these nanoparticles boast an elevated surface area and particle density per unit space, conferring advantages surpassing traditional urea. Their propensity to facilely breach cell walls or traverse leaf stomatal pores is evident. Following cellular ingress, phloem cells, plasmodesmata (40 nm diameter), and carrier proteins encompassing aquaporins, ion channels, and endocytosis mediate their dispersion across various plant compartments. Ergo, administering nano urea liquid via foliar application precipitates heightened nitrogen assimilation efficiency, culminating in augmented physiological growth, amplified grain yield, and elevated fruit quality."

### **Crop and dose requirement**

Nano urea proves amenable to application across a comprehensive spectrum of crops, spanning cereals, pulses, vegetables, fruits, flowers, medicinal, and ancillary varieties. Dilute 2-4 ml of Nano urea (4% N) per liter of water, subsequently disseminating this solution upon crop leaves during active growth phases. Notably, a quantity of 500 mL is generally adequate for a single acre, amenable to various application methodologies including knapsack, boom, power sprayers, and drones.

### **Time and method of application**

Dilute 2-4 ml of Nano Urea (4% N) in one liter of water, thereafter administering this solution onto crop foliage during phases of active tillering/branching (30-35 days post germination or 20-25 days subsequent to transplanting) for the initial spray. Subsequently, a second application is recommended 20-25 days post the initial spray or anterior to the flowering phase. It is imperative to exercise discretion in the administration of basal nitrogen through DAP or complex fertilizers, safeguarding against overlap.

### **Limitations of nanourea**

**Certainly, here are four important limitations of Nanourea**

**Cost and Affordability:** Nanourea production and application might be more expensive compared to conventional fertilizers, potentially limiting its adoption among small-scale or resource-limited farmers.

**Environmental Fate and Safety:** The long-term environmental impact and potential nanotoxicity of Nanourea require thorough investigation to ensure its safety for ecosystems and human health.

**Application Challenges:** Effective and uniform application of Nanourea might require specialized equipment or techniques, which could be a barrier for farmers lacking access to such resources.

**Variable Performance:** Nanourea's efficacy could vary across different soil types, crops, and climatic conditions, necessitating tailored recommendations and careful management practices for optimal results.

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## *Eragrostis tef* (Teff): A Rising Global Crop

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Small millets can be grown even in poor soil and climatic conditions. They have short growing season and can be very well fitted into multiple cropping systems both under irrigated as well as dry farming conditions. They can provide nutritious grain and fodder in a short span of time. Their long storability under ordinary conditions has made them "famine reserves". This aspect is very important as Indian agriculture suffers from vagaries of monsoon. The most important minor millets cultivated in India are finger millet (ragi), proso millet, barnyard millet, italian millet, kodo millet, little millet and teff.

*Eragrostis tef* is a self-pollinated tetraploid annual cereal grass. Teff is a C4 plant which allows it to more efficiently fix carbon in drought and high temperatures, and is an intermediate between a tropical and temperate grass. The word 'teff' comes from the Ethiopian word 'teffa', which means 'lost' because of its minute grain size, which have a diameter smaller than 1 mm. Teff is a fine-stemmed, tufted grass with large crowns and many tillers. Its roots are shallow, but develop a massive fibrous rooting system. Teff (*Eragrostis tef* (Z.) Trotter) is a cereal crop (nutri-millet) belonging to Poaceae family, extensively cultivated in Ethiopia, where the crop is known to have originated. In Ethiopia, it is grown on 2.8 million hectares (24% of the total cultivated land) annually and contributes 17.57% of the gross grain production of all grain crops, with a national productivity of 15.75 q ha<sup>-1</sup>. Over 6.5 million farmers grow teff, which is a major staple food of Ethiopians (greater than 50 million) and contributes to the national food security.

It grows best with an annual rainfall of 750-850 mm (sufficient for minor millets to complete their life cycle) and with a temperature range of 25-35°C. The length of growing period ranges from 60 to 180 days with an optimum of 90 to 130 days. Teff is more like a grass, can be grown under a wide range of conditions, including situations not suitable for other cereals. It bears very tiny seeds which are highly nutritious, especially in protein content. The primary use of teff is for grinding into flour to make injera, the spongy fermented flat bread that is a staple food for most Ethiopians. This crop needs minimum tillage to cultivate, though productivity is less. A handful of teff is enough to sow a typical field, and it cooks quickly, using less fuel than other foods. Teff also thrives in both waterlogged soils and during droughts, making it a dependable staple wherever it's grown. Teff is an emerging annual cereal crop. Because of high nutritional quality and hardiness coupled with low water requirement, teff is preferred by the small farmers in rainfed environments. Teff is also a strategic crop with high potential to enhance commercialization of smallholder agriculture and improve food security in Ethiopia. Shorter duration of the crop makes it the most suitable crop for multiple cropping systems such as double and relay cropping. Compared to other cereals, teff has few insect pests and disease problems in the field. Therefore, it is a healthy, reliable and a low-risk crop. Grains can be stored for many years and fetches higher price as compared to other annual cereals. Teff is the most preferred cereal among better-off households due to nutritional value and cultural preference and it is nutritionally rich

with 9.4–13.3% protein (with an excellent balance in essential amino acids, glutamic and aspartic acids being the major), 73% starch present in whole kernel (stored endosperm section of the grain; 2.6–3.0 % ash and 2.0–3.1% lipid, with rich source of Fe, Ca, Zn, Mg than other cereal grains. Teff straw is preferred by the cattle over other cereal crop straw. Tef straw is also used for construction purpose, i.e. for reinforcing mud for plastering walls of houses and other household items.

#### **Taxonomical classification**

Kingdom: Plantae

Order: Poales

Family :Poaceae

Subfamily :Chloridoideae

Genus: *Eragrostis*

Species : *E. tef*



**Table 1: Nutritional and Microelement Composition of Teff Grain**

| Nutrients               | Amount |
|-------------------------|--------|
| Crude protein (g/100 g) | 11.0   |
| Crude fat (g/100 g)     | 2.5    |
| Moisture (g/100 g)      | 10.5   |
| Ash (g/100 g)           | 2.8    |
| Crude fibre (g/100 g)   | 3.0    |
| Carbohydrate (g/100 g)  | 70.2   |
| Calcium (mg/100 g)      | 165.2  |
| Copper (mg/100 g)       | 2.6    |
| Iron (mg/100 g)         | 15.7   |
| Magnesium (mg/100 g)    | 181.0  |
| Manganese (mg/100 g)    | 3.8    |
| Phosphorus (mg/100 g)   | 425.4  |
| Potassium               | 380    |
| Sodium (mg/100 g)       | 15.9   |
| Zinc (mg/100 g)         | 4.8    |

#### **Importance**

Apart from Ethiopia, India, Australia, and other European countries are the main areas where it is grown. Its gluten-free nature has made it popular among the researchers. Teff is not only gluten-free but also naturally has a higher content of macro and as well as micronutrients such as calcium, iron and zinc, which make it a very good alternative in gluten-free products.

It contains a good amount of protein including all the essential amino acids especially lysine, which is most often deficient in grains. One more characteristic of this cereal is its small size because of which teff can be made into whole-grain flour (bran and germ included), this enables very high fiber content in the cereal, and thus, it is useful to improve the hemoglobin level in the human body which can prevent malaria and incidences of anemia.

The qualitative value of teff as a gluten-free millet united with its nutritional value and health benefits has attracted global interest in its consumption compared to the other major cereal

crops. The crude protein, crude fiber, fat, and starch concentrations of teff grain are either similar or superior to those of maize, oat, sorghum, wheat and quinoa in general. Due to the many health benefits of this gluten-free product, the demand for teff grain has increased over the last decade globally.

Teff has a slightly grainy texture that adds a great crunch to any recipe. It has a unique nutty

flavour and cooks faster than other grains. This versatile nature of the grain means that it can be added to anything, from chapattis<sup>1</sup>, dosas and breads to cookies and cakes. Hence the grain can be incorporated into any diet very easily. Basically, it's everything a superfood should be!

**“Millets were the first crop; Millets are the future crop”**

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# Heat Exchangers: Classification and Applications in Food and Service Industries

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The heat exchange process between two or more streams at different temperatures happens in numerous industrial, commercial, and domestic applications and is usually affected in some type of a heat exchanger. The plate heat exchangers are widely used in warming, heating, cooling applications, food, and cosmetic and chemistry industry. The plate type heat exchangers are initially developed for the pasteurized liquid food domain which mostly requires hygienic application. Typical applications involve heating or cooling of a fluid stream of concern, evaporation, or condensation of a single or multicomponent fluid stream, and heat recovery or heat rejection from a system [1]. But, other than above these heat exchangers have a large application area in chemistry and food sector because of being compact and having the quality to be easily cleaned [2-6]. They can be broadly classified as either direct contact or indirect contact (or transmural) type of heat exchangers. In the former, the fluids transferring heat are in direct contact and not separated by a wall. Owing to the absence of a wall, closer approach temperatures are attained, and the heat transfer is often also accompanied with mass transfer [7].

## Classification of Heat Exchangers

Heat exchangers may be classified according to transfer process, construction, flow arrangement, surface compactness, number of fluids and heat transfer mechanisms as shown in Fig. 1 modified from Shah [8] or according to process functions as shown in Fig.2 [9]. For the sake of article, a brief description of some of these exchangers majorly

used in dairy & food industry classified according to construction is provided next along with their advantages and disadvantages over others.

## Classification according to construction

### Pipe-in-pipe heat exchangers

This kind of heat exchanger is widely used in chemical, food, oil and gas industries. Upon having a relatively small diameter, much precise research has also held firmly the belief that this type of heat exchanger is used in high-pressure applications. They are also of great importance where a wide range of temperature is needed. It is also well documented that this kind of heat exchanger makes a significant contribution to pasteurizing, reheating, preheating, digester heating and effluent heating processes [10].

Equipment consisting of two pipes with different diameters inserted one into the other. With the help of clutch couplings, all parts of the pipes are assembled into a coil, which provides the necessary space for the heating and cooling medium. Sections are placed one above the other. The flows are directed counter-currently (towards each other). The cooling agent comes from below, and after heating rises. The heated steam accumulates from above. After condensation, it goes to the bottom of the heat exchanger. This heat exchange equipment is used in the food industry. Heat exchangers of this design are characterized by a significant heat transfer coefficient and can operate at high pressure. The pipes are cleaned mechanically on level areas. The flow inside the two-pipe heat exchangers can be parallel or counter-current [11].

The main advantages of the device of this design include:

- a) High flow rate of the coolant: this is achieved through careful selection of water pipes of the desired diameter, which allows the medium to flow freely inside the pipes.
- b) Ease of maintenance: This property makes it possible to carry out regular cleaning of equipment, which allows to increase the duration of its operation.
- c) Versatility: In systems, it is permissible to use a coolant both in the liquid and in the vapor phase.

The disadvantages of the equipment are:

- a) Dimensions: due to the large size, difficulties arise during transportation and use of the device. Most of all this refers to individual use, where space is very limited.
- b) High cost: the price of external pipes that are not involved in heat exchange, and which are connected to the heat exchanger, is quite impressive.
- c) Difficulties in the design: when choosing this equipment, you must contact the professionals, which is associated with the complexity of the calculation. At the same time, the overall cost of manufacturing and installation work increases.

### Shell-and-tube heat exchangers

When the required heat transfer surface is large, the recommended type of heat exchanger is the shell-and-tube. In this type of heater or cooler, large heat-transfer surface can be achieved economically and practically by placing tubes in a bundle, the ends of the tubes are mounted in a tube sheet. This is very commonly accomplished by expanding the end of the tube into a close-fitting hole in the tube sheet by a process called rolling. The resultant tube bundle is then enclosed by a cylindrical casing (the shell), through which the second fluids flow around. They

are used as evaporators and condensers. Depending on the operating conditions of the equipment, it is installed in a vertical or horizontal position [12].

In multi-way devices, it is necessary to firmly fix the base and pipe sections. Such modules function even with a small difference in temperature of the working environment. When choosing the material of the heat exchanger, it is necessary to consider the aggressiveness of the environment. Due to the inaccessibility of the heat exchanger tubes, the formation of corrosion is highly undesirable. Cleaning is carried out exclusively by a chemical method [13].

The advantages of the devices are:

- a) Internal reliability: Shell-and-tube heat exchangers are more resistant to scale formation, which implies that cleaning should be done less frequently than with other heat exchangers.
- b) Possibility of power regulation: If necessary, increase or decrease the power, adjust the number of
- c) Sections: the length and diameter of the pipes.
- d) Long service life: Shell-and-tube heat exchangers have a long service life.

The disadvantages of the equipment are:

- a) Large dimensions. A heat exchanger weighing 120–150 kilograms and a length of 4 meters cannot always be fitted and installed at the facility.
- b) Vulnerability of the outer part of the case. Tube heat exchangers are made of electric welded pipe. After a short period of work, the outer coating begins to diverge along the seam, leaks appear, because of which oxygen begins to be released when the water is heated. This contributes to the development of metal corrosion [14].
- c) Efficiency. The coefficient is only 70%, which increases energy losses.

### Plate Heat Exchangers

A popular heat exchanger for fluid of low viscosity, such as milk is the plate heat exchangers, where heating and cooling fluids flow through alternate tortuous passages between vertical plates. The plate heat exchanger is commonly used in HTST units, for heating temperatures which are below the boiling point of milk. The advantages are highly efficient, occupy less space, compact, simple easily cleaned, low in cost, versatile, sanitary easily inspected and can be used for heating, cooling, regeneration and holding.

They consist of many corrugated plates made of stainless steel. They are separated by seals that are installed without the use of adhesive mixtures but allow tight fit to each other. Gaskets provide absolute tightness and do not allow mixing of media. The choice of material of the heat exchanger must be carried out depending on the technological process, the type of coolants in the system, temperature load and pressure. The most universal in application: plate heat exchangers made of stainless steel with copper pipes [15].

The advantages are:

- a) High efficiency. Due to the large area of the heat exchange surface, the efficiency reaches 95%, which is much higher than that of tubular apparatuses.
- b) Compactness. The device is selected in accordance with the required heat consumption. With a small number of plates, the differences will be less, respectively, with a larger number of plates, the differences will increase.
- c) Multifunctionality. Plate heat exchangers are used in many areas of life, have a wide range of capacities.
- d) The cost of the device depends on the number of plates installed in it. There is the possibility of

selecting the right number of plates. Repair costs replacing a worn (damaged) plate, and not the entire system.

The disadvantages of the equipment are:

- a) Short service life. Plate heat exchangers are quickly clogged. The maximum service life without cleaning is 3 years.

### Spiral plate heat exchangers

Spiral plate heat exchangers are made of two metal plates that are wound on each other. One stream of process fluid enters the heat exchanger through the centre and flows from the outside, while the second stream enters from the outside and flows inward. This creates a close to natural backflow [16].

The advantages are:

- a) Single flow paths reduce the rate of scale build.
- b) Ability to work with two highly polluting liquids.
- c) Lack of dead zones for accumulation of solid particles inside the heat exchanger
- d) Counterflow.
- e) Made of many alloys.
- f) Very low pressure drops.

The disadvantages of the equipment are:

- a) Designs are the intellectual property of companies, a limited number of manufacturers.
- b) As a rule, the design is more expensive than other types of heat exchangers.

### Spiral tube heat exchangers

Spiral tubular heat exchangers are made of spiral pipes. In some cases, the tube is installed inside the bundle to ensure the compactness of the heat exchanger. In this, Heating or cooling medium flows in one direction. Product counter-flows in the opposite direction. In construction of these PHEs Gasket, clamps, bolted fittings and packing glands

are avoided, producing constant flow area throughout the entire unit, even return bends. These heat exchangers are mainly used for small capacities [17] and can be mounted on walls floors or ceilings.

The advantages are:

- a) Compact and inexpensive heat exchanger requiring low power.
- b) Can withstand high pressures.

The disadvantages of the equipment are:

- a) Designs are the intellectual property of exchanger- a limited number of manufacturers.

### **Air-cooled heat exchangers**

Air-cooled heat exchangers use ambient air to cool and condense the working medium. They are usually used in places where there is a shortage of cold water. Air-cooled heat exchangers are commonly used when the temperature at the outlet of the heat exchanger is at least 20° C higher than the ambient temperature. They can be designed for closer temperatures, but often become expensive compared to a combination of a cooling tower and a water-cooled heat exchanger. Air-cooled heat exchangers use electric fans to move air through a series of pipes [18]. There are two main mechanisms:

- a) Induced draft fans draw air through the tube blocks.
- b) Fans blow air through a series of pipes.

Air-cooled heat exchangers are expensive compared to water-cooled heat exchangers due to their large size, low air heat transfer coefficient, and structural and electrical requirements. In addition, air cooler heat exchangers require large surface areas of pipes and must be designed in such a way as to withstand daily and seasonal changes in air temperature [18]. The low heat transfer coefficient associated with the flow around the air of the outer

sides of the pipes is partially overcome due to the wide use of finned pipes to increase the outer surface area. Changes in ambient temperature are often controlled by fans with a variable speed or airflow adjustment step. In cold climates, it may be necessary to develop a design with the ability to recirculate air to prevent freezing during operation. Smaller heat exchangers (like radiators) are used for small areas of responsibility [19].

### **Advantages of Air-cooled Heat Exchangers**

- a) Do not use water for cooling.

Disadvantages:

- a) Requires a large area of the site.
- b) High manufacturing costs.
- c) Ribs may become clogged in dirty environments.
- d) Fans may make noise.

### **Application in Food and Service Industries:**

Heat Exchangers which are starting from its dairy industry origins for milk pasteurization, the modern-day applications of Heat Exchangers have expanded considerably to encompass a variety of different industries and processes.

#### **1) Food processing**

A general categorization of the food processing industry includes dairy products (e.g. milk, yoghurt, cream, and ice cream), brews and distilled products (e.g. wort, beer, wine, and alcohol), beverages (e.g. juice, carbonated drinks, tea, and coffee), and processed fruits and vegetables (e.g. purees, pastes, sauces, and jams). Here, pasteurization is perhaps one of the most important processes involved. There are several reasons why PHEs have been widely used historically as well as in present times for milk pasteurization. Perhaps the two most prominent factors are: (1) PHEs can be easily opened and thoroughly cleaned, and with



plates made of high-grade stainless steel, this ensures maintenance of very stringent hygienic requirements and (2) the high heat transfer coefficients promoted by their corrugated inter-plate channels permit very close approach temperature difference (as low as 1°C) operation.

Pasteurization is also required in a variety of foods and beverage processing, including fruit juice, tomato paste, cream, whey, ice cream, beer, wine, etc., and PHEs are increasingly being used in most systems. In food processing applications, typical examples are sensible heating and cooling in pre-treatment and fermentation, drying, blending, freezing, sterilization, as well as phase change (boiling/evaporation) in cooking, forming pastes, crystallization, and polymerization.

### **Air-conditioning and refrigeration systems**

In the past several decades, the high demands from residential comfort, commercial climate control, and food, biological, and biodegradable material preservation, etc., have greatly increased the general usage of heating, ventilation, air-conditioning, and refrigeration (HVAC&R) systems. For example, in a central comfort cooling or building air-conditioning system, the main chiller segment is essentially a vapour-compression refrigeration cycle unit: compressed refrigerant vapour flows through the condenser (heat sink), the exiting liquid refrigerant then expands through the throttle valve, low-pressure liquid refrigerant then flows through the evaporator (heat source), and the outlet vapour is finally fed to the compressor again to complete the cycle. The secondary heat exchange units, both on the condenser and evaporator sides, usually operate with cold water or water-glycol solutions as working fluids.

In the refrigeration system, PHEs (particularly brazed or welded types) are increasingly being employed as a condenser or evaporator directly in chiller units, as they have been found to provide a viable high-performance alternative to the traditional tube-fin type heat exchangers [20–23].

### **Service heating and cogeneration**

Previously heating, is needed to provide a comfortable indoor environment in residential, commercial, office, and public facility buildings. However, heating needs are now increasingly required for a variety of other services that include, among others, tap water, swimming pools, and greenhouses. All heating applications are generally divided into two categories, based on several major differences:

- a) service heating b) district heating,

Service heating systems normally have the heat source inside and it is supplied only to a single building. The heat source is normally not only a boiler, but it can also come from heat pumps and solar panels. The normal operating temperature is below 100°C and the pressure is 6 bar or below for these systems. In contrast, district heating systems distribute hot water or steam to multiple buildings (and, in some cases, to an entire township). A variety of heat recovery from industrial systems. Their normal operating temperature and pressure are, respectively, 100–150°C and 16 bar.

In both types of systems, PHEs can serve both as the condenser and as the secondary heat exchanger. Their close approach temperature difference operation makes the system more energy efficient, and this economic incentive is further supplemented by the much smaller space needed for PHEs as compared to shell-and-tube heat exchangers [20–23].

### Chemical processing

Chemical processing generically encompasses many different types of industrial applications in petrochemicals, pharmaceuticals, oil or gas production and delivery, and manufacture of organic and inorganic chemicals, to name a few. In all these applications, heat transfer plays a centrally important role and has a significant impact on the process efficiency, product delivery and reliability, and plant economics. To illustrate the role of heat exchangers, and PHEs, four typical thermal processes are described in this section, namely, evaporation, absorption and stripping, distillation, and reactor temperature control. These processes are representative of the chemical industry applications in general, and clearly highlight the advantages of selecting PHEs. Plate evaporators today can be found in sugar factories, distilleries, paper mills, alkali and alumina plants, pharmaceutical production, and the manufacture of many inorganic salts and organic chemicals such as ethylene glycol, detergents, personal hygiene products, and glycerol. Absorption and stripping are principally a way of recovering volatile organic compounds. While the economic incentive for this is to minimize the consumption of solvent, it is also increasingly a legal requirement to meet the newer more stringent environmental impact regulations. The system efficiency improvement essentially requires maximization of the heat recovery and minimization of the external heating and cooling utilities. Close approach temperature difference operation facilitates this and PHEs clearly have an advantage over traditional shell-and-tube heat exchangers. Moreover, with counter-current flows in PHEs as well as with conventional shell-and-tube units.

Distillation unit system consists of a condenser and a reboiler placed, respectively, at the

top and bottom of the distillation column. For the condenser duty, PHEs are very attractive because they are small and light and are thus easy to be mounted on top of a distillation column, saving space and reducing installation costs. Like the condenser, PHEs are suitable as reboilers mounted at the bottom as well, taking up minimum space and requiring minimum piping.

### Pulp and paper industry applications

As pulp and paper mills adopt closed water cycle systems, it has become more and more important for plant operators to focus on energy and water management. Inducting PHEs in such applications can provide viable solutions as well as meet new environmental requirements. Standard PHEs readily meet all of these constraints, except for handling fibrous media. For those applications with fibers in one stream, the single-side widegap PHE can be used, a double-sided wide-gap plate pack is used in cases where both fluid streams have fibrous content.

Typical applications involving PHEs in pulp and paper mills include cooling of bleaching plate filtrate by heating of process water (waste-heat recovery), heating of intermediate black liquor by cooling of evaporation condensate, heating of wire pit white water by condensation of steam, and heating of fouled condensate before stripping by cooling of clean condensate after stripping, among others.

### Conclusions

The content presented in this article involves some of the majorly used types of heat exchangers in Dairy, Food and beverages industries but also highlighted the importance of heat exchangers (PHEs & Shell and tube) in different industries includes chemical, paper, refrigeration, and other

service industries. Since due to diversity and complexity of topics related to heat exchangers it is a vast subject to cover in one article. Space limitation, however, has prevented the authors from thoroughly covering many equally important aspects of design and operation of heat exchangers. The examples briefly outlined in this article are quintessentially representative and serve as an introduction to readers. Many other industries, such as pharmaceuticals, electronics and electrical equipment, steel and metal industry, motor vehicle industry also use heat exchangers. However, in some of these cases special and customized exchangers may be needed.

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# Environmental Sustainability through Natural Resource Conservation in the Hills of Sikkim

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The search for sustainable growth has been prompted by the speeding up of environmental degradation and worries about climate change. The abundance of natural resources worldwide is further threatened by global warming and climate change. In light of good management and conservation of natural resources, it is absolutely necessary to recognize that the base of available natural resources is limited and that their wise use is essential to securing the future of the next generation. The Sikkim Himalayas are a highly biodiverse, fragile ecosystem that are rich in various agro-climatic zones from the north to the south, giving rise to distinct ecosystems. The state is blessed with plentiful wildlife, diverse woodlands, and mineral wealth. Natural resources and the rich biodiversity of Sikkim, a state in the eastern Himalayas, face an uncertain future due to climate change.

## Environment and its conservation

Our surroundings are what we call our environment. Both living and non-living things in our immediate environment fall under this category. Land, water, and air are the non-living elements of the environment. Germs, plants, animals, and people are the living things. All plants and animals adapt to the environment in which they are born and raised. Any alteration to the environment has the potential to be uncomfortable and have an impact on everyday living.

Environmental pollution is the term for any unfavorable alteration or degradation of the environment. Clean surroundings and protection from pollutants are essential for a better

environment. Our woods, water supplies, land, and atmosphere need to be well-maintained. In order to fulfil human needs, it is also important to maintain a balance between these resources and living things.

**The three R's to save environment are Reduce, Recycle and Reuse.**

- ❖ Reduce: refers to utilizing less natural resources and preventing resource wastage.
- ❖ Recycle refers to the process of reusing previously created materials, such as paper, plastic, glass, or metals, in place of creating new ones synthetically or through the extraction of new materials.
- ❖ Reusing something involves putting it to use repeatedly, such as when we buy jam, pickles, and other items in plastic bottles that we later use to store things.

## Climate change and effect on natural resources:

The resources found in nature, such as air, water, sunlight, soil, minerals, forests, and wildlife, are known as natural resources. Natural resources are abundant in Sikkim. It is where roughly half of the country's biodiversity is found. Important natural resources, such as land, water, air, biodiversity, forests, etc., are deteriorating daily as a result of anthropogenic disruptions, overexploitation, and risks posed by global warming. The quality of the land, water, and air are steadily declining, which could have a serious impact on people's health. Natural resources are classified mainly into two categories:

1. **Renewable natural resources:** Natural resources that can be replaced quickly, such

as water, air, light, and forests, are known as renewable resources.

2. **Nonrenewable natural Resources:** Non-renewable natural resources are those that require millions of years to create, such as minerals (coal, petroleum, natural gas, metals, etc.), and which cannot be renewed quickly.

### Need of conservation of natural resources

- ❖ To maintain ecological balance for supporting life.
- ❖ To preserve different type of biodiversity.
- ❖ To preserve the natural resources for the present and future generations.

### The proper management of natural resources consists of:

- ✓ Judicious use of natural resources and avoiding wastage of natural resources.
- ✓ Long term planning for the use of natural resources so that it last not only for the present but also for the future generations.
- ✓ The exploitation of natural resources should not be for the benefit of few people but should be distributed equally for all.
- ✓ While extracting and using natural resources we should also plan for the safe disposal of waste so that no damage is caused to the environment.

### Conservation of Water Resources and water quality in Sikkim:

Availability of fresh water resources is one of the best environmental index of any region. The Sikkim state of India have huge water resources available in the form of rivers and natural springs. Glaciers, rivers and springs form an important component of the surface water resources of Sikkim.

There is a strong need for ensuring water security in Sikkim due to its dependence on springs, streams and rainfall for drinking water and irrigation. The water quality in Sikkim varies seasonally. Sikkim relies only on bodies of surface water.

### Water pollution and classification of impurities in water:

1) **Suspended impurities:** These impurities are solid particles that are large enough to be removed by filtration or if they are heavier they will settle down. The suspended impurities are macroscopic in size and cause turbidity in water. Suspended impurities are algae, fungi, protozoa, bacteria, clay silt, etc.

2) **Dissolved impurities:** Some impurities in the form of solid, liquid & gas are dissolved in water when it moves over the rocks, soils etc. These may contain Organic compounds, inorganic salts and gases etc. The concentration of total dissolved solids is expressed in ppm & is obtained by weighing the residue after evaporating the filtered water sample. They may be Ca, Mg, Na of  $\text{HCO}_3$ ,  $\text{CO}_3$ ,  $\text{SO}_4$ , F,  $\text{Cl}_2$  metals & gases.

3) **Organic impurities:** Again these organic impurities may be either suspended organic impurities or dissolved organic impurities. Mostly all the colloidal impurities are associated with organic matter containing bacteria. These are the chief source of epidemics. These organic impurities are either suspended or dissolved vegetable or animal matters.

### Water treatment suitable to rural community of Sikkim

The various methods which may be adopted for purifying the public water supplies are,

- ❖ Screening
- ❖ Plain Sedimentation

- ❖ Sedimentation aided with Coagulation
- ❖ Filtration
- ❖ Disinfection
- ❖ Aeration
- ❖ Softening
- ❖ Miscellaneous treatments such as fluoridation, re-carbonation, liming, desalination etc.

Among the above processes screening, plain sedimentation and filtration are suitable to rural community

### Strategies for water management and conservation in Sikkim:

The biggest stresses on Sikkim's water sector are due to the state's expanding population and pollution. Domestic, hydroelectric, agriculture, industrial, recreation, and other industries are among the various sectors with water demands. Sikkim's primary industry is agriculture, which requires attention to improve crop yield and net crop production. The infrastructure for water storage at the home, neighborhood, and village levels needs to be improved due to the winter months of November to March's rising water scarcity.

#### Technical method to conserve water:

- ❖ Rain water harvesting
- ❖ Historical water bodies
- ❖ Lined earthen ponds
- ❖ Digging pits, ponds, lakes
- ❖ Building small earthen dams or concrete check dams.
- ❖ Construction of dykes.
- ❖ Construction of reservoirs.
- ❖ Groundwater recharge
- ❖ Spring rejuvenation

### Conservation and Management of Land resources:

Due to its mountainous terrain and small size, the state has a restricted supply of land, a scarce resource. Sikkim makes up 0.22% of India's total land area. The land sustains the entire terrestrial environment, which is essential to human survival in major part. The land resources in Sikkim are negatively impacted by the region's high terrain, tectonic instability, strong monsoon rains, and rapid population increase. Due to the state of Sikkim's undulating terrain, strong rainfall, and large amount of runoff creation, erosion is a serious issue. Agriculture, catastrophe susceptibility, and urbanization are some of the negative aspects that put pressure on Sikkim's land; as a result, sustainable land management techniques must be employed in order to safeguard Sikkim's environment. About 75 percent of Sikkim population resides in the rural areas and primarily depends on agriculture and allied activities for their livelihood. Soil conservation measure should aim at preventing or at least minimizing the soil loss. In order to do this proposal land utilization coupled with agricultural practices should be adopted. Some methods of conserving soil are listed below:

- ❖ **Crop rotation:** alternatively growing cereal and a legume in the same field will not only increase in the yield, but also increases the fertility of the soil. They also help in checking soil erosion.
- ❖ **Mulching:** inter culturing operations will kill weeds and soil mulches help the plants to be rooted firmly in the soil.
- ❖ **Strip cropping:** this is an agricultural practice of growing plants in suitable strips in the field.
- ❖ **Dry farming method:** this may be practiced where rainfall is low, indefinite and variable.

In dry farming methods only crops are grown that sustain even a very low rain fall.

### **Air Pollution: issues, sources and control measures**

Air is the most essential for our living. Air pollution is a serious problem in many countries of the world. Air pollution is nothing but a system where presence of any substance (solid, liquid or gas) in the atmosphere in such a concentration that may or may tend to cause injuries to human, crops or property and to the atmosphere itself. The substances which cause air pollution are called as air pollutants. Air quality data generated by the Central Pollution Control Board (CPCB) under the National Air Quality Monitoring Programme (NAMP). Major issues of concern in air pollution are Global warming, Acid rain, photochemical smog and ozone depletion. Air pollutants may be classified by sources as stationary or mobile sources

- ✓ Stationary sources include
  - Point sources (Industrial processing, power plants, fuels combustion etc.)
  - Area sources (Residential heating coal gas oil, on site incineration, open burning etc.)

- ✓ Mobile sources are Highway vehicles, railroad locomotives, channel vessels etc.

Some of the preventing measures of air pollution are:

- ❖ Use of Public Transport
- ❖ Reduce the Consumption of Electricity
- ❖ Avoid Burning of Plastics
- ❖ Use Filters in Chimneys
- ❖ Reduce the Use of Chemicals
- ❖ Reduction of forest fires and smoking
- ❖ Planting more Trees

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# Role of Veterinarians in Public Health and One Health

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Over the past decade, a significant increase in the circulation of infectious agents was observed. With the spread and emergence of epizootics, zoonoses, and epidemics, the risks of pandemics became more and more critical. Human and animal health has also been threatened by antimicrobial resistance, environmental pollution, and the development of multifactorial and chronic diseases. This highlighted the increasing globalization of health risks and the importance of the human-animal-ecosystem interface in the evolution and emergence of pathogens. A better knowledge of causes and consequences of certain human activities, lifestyles, and behaviors in ecosystems is crucial for a rigorous interpretation of disease dynamics and to drive public policies. As a global good, health security must be understood on a global scale and from a global and crosscutting perspective, integrating human health, animal health, plant health, ecosystems health, and biodiversity. In this study, we discuss how crucial it is to consider ecological, evolutionary, and environmental sciences in understanding the emergence and re-emergence of infectious diseases and in facing the challenges of antimicrobial resistance. We also discuss the application of the “One Health” concept to non-communicable chronic diseases linked to exposure to multiple stresses, including toxic stress, and new lifestyles. Finally, we draw up a list of barriers that need removing and the ambitions that we must nurture for the effective application of the “One Health” concept. We conclude that the success of this One Health concept now requires breaking down the interdisciplinary barriers that still separate human and veterinary medicine from ecological,

evolutionary, and environmental sciences. The development of integrative approaches should be promoted by linking the study of factors underlying stress responses to their consequences on ecosystem functioning and evolution. This knowledge is required for the development of novel control strategies inspired by environmental mechanisms leading to desired equilibrium and dynamics in healthy ecosystems and must provide in the near future a framework for more integrated operational initiatives. Most veterinarians contribute, directly or indirectly, to public health goals and outcomes. Veterinary public health contributions can be categorized into six core domains. These are as follows: -

- Role of Veterinarians in elimination of Zoonotic Diseases.
- Role of Veterinarians in Food Safety.
- Role of Veterinarians in the Health Aspects of Laboratory Animal Medicine and Diagnostic Laboratories.
- Role of Veterinarians in Biomedical Research.
- Role of Veterinarians in Health Education and Extension.
- Role of Veterinarians in the Production and Control of Biologics, Medical Devices, and Pharmaceuticals.
- Role of Veterinarians in Government and Legislative Activity

## Role of Veterinarians in elimination of Zoonotic Diseases

Most private veterinary practitioners contribute to public health during routine practice.

Both large and small animal practitioners become skilled diagnosticians for acute and chronic diseases of animals that may affect the owners and their families and the surrounding communities. Specific examples of public health activities include performing routine health examinations, maintaining vaccination regimens, implementing parasite control programs, advising on the risks of animal contact for immunocompromised individuals, facilitating the use of guide and service dogs for people with disabilities, and promoting the benefits of the human-animal bond (eg, for the disabled and elderly as well as veterans and others with posttraumatic stress disorder). Communities are best served when veterinarians approach collective health issues with a population health perspective, applying relevant epidemiological principles at the community or population levels. In addition to these direct services, veterinary practitioners report disease events and trends to state public health and regulatory agencies, collaborate with human medical counterparts on zoonotic disease prevention and control, and advise local health boards and commissions. These relationships would not exist if not for the inextricable link between animal and human health. Many factors contribute to the increasing vulnerability of production animals to infectious disease. These include increasing intensity and concentration of production agriculture, genetic convergence of many food-producing species, accessibility of production animals to external contact (despite rigorous biosecurity measures), scale and frequency of animal transport (domestic and international), increasing size of feedlots, lack of immunity to foreign animal diseases, the relatively porous nature of national borders, and the marked shortage of trained foreign animal disease

diagnosticians and epidemiologists. Many important zoonotic diseases transmitted by food-producing animals (eg, brucellosis and tuberculosis) have been eradicated or controlled in North America and Europe by pasteurization of dairy products, herd testing and culling, and inspections at slaughter. Other diseases transmitted to humans from food-producing animals (eg, campylobacteriosis, listeriosis, salmonellosis, staphylococcosis, and Shiga toxin-producing E coli disease) cause a sizable fraction of the national and international burden of foodborne morbidity and death.

### **Role of Veterinarians in Food Safety**

Veterinarians in food-producing animal practice and government service contribute importantly to the safety of the food supply. Roles in food animal production can be categorized by stage of production. Antemortem activities include assurance of animal welfare, zoonotic disease recognition and prevention, inspection of preslaughter animals, and antimicrobial residue testing. Postmortem activities include carcass inspection and tissue residue determination. Veterinarians in food animal practice also contribute generally to public health through herd health programs, including disease treatment and prevention; husbandry, handling, and environmental advice; reproductive efficiency; vaccination regimens; nutrition; stress reduction; commodity group protocols (eg, the national Beef Quality Assurance program); and biosecurity and biocontainment plans. In addition to monitoring herd health, other important activities include appropriate and judicious use of antimicrobials, disease surveillance, outbreak investigation and mitigation, vaccination against specific high-consequence or high-prevalence pathogens (eg, E coli O157:H7 and Salmonella), collaboration with

other health professionals (One Health), food facility inspection (eg, production, retail, and storage), import-export examinations, health department leadership, public health (risk) communication, food supply after disasters, and research into safer food production processes.

### **Role of Veterinarians in the Health Aspects of Laboratory Animal Medicine and Diagnostic Laboratories**

The challenges of recognizing resurgent infectious diseases and developing novel therapeutics have placed unprecedented emphasis on managing and maintaining laboratory animal colonies and facilities for research and diagnostic efforts. Increasing emphasis is being placed on international collaboration and reference centers, many of which focus on zoonotic diseases and comparative medicine. Because most outbreaks of zoonotic disease occur in regions where local surveillance and diagnostic and response capacity is lacking, the role of these international collaboration and reference centers likely will expand, requiring larger numbers of trained, experienced veterinary personnel. Trained laboratory animal medicine practitioners are needed to maintain health laboratory animals and ensure their humane use for research and diagnostics.

### **Role of Veterinarians in Biomedical Research**

Humans interact with animals in a variety of ways every day, from sharing a loving companionship with pets, to playing and competing together in sports, to managing herds and flocks that provide food. The health and well-being of the animals in our lives is remarkably tied to that of humans in a number of ways. Many naturally occurring diseases and disease processes in animals are identical to those in humans (eg, osteoarthritis, diabetes, and many cancers). Basic biomedical

research of these problems yields solutions that can benefit both animals and humans. Animals have benefited from many therapeutic advances adopted from human medicine. Conversely, clinical veterinary trials can inform promising therapies for use in humans. Building on the information from public health surveillance, research institutions must follow with a greater understanding of the interactions between hosts, parasites, vectors, pathogens, and the environment. Establishing a causal link between human and animal disease relies on such research efforts, often through some combination of molecular studies, mathematical theory, and experimental epidemiology, using either field or laboratory research. As highlighted by the World Health Organization (WHO), research of endemic and resurgent zoonoses is often limited by a lack of basic knowledge of host-pathogen interactions. For many zoonotic species, even the route of transmission to humans remains uncertain. In some cases, the molecular biology of the agents in human and animal hosts may be very different. For example, there are major research efforts aimed toward the identification of virulence factors for *E coli* O157:H7 and the reasons for their differential expressions in humans and cattle.

### **Role of Veterinarians in Health Education and Extension**

Training new veterinary practitioners and disseminating new capabilities to those already in practice falls largely on the nation's academic (especially land-grant) institutions. At the collegiate level, this increasingly involves multidisciplinary relationships between schools of medicine, veterinary medicine, sociology, and basic sciences. Most epidemiologists are employed by governmental or industrial stakeholders, but virtually all veterinarians help educate the public on

the threat of infectious and non-infectious diseases. Veterinary practitioners have a responsibility to remain knowledgeable about disease threats and credible sources of that knowledge for their communities. Enabling appropriate knowledge and awareness among the public requires a blend of risk perception and awareness, especially because community stakeholders play important roles in risk resolution.

### **Role of Veterinarians in the Production and Control of Biologics, Medical Devices, and Pharmaceuticals**

Ensuring that animal drugs, vaccines, and devices are safe and efficacious is a shared responsibility between veterinarians in FDA, USDA, and EPA. In general, FDA, specifically the Center for Veterinary Medicine, regulates animal drugs, animal feeds, and veterinary devices, whereas USDA regulates animal vaccines and biologics. Specific to pesticides, FDA regulates certain flea and tick products for animals, whereas EPA regulates others. Within each of these governmental agencies, veterinarians serve to encourage the development of novel products and, at the same time, protect the consumers of those products from false or misleading claims. Another important function regarding biological agents is the regulation of their storage, use, and transfer. Because of inherent virulence and transmissibility, access to many disease pathogens, termed select agents, has increasingly been limited to legitimate facilities for legitimate uses. The Federal Select Agent Program is jointly administered by CDC and USDA's Animal and Plant Health Inspection Service (APHIS). This effort oversees the possession, use, and transfer of certain biological agents and toxins that have the potential to pose a severe threat to the public, to

animal or plant health, or to animal or plant products.

### **Role of Veterinarians in Government and Legislative Activity**

veterinarians are employed at various levels of state and federal government. More than 3,000 veterinarians are employed at the federal level, nearly two-thirds of which are with USDA. Other federal agencies employing large numbers of veterinarians include the Department of Defense (DoD) and the Department of Health and Human Services (DHHS; eg, in the CDC, FDA, and National Institutes of Health [NIH]). Public health programs comprise most of these employment opportunities, with direct animal care being a minor fraction. Examples include oversight of food safety inspection programs, disease surveillance and outbreak investigation, laboratory animal care, biomedical research, and public health program management and leadership. At the state level, each department of agriculture typically has a state veterinarian who is responsible for protecting the production animal, poultry, and aquaculture industries directly, and the public indirectly, through the prevention, early detection, containment, and eradication of economically important production animals, poultry, and fish diseases that, in many cases, are transmissible to humans. The state veterinarian's office regulates the importation, transportation, and processing of animals and is responsible for the control and eradication of poultry and production animal diseases, regulation of fish farming, and emergency response programs. Welfare of farm animals is monitored, and when necessary, the office of the state veterinarian conducts investigations and prosecutions relating to cases of cruelty to animals. Most states and territories employ veterinarians in their health departments as public health



veterinarians, who generally work in zoonotic disease control and prevention. However, they are increasingly involved in One Health efforts. Public health veterinarians typically work in communicable disease epidemiology, toxicology, or environmental health programs within state, regional, or local health departments. For more information, see National Association of State Public Health Veterinarians. A final category of governmental activity is legislative. A relatively small number of

veterinarians serve at various levels to promulgate laws, rules, and regulations that serve to protect public health, domestic preparedness, and national defence. Veterinarians serve in the US House of Representatives, in senior leadership positions of several US cabinet-level departments (including USDA, DHHS, DoD, and Department of Homeland Security [DHS]), and as legislative liaisons for professional associations such as the AVMA.

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## Success Story - Nutrient Management in No-Tillage Mustard

Sakhen Sorokhaibam<sup>1</sup>, Anando N<sup>2</sup>, Brajamani Kh<sup>3</sup> and Maipak Kh<sup>4</sup>

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Konjengbam Biteshwor Singh of Kwasiphai Maning Leikai, Khoijuman Khunou, Bishnupur, Manipur-795126 Located at Kwasiphai village, Bishnupur sub division, Bishnupur district 2 km from district Headquarter. After kharif paddy, he used to grow rapeseed without proper technical knowledge and as a result the yield was not up to his satisfaction.

### KVK intervention:

KVK Bishnupur paid a visit to Kwasiphai village for selecting site for conducting Cluster Front



Line Demonstration (CFLD) programme on Mustard var. NRCHB-101 under NMOOP. After interacting with the farmers, it was learnt that most of the

farmers left their land fallow during *rabi* season after paddy and some of them use to grow rapeseed that also without proper technical know-how of cultivating rapeseed/mustard and as a result the yield is not up to their satisfaction.

KVK Bishnupur conducted training on Improved package of practices of growing rapeseed/mustard and provided critical inputs such as seed, micronutrient and pesticide under the programme and the field was monitored time to time right from sowing to harvesting. Soil test were done and the soil of the farmer field was slightly acidic in reaction (pH 6.05), high in organic carbon (1.91%), medium in available nitrogen (345 kg N ha<sup>-1</sup>), phosphorus (28 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>) and potassium (255 kg K<sub>2</sub>O ha<sup>-1</sup>). The technology followed by the farmer is application of NPKS @ 40:20:20:20 kg/ha, Total Sulphur + SSP+1/2 MOP at or before sowing when there is moisture in the field, first ½ urea when 1-2 true leaves emerged and remaining half MOP at 25-30 days after first application.





### Success point

The yield was much better than the previous year and he could earn a handsome income which was very much beyond his expectation.

Performance of technology vis-à-vis Local check (Increase in productivity and returns)

**Farmer feedback:** Wonders can be done in agriculture if investments are made in the right direction and farmers are equipped with the latest knowledge.

**Table: 1 Economics of Demonstration conducted**

| Used Practice    | Yield (q/ha) | Gross cost (Rs/ha) | Gross income (Rs/ha) | Net income (Rs/ha) | B:C ratio |
|------------------|--------------|--------------------|----------------------|--------------------|-----------|
| Farmer practices | 8.7          | 15000              | 47850                | 32850              | 3.19:1    |
| Demonstration    | 10.62        | 20000              | 84960                | 64960              | 4.25:1    |
| % Increase       | 22.06        |                    |                      | 97.74              |           |

\* \* \* \* \*

# Phytomicrobiome: An Unexplored Wealth of Plants for The Management of Plant Diseases

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The term "phytobiome" refers to all biotic and abiotic elements that affect the health and production of plants in a given biome, not only the collection of microorganisms associated with a particular plant. Abiotic factors such as soil and climate also impact plants and regulate the presence and function of many organisms interacting with them. Historically, Agriculture and natural systems have been managed by concentrating on specific phytobiome components (e.g., nutrient applications, pesticides, and novel of invasive organisms). To achieve optimum and long-lasting ecosystem production and health, regulating the phytobiome as a whole system of interrelated components is more advantageous. Plant colonization of terrestrial and aquatic habitats ignited the formation of biodiverse systems termed phytobiome. In phytobiome, plants constantly interact with microbial communities adapted to colonize plant tissues, termed microbiomes.

The phytomicrobiome comprises a community of microorganisms that associate and interact with a host plant, including bacteria, archaea, fungi, oomycetes, viruses, protozoa, algae, and nematodes. Collectively, the plant and its phytomicrobiome are a holobiont, a term originally coined by Adolf Meyer-Abich but most frequently associated with and popularized by Lynn Margulis and rigorously explored by Bordenstein and Theis.

The phytomicrobiome includes Parasitic and commensal microbes; it is also comprised of mutualists, or beneficial microbes, such as

mycorrhizal fungi (MF) and plant growth-promoting bacteria (PGPB) that enable the plant holobiont to survive within a wide range of environments. Based on habitats, plant-associated microbial communities are referred to as rhizosphere microbiome, rhizoplane microbiome, phyllosphere microbiome, and endosphere microbiome.

The term 'endophytic bacteria' refers to those bacteria that colonize the interior of the plant parts, viz., root, stem, or seeds, without causing any harmful effect on the host plant. These bacteria may promote plant growth in terms of increased germination rate, biomass, leaf area, chlorophyll content, nitrogen content, protein content, hydraulic activity, roots, shoot length, yield, and tolerance to abiotic stresses like drought, flood, salinity, etc., Plant associated bacteria can promote plant growth directly through biological nitrogen fixation (BNF), phytohormone production, phosphate solubilization, inhibition of ethylene biosynthesis in response to biotic or abiotic stress (induced systemic tolerance), etc., or indirectly through inducing resistance to the pathogen. Bacteria can be highly competitive for nutrients and produce various antimicrobial metabolites allowing them to colonize and proliferate on plant surfaces in the presence of indigenous microbial communities.

## How phytobiome microorganisms involve in plant health and growth:

Different microbiome interacts with host plants and impact plants in various ways. Plant-associated microbial organisms can positively and



negatively impact plant growth, development, and health. Beneficial microbes mediate plant holobiont responses to abiotic and biotic stresses and allow the plant holobiont to adapt to environmental variations. The plant host can then modify the abundance and composition of beneficial microbial species within the phytomicrobiome, at least in part, by secreting biochemical compounds. This selection occurs most strongly in the endosphere, followed by the rhizoplane and the rhizosphere. For example, root exudates can select for and promote the growth of certain beneficial microbes by serving as carbon and/or energy sources for microbial metabolism.

Direct impacts on plant growth and development by microorganisms include improved nutrient accessibility such as nitrogen fixation and phosphate solubilization; altered microenvironments such as changed acidity ( $p^H$ ); and hormonal stimulation (phytohormone production). Microorganisms are also involved in promoting or suppressing plant diseases either directly (such as antibiotics production) or indirectly (*via* disease resistance). In addition to direct antagonism, these organisms also appear to trigger ISR in plants.

Plants depend upon beneficial interactions between roots and microbes for nutrient availability, growth promotion, and disease suppression. The root microbiome is predominantly assembled from the external microbes in the soil. Plants and microbes have adapted to use their close association for mutual benefit. Microbes convert critical nutrients to more usable forms before plants' assimilation. In turn, bacteria in the rhizosphere receive carbon metabolites from the plant through root exudates. Beneficial soil microbes also contribute to pathogen resistance, water retention and synthesis of growth-promoting hormones. Microbial communities

associated with plants carry a great diversity of metabolic capabilities and often influence broad aspects of plant biology. In agricultural environments, the composition of these communities affects overall crop performance by contributing to essential plant functions such as nutrient uptake, environmental responses and host development.

### **Beneficial Microbes Aid Plant Holobionts in Nutrient Acquisition:**

As organisms fought for newly discovered resources with the development of oxygenic photosynthesis, species were quickly diversified. However, to help them meet their nutrient needs, plants have historically relied on helpful microbes (specifically bacteria). Beneficial microbes can support plant holobiont nutrition through 1) biological nitrogen fixation (BNF), 2) solubilization of insoluble nutrients, and 3) increased root surface area.

Almost all plants also form interactions with mycorrhizal fungi (MF) to improve nutrient acquisition. MF can increase the effective root surface area and improve nitrogen, phosphorus, iron, and zinc extraction efficiency from the rhizosphere. MF also produces organic acid (e.g., acetic acid, oxalic acid, and succinic acid) exudates that decrease the rhizosphere pH, dissolving insoluble minerals into the soil solution and contributing to greater nutrient acquisition. Simard illustrated that MF facilitates plant "cognition," enabling the plant host to recognize signals from its environment and take action to improve its resistance to stress and general fitness. In addition, MF promotes communication among plants via signaling pathways, contributing to specific changes or overall shifts in plant morphology, physiology, and fitness. It is true that the evolutionary success of

a plant and its companion microorganisms are inextricably linked.

Plant holobiont microbiome interactions influence nutrient cycling in the rhizosphere, which in turn influences plant nutritional status and crop productivity in farming environments. For example, arbuscular mycorrhizal fungi create a suitable environment for the colonization of plant growth-promoting bacterial endophytes if inoculated together onto crop plants, and plant root and hyphal exudates provide a carbon source for the bacterial endophytes. Co-inoculation of both fungi and bacteria as a consortium can improve crop yields more than single-strain inoculants.

### **Microbial Phytohormone Production Promotes Plant Holobiont Growth and Stress Resistance**

By producing and delivering plant growth regulators, growth regulatory precursors, or their counterparts, microbial communities found in the rhizosphere can regulate the growth, development, and stress reactions of plant holobionts. These plant-microbe interactions rely on a wide variety of long-distance chemical signaling compounds, including plant hormones (indole-3-acetic acid (IAA), auxins, cytokinins, and gibberellins) and microbial-produced compounds that can mimic or induce plant hormone production. For example, many bacteria produce auxin or manipulate host auxin signaling to, in the case of rhizosphere PGPR, promote plant root growth or interfere with plant development in the case of plant pathogens. A specific example is microbially produced auxins from either pathogenic or mutualistic bacteria, which can influence plant root growth and branching.

Signal compounds, such as thuricin and lipochitooligosaccharides, produced by beneficial

microbes can also assist plant adaptation to biotic and abiotic stresses. For example, When plant cells detect microbial signal molecules, messages are transmitted from stressed tissues to healthy tissues through the plant, enabling the healthy tissues to receive "danger" signals that cause defense-related gene activation. Interestingly, beneficial microbes can also induce resistance in the absence of a phytopathogen, and this may give the plant a stronger defense against upcoming phytopathogenic threats. These shared, interconnected signaling networks are essential for boosting long-term stress adaptation at the level of plant holobionts and enable complex and coordinated defense responses to intruders quickly, improving ecological fitness. In a similar way, these signaling substances can support a plant's defensive mechanisms in response to abiotic challenges, including salinity, low temperatures, and drought.

### **Phytomicrobiome as Biocontrol Agents**

Plant holobionts promote the growth of phytomicrobiomes that inhibit pathogens by favoring microbial taxa with biocontrol capabilities. Many examples of *Pseudomonas* spp., *Bacillus* spp., and *Trichoderma* spp. strains, among others, have been described as being capable of plant pathogen biocontrol. The potential to harness and improve this auxiliary plant holobiont immunity underlines the real-world applications of the holobiont concept in our era of agricultural optimization.

Some members of the phytomicrobiome provide either direct or indirect mechanisms of biocontrol. Direct mechanisms involve microbes that discharge different chemicals with antibacterial characteristics. Indirect mechanisms of biocontrol limit the fitness of plant pathogens by reducing their ability to access vital resources. The metal depletion biocontrol mechanism is accomplished through the

excretion of siderophores, which chelate soil metals such as iron, copper, and zinc, and funnel them back to the excreting cells using active transport systems. The vulnerable host biocontrol mechanism is subtracted via the production of volatile organic compounds (VOCs) that lead to the establishment of induced systemic resistance (ISR) in infected plants.

There are nevertheless abundant indications of the existence of other holobiont biocontrol systems. All signs point, for example, to phytomicrobiome diversity being key in reducing pathogenic infection efficiency. This phenomenon inherently suggests the existence of yet-to-be-identified pathogen adversaries, a hypothesis supported by analyses of rhizosphere microbiome responses to pathogen-induced root exudation. Genomic and metagenomic analyses have identified many putatively novel pathogen-antagonistic genes in known biocontrol microbes and suppressive soils.

Analyses of species-specific and community-wide microbial VOCs have also singled out many compounds that may have the same role. Moreover, VOCs produced by microbes can act as plant growth promoters and signaling molecules between plant holobionts and their rhizosphere communities. Furthermore, as signals, VOCs can be transferred via mycorrhizal networks in the rhizosphere between plants and their neighbors. The production and roles of VOCs are complex and indicate a wide range of roles within the rhizosphere; more information on microbial VOCs can be found in several recent reviews.

Plant microbiota colonizes all plant organs and plays crucial roles, including providing nutrients to plants, stimulating seed germination, promoting plant growth, and defending plants against biotic and abiotic stress.

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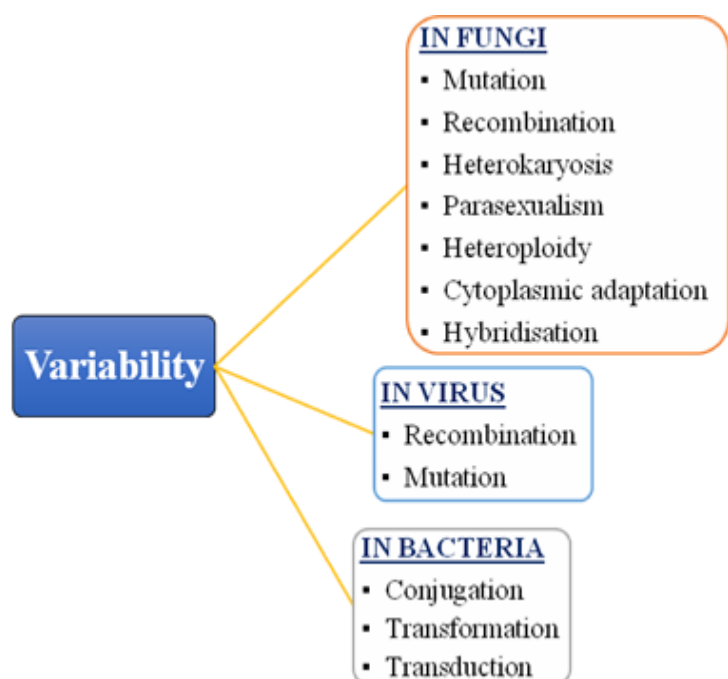
# Variability in Pathogens

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Variability in Plant Pathogens is one of the dynamic and significant aspects of biology: individuals have different characteristics, not fixed *i.e.* phenomenon of Variation. The property or ability of an organism to change its characteristics from one generation to other is called Variability (Agrios). Individuals produced by sexual process including Sexual spores, higher Parasitic plants, Nematodes, Bacteria, Cultivated Plants differ among themselves and from their parents.

## Stages of variation in pathogens

- **Genus:** group of species having common characters
- **Species:** organism with common morphological and phenotypic characters
- **Forma special (f.sp):** individual of morphologically similar pathogen species but attack particular host or group of usually related hosts

- **Race:** sub division of f.sp , based on pathogenicity towards particular set of host varieties/cultivars
- **Biotype:** identical individuals produced asexually by a variant
- **Isolates:** strain that has been isolated from particular area (Kumar and Verma, 2019)

## Terminology

- **Physiological specialization:** - within the species of a pathogen there exist certain individuals that are morphologically similar but differs with respect to their physiology.
- **Physiologic race** - individuals within the species of a pathogen that morphologically similar but differ with respect to their pathogenicity on particular set of host varieties.
- **Forma specialis (f. sp.)** - individuals within the species of a pathogen that are morphologically similar but differ with respect to their pathogenicity on particular host genera. *e.g., Puccinia graminis f.sp. tritici* host specific to wheat.
- **Variability** - it is the property of an organism to change its characters from one generation to the other.
- **Variation** - when progeny of an individual show variation in characters as compared to parents such a progeny is called a variant.
- **Pathotype** - A pathotype is a population of a parasite species in which all individuals have a stated pathosystem character



(pathogenicity or parasitic ability) in common.

- **Biotype** - progeny developed by variant having similar heredity is called a biotype or a subgroup of individuals within the species, usually characterized by the possession of single or few characters in common.

### Variability in fungi

#### Mutation

Mutations are spontaneous. It is a more or less abrupt change in the genetic material of an organism. It represents change in sequences of the bases in DNA either by substitution or by deletion or addition, may be by amplification of particular segment of DNA to multiple copies by insertion or excision of a transposable element into coding or regulatory sequences of the gene. It is fast and expressed soon in single celled organism (mostly recessive) and also reported in the extra nuclear DNA (cytoplasmic DNA).

#### Recombination

Pathogens undergo recombination during sexual processes, causing significant changes. When two haploid nuclei (1N) containing different genetic material unite to form diploid (2N) nucleus called a Zygote, when undergo meiotic division produce new haploid. Recombination of genetic factor occurs during zygote division through cross-over, expressing part of chromosomes, and can also occur during mitotic division of cell in the course of growth of the individual.

#### Heterokaryosis

In some fungi, hyphae or parts of hyphae contain nuclei, which are genetically different, generally of two different kinds. This condition is known as heterokaryosis. The phenomenon is commonly brought about by hyphal anastomosis

between mycelia of two parental genotypes e.g., *Rhizoctonia solani*. In Ascomycotina and Basidiomycotina, some fungi possess cells containing numerous nuclei and these may be heterokaryotic. The underlying implication of this state is that the fungus may respond to selection by varying the proportion of the dissimilar nuclei in the cells.

#### Parasexualism

First demonstrated by Pontecorvo (1956) in *Aspergillus nidulans*. It is a process by which genetic recombination can occur within fungal heterokaryon. In heterokaryotic fungal mycelium there is always the opportunity for dissimilar nuclei to fuse and produce diploids or what is known as mitotic recombination. Mitotic recombination can then occur producing a random re-assortment of genetic material that is released in progeny after haploidization. This sequence of events has been described in the parasexual cycle (genetic recombination without meiosis).

#### Stages of the parasexual cycle are numbered as follows

- (1) Hyphal conjugation (plasmogamy)
- (2) Heterokaryosis
- (3) Nuclear fusion (karyogamy)
- (4) Mitotic recombination and nondisjunction
- (5) Haploidization and nuclear segregation leading to homokaryosis.

#### Heteroploidy

Heteroploidy is the existence of cells tissues or whole organisms with numbers of chromosomes per nucleus. Heteroploids may be haploids, diploid, triploid or tetraploids i.e., have one or more extra chromosomes from normal euploid number e.g.,  $N+1$ ; This represents a normal situation in eukaryotes.

## Variability in Viruses

### Recombination

Occurs mostly during replication  
Reassortment. May results from mixed infection of  
two strains of the virus.

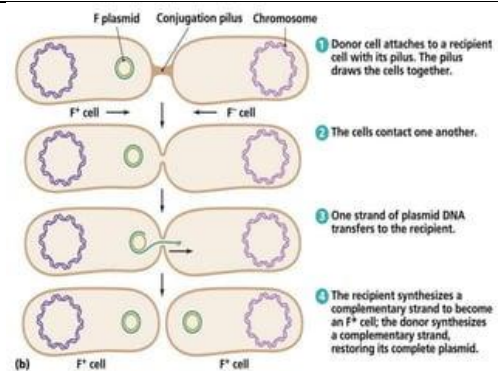
### Mutation

Results from nucleotide changes in the  
coding regions due to addition or deletion or  
replacement. Ultimately leads to functional changes  
in the genes.

**Table 1: Variability in Bacteria**

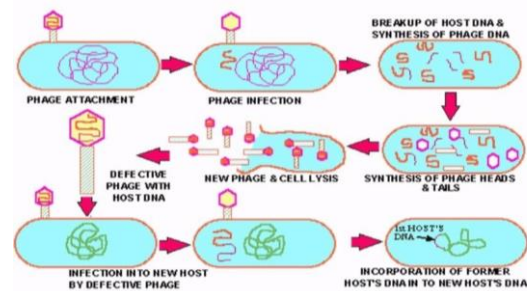
### Conjugation:

Transfer of DNA from one bacterial cell to another. Donor cell (F<sup>+</sup> or Hfr) transfers DNA to recipient cell (F<sup>-</sup>). Two compatible bacteria come in contact and exchange the portion of plasmid or chromosome through Conjugation Bridge or pilus.



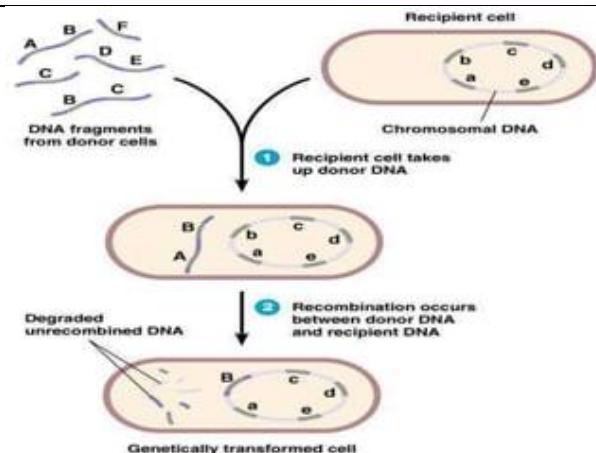
### Transduction:

Process by which DNA is transferred from one bacterium to another by a virus (bacteriophage).



### Transformation:

Process of horizontal gene transfer by which some bacteria take up foreign genetic material (naked DNA) from the environment.



\* \* \* \* \*

# Impact of Climate Change on Vegetable Production

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One of the most important variables affecting vegetable production year after year is climate change. It encompasses temperature rise, altered rainfall patterns that cause floods and droughts, salinity or alkalinity, etc., and is acknowledged as a global problem. Due to growing emissions from the energy, industrial, and agricultural sectors as well as widespread deforestation, swift changes in land use, and land management practices, the earth's atmosphere's gaseous composition has been changing significantly. Mitigation and adaptation efforts must be coordinated in order to reduce agriculture's vulnerability to the negative effects of climate change and make it more resilient. Poor farmers' adaptive capacity is limited due to subsistence agriculture and a low level of formal education. These are straightforward, economically viable, and culturally acceptable adaptation strategies must be devised and implemented. Moreover, knowledge transfer as well as access to social, economic, institutional, and technical resources must be provided and integrated into farmers' existing resources.

## Different types of environmental stresses

There is major five environmental stresses that effect the vegetable production:

- High Temperature
- Cold Stress
- Drought
- Salinity
- Flooding

## High Temperature

Due to rise in temperature, heat stress is a major agricultural problem. A constantly increase in temperature causes many of morpho-anatomical and cytological changes in plant which affect the seed germination, plant growth, flower shedding, pollen viability, gametic fertilization, fruit setting, fruit size, fruit weight, fruit quality etc. For example, in tomato crop due to heat stress if temp. above 35 °C has become a major limiting factor for seed germination, seedling and vegetative growth, flowering & fruit setting, and ripening that drastically reduced the yield. High temperatures also effect the floral bud development due to flower abortion.

## Cold Stress

Decrease in temp. cause cold stress in vegetable crops and increase in permeability of plasmalemma results in leakage of organic and inorganic substances. Like as, chilling injury in cultivated tomato genotype (*Solanum lycopersicum*) showed limited growth and development at temperatures under 12°C. At temperatures between 0 and 12°C, vegetables crops are damaged by the chilling stress. The degree of damage is proportional to the length of time spent in this temperature range.

## Drought stress

Lack of water effects the crop growth in several ways and it depends on the severity, duration, and time of stress in respect to the stage of growth. Almost all vegetable crops are sensitive to drought during their critical points in two periods e.g., flowering and two to- three weeks before harvesting. The water requirements of vegetable crop vary from crop to crop that range from about 6

inches of water per season for radishes to 24 inches for tomatoes and watermelons. Based on crop water-use and effective precipitation values, precise irrigation requirements can be predicted.

### Salinity

Salinity is the major threat for vegetable crop production because vegetable crops are highly sensitive to salt. In addition, the salinized areas are increasing at a rate of 10% annually mainly due to low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices are the major factors that increasing soil salinity.

### Flooding

The damage to vegetables by flooding is due to reduction of oxygen level in the root zone, which inhibits aerobic processes. Most vegetables are highly sensitive to flooding and genetic variation with respect to this character is limited, particularly in tomato and early cauliflower.

### Environmental Constraints Limiting Vegetable Productivity

Climatic changes will affect the severity of abiotic stress on the vegetable crops. Like as, increase in temperature, reduced irrigation-water availability, flooding, and salinity will be the major upcoming limiting factors in sustaining and increasing vegetable productivity.

1. Plants may respond same to avoid one or more stresses through morphological, physiological or biochemical mechanisms.
2. Stress responses of plants will be more complex due to environmental interactions and influence the degree of impact of climate change.

3. Methods adapt to this climate change induced stresses are critical for sustainable vegetable production.

### Methods

#### Mitigation Strategies to Climate Change

To mitigate the possible impact of climatic change on vegetable production as well as on productivity, several initiatives have been undertaken. These include:

1. Selection of resistant genotypes,
2. Genetic manipulation to overcome severe climatic stresses,
3. Methods to improve water and nutrient-use efficiency
4. Biological nitrogen fixation as well as exploiting the beneficial effects of CO<sub>2</sub> enhancement on crop growth.

#### Potential Adaptation Strategies to Climate Change in Vegetable Crops

##### Water Management

Water needs depends upon the crop, water supply, soil characteristics and topography and critical stage of crop. Surface irrigation methods are utilized in more than 80% and its field level application efficiency is often 40-50%. So, to generate income and alleviate poverty of the small farmers, promotion of affordable, small-scale drip irrigation technologies is essential and water use efficiency is more.

Drip irrigation minimizes water losses due to run-off and deep percolation and water savings of 50-80% when compare to surface irrigation methods. Crop production per unit of water consumed by plant evapo-transpiration is typically increased by 10- 50%. Thus, more plants can be irrigated per unit of water by drip irrigation, and with less labour.



Example: The water-use efficiency by chili pepper was significantly higher in drip irrigation compared to furrow irrigation, with higher efficiencies observed with high delivery rate drip irrigation regimes.

For drought-tolerant crops like watermelon, yield differences between furrow and drip irrigated crops were not significantly different; however, the incidence of Fusarium wilt was reduced when a lower drip irrigation rate was used.

### Cultural Management

Mulching is most appropriate measures that are used in high-value vegetable production systems. Both organic and inorganic protective coverings help to reduce evaporation, moderate soil temperature, reduce soil runoff and erosion, protect fruits from direct contact with soil and minimize weed growth.

During the hot rainy season, vegetables such as tomatoes suffer from yield losses caused by heavy rains. Simple, clear plastic rain shelters prevent water logging and rain impact damage on developing fruits, with consequent improvement in tomato yields. Fruit cracking is also reduced. By using shelter shade cloth temperature stress should be reduced. Planting vegetables in raised beds can ameliorate the effects of flooding during the rainy season.

### Grafting of Vegetables for Stress Management

Grafting of susceptible plant (scion) on tolerant plant (rootstock) helps to grow plant successfully under stress conditions, especially under salt and drought stress conditions. Grafting of vegetables has been used primarily to control soil-borne diseases affecting the production of vegetables such as tomato, eggplant, and cucurbits. It provides tolerance to soil-related environmental stresses such

as drought, salinity, low soil temperature and flooding if appropriate tolerant rootstocks are used.

### Use of Resistant/tolerant genotypes

#### Heat- and Cold-Tolerant Genotypes

The way to achieving high yields with heat tolerant cultivars is the broadening of their genetic base through crosses between heat tolerant tropical lines and disease-resistant temperate or winter varieties.

#### Drought Tolerance

Most of the vegetables are sensitive to drought however, brinjal, cowpea, amaranth, and tomato can tolerate drought to a certain extent. Transfer and utilization of genes from these drought-tolerant species will enhance tolerance of tomato cultivars to dry conditions, although wide crosses with *Solanum pennellii* produce fertile progenies.

#### Salt Tolerance

Screening for salt tolerance in the field is not a recommended practice because of the variable levels of salinity in field soils. Screening should be done in soil-less culture with nutrient solutions of known salt concentrations. A few vegetables like, beet palak, tomato, etc. can tolerate salt to some extent. Most commercial tomato cultivars are moderately sensitive to increased salinity and only limited variation exists in the cultivated species.

### Use of Biotechnological Tools in Stress Management

Use of molecular technologies has enumerated the process of traditional plant breeding. Combining of new knowledge from genomic research with traditional breeding methods has enhanced our ability to improve crop plants. Several QTLs have been identified to stress tolerance in tomato, i.e., for water-use efficiency in *Solanum pennellii* and *Solanum pimpinellifolium* as source of salt

tolerance. Only a few major QTLs account for the majority of phenotypic variation, indicating the potential for marker-assisted selection (MAS) for salt tolerance.

### Conclusions

An overall approach is required to overcome stress tolerance rather than a single measures. These germplasms will include both cultivated and wild accessions possessing genetic variation unavailable in current, widely grown cultivars. Better agronomic practices should be followed during the crop

duration for better production. For reducing malnutrition and alleviate poverty in developing countries through improved production and consumption of safe vegetables will involve adaptation of current vegetable systems to the potential impact of climate change. Vegetable germplasm with tolerance to drought, high temperatures and other environmental stresses, and ability to maintain yield in average soils must be identified to serve as sources of these traits for both public and private vegetable breeding programmes.

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# Prospects and Way Forward in Conservation Agriculture

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The global population is projected to experience a notable increase, moving from its current 8 billion in 2022 to an estimated 9.7 billion by the year 2050, as indicated by the United Nations in 2022. This surge in human numbers presents a dual challenge on a global scale, particularly in the South Asian region (Falcon *et al.*, 2022). The challenge entails the necessity to enhance production to meet the escalating demands for food due to the growing populace while concurrently reducing the ecological impact. This complex situation is compounded by the ongoing depletion of natural resources, exemplified by the diminishing per capita availability of both land and water resources. Furthermore, the confluence of factors such as climate change and water scarcity has rendered agricultural production systems acutely vulnerable, significantly affecting the livelihoods of millions in this geographical area. Notably, the agricultural sector stands responsible for approximately 30% of the overall greenhouse gas emissions, encompassing CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub>. Coincidentally, this sector finds itself in the crosshairs of the repercussions stemming from a changing climate. Historically, conventional intensive agricultural practices have succeeded in attaining production targets. However, their success has come at a steep cost, leading to the degradation of natural resources and thereby imperiling the future potential of agricultural productivity. This mode of agriculture has been implicated in the decline of soil organic matter, deterioration of soil structure, diminished rates of water infiltration, erosion-related predicaments, inefficient utilization of water resources, and a contribution to the global warming predicament (Wassie *et al.*, 2020).

The cumulative impact of these multifaceted challenges underscores the imperative need to expeditiously explore and implement strategies that can effectively counteract the threats posed to the agricultural sectors of West Africa and India. In 2008, the Food and Agriculture Organization (FAO) introduced the concept of Conservation Agriculture (CA) as a means of establishing a resource-efficient framework for crop production. This innovative approach is designed to tackle the contemporary challenges encountered by agriculture.

Conservation Agriculture is envisaged as a means to reverse the degradation of natural resources, thereby steering agricultural practices toward sustainable trajectories. The central focus on sustainability assumes paramount importance in the contemporary agricultural landscape, and in this context, CA emerges as a robust and viable path forward. The shift from conventional practices to CA methodologies holds considerable promise in fostering the vitality of soil ecosystems, chiefly through the enhancement of soil organic carbon (SOC), bolstering soil aggregation, augmenting water infiltration capacities, and curbing soil erosion (Hajer *et al.*, 2016).

The merits of Conservation Agriculture extend beyond these ecological aspects. The approach embodies a potential strategy for both mitigating and adapting to climate change, effectively functioning as an adaptive mechanism in the face of the ever-evolving climate patterns. Moreover, CA is particularly poised to benefit African agriculture by bolstering crop productivity, a region grappling with challenges ranging from low yields and soil health issues to capital constraints

and labor shortages. Its adaptability across diverse agricultural production systems and farm types positions CA as an inclusive approach.

Over the course of the past three decades, Conservation Agriculture has emerged as a cornerstone for transitioning toward the sustainability of intensive agricultural systems on a global scale.

Conservation agriculture conserves natural, biodiversity and labor. It increases available soil water, reduces weeds, reduces heat and drought stress, and builds up soil health in the longer term.

Conservation agriculture, as defined by the United Nations' Food and Agriculture organisation (FAO), is “**a farming system that promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species.**”

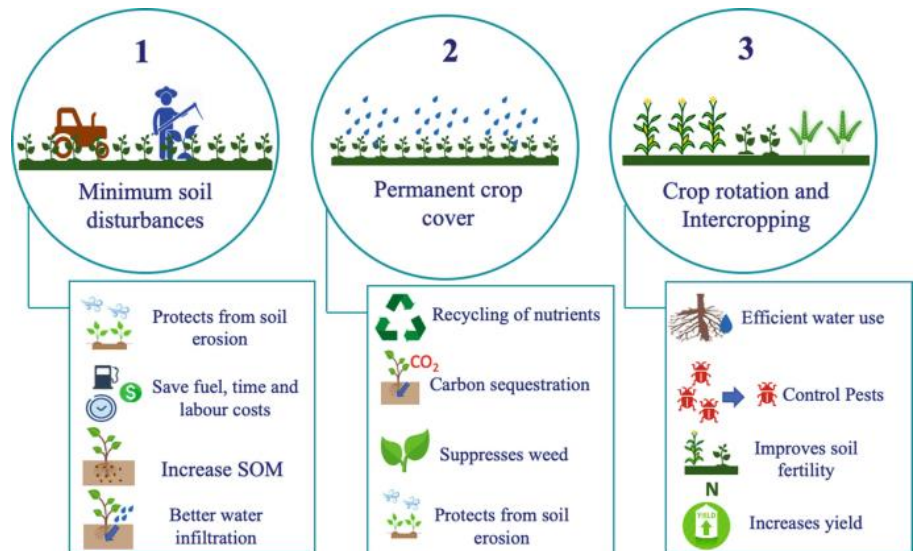
**What are the principles of conservation agriculture?**

CA relies on the simultaneous application of three core principles (also called as three pillars) which are linked to each other in a mutually reinforcing manner:

1. Minimum soil disturbance or no tillage
2. Permanent organic soil cover through crop residues or other cover crops
3. Diversification of crop species through the use of crop rotation or/ and intercropping (Naorem, 2021)

### Challenges in agriculture and their solution

Conventional agriculture relies on intensive tillage to achieve several objectives, including soil loosening, weed control, enhanced nutrient release



**Figure: 1 Three principles of conservation agriculture (Naorem, 2021)**

for crops, and alteration of soil water movement and aeration patterns. However, this method has been identified as a contributing factor to the gradual reduction of soil organic carbon (SOC), primarily due to accelerated oxidation and erosion resulting from the excessive breakdown of soil aggregates. Notably, the widespread adoption of conventional tillage (CT) practices has resulted in significant soil loss through erosion, particularly exacerbated by wind and water actions, leading to desertification in numerous developing countries, including various parts of Africa.

Furthermore, conventional agriculture practices often involve the removal or burning of crop residues, which introduces pollution through greenhouse gas (GHG) emissions and the loss of valuable plant nutrients. Inadequate crop rotation strategies have also worsened the situation in multiple countries. The extensive use of heavy machinery in conventional tillage further contributes to GHG emissions and soil compaction. Within the context of smallholder agriculture in West Africa, CT among farmers with access to draft animals involves employing animal-drawn plows for primary tillage,



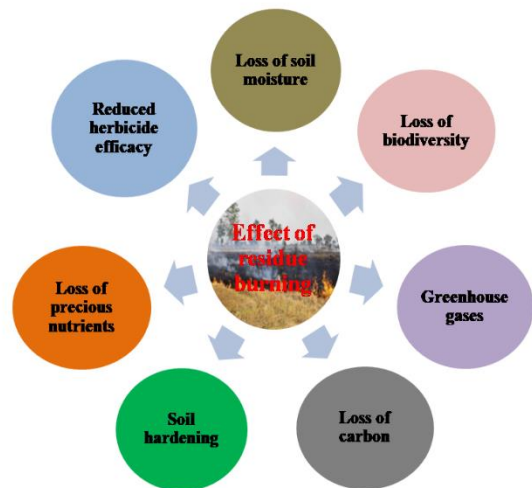
followed by harrowing and cultivation during the cropping season for weed control. On the other hand, for smallholders lacking draft animal power, CT continues to rely on manual hoe cultivation in sub-Saharan Africa.

However, conventional agricultural practices are struggling to keep up with the growing demands imposed by expanding human and livestock populations. Unlike conventional systems where soil tillage is a necessary step, Conservation Agriculture (CA) excludes tillage from its strategy. Instead, CA emphasizes retaining crop residues on the soil surface combined with no tillage (NT), initiating processes that promote improved soil quality and overall resource enhancement. A gradual shift occurred globally over the course of several decades, moving away from the traditional belief that extensive plowing was the sole means of enhancing farm productivity. The recognition that significantly reduced or zero tillage (ZT) was more advantageous marked a pivotal change in perspective.

To ensure both food security and environmental sustainability, there is an urgent imperative to embrace and implement CA-based best practices across various agricultural aspects. CA functions as a sustainable management system applicable to both irrigated and rainfed regions. It does not enforce rigid rules, but rather offers adaptable guidelines for cultivating crops in a more sustainable manner, allowing farmers to tailor CA practices to local conditions such as soil type, rainfall patterns, and financial capacities.

Adopting CA practices involves retaining crop residues on the soil surface alongside ZT, catalyzing processes that lead to enhanced soil quality and overall resource enrichment. However, transitioning to CA necessitates a comprehensive paradigm shift from conventional agriculture. This shift

encompasses the management of crops, soil, water, nutrients, weeds, and farm machinery. CA introduces a profound alteration in the management of soil systems and cropping system design, subsequently triggering significant changes in required field operations and mechanization approaches.



**Figure: 2 Negative impacts of residue burning on soil health and environment (Kumar *et al.*, 2023)**

### Goal of conservation agriculture

- Conservation agriculture aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs.
- It contributes to environmental conservation as well as to enhance and sustain agricultural production.
- It can also be referred to as resource efficient or resource effective agriculture.
- It can also maintain many sustainability issues, such as declining water resources, degrading soil health, and environmental degradation which further responsible for low land productivity (Pokharel *et al.*, 2018).

### Machinery in conservation agriculture:

Machinery and agriculture tool that supports conservation agriculture usually with minimum or zero tillage and management of crop residue. Agricultural machinery or tools, which support CA generally, refer to the cultivation with minimum or zero tillage and management of crop residues. Minimum tillage is aimed at reducing tillage to the minimum necessary that would facilitate favorable seedbed condition for satisfactory establishment of crop.

### Success story of conservation agriculture:-

1. **Diversified Cropping Systems:** The introduction of conservation agriculture led to a shift from the traditional rice-wheat cropping pattern to diversified cropping systems that include pulses, oilseeds, vegetables, and fruits. This diversification enhances soil health and reduces the risk of pest and disease outbreaks.
2. **No-Till Farming:** No-till or reduced tillage practices were promoted to minimize soil disturbance and maintain soil cover. This helps in reducing erosion, improving water retention, and enhancing overall soil structure.
3. **Residue Management:** Farmers were encouraged to retain crop residues on the field after harvest. These residues act as natural mulch, protecting the soil from erosion, conserving moisture, and promoting soil microbial activity.
4. **Water Management:** Conservation agriculture practices promote efficient water use through improved soil structure and reduced evaporation. This is particularly significant in a region facing water scarcity challenges.
5. **Yield Increases:** Over time, farmers who adopted conservation agriculture reported significant increases in crop yields. This was attributed to improved soil health, better water management, and diversified cropping systems.
6. **Cost Reduction:** By reducing the need for plowing and decreasing chemical inputs, farmers practicing conservation agriculture have been able to reduce their production costs.
7. **Environmental Benefits:** The adoption of conservation agriculture practices has led to reduced chemical runoff and pesticide use, contributing to a healthier environment.

The success of conservation agriculture in Punjab has sparked interest in other parts of India facing similar challenges. Farmer field schools, extension services, and collaborations between agricultural universities, NGOs, and government agencies have played a crucial role in disseminating knowledge and encouraging adoption.

It's important to acknowledge that the transition to conservation agriculture may face challenges related to farmer knowledge, equipment availability, and initial costs. However, the case of Punjab demonstrates that with proper training, support, and long-term commitment, conservation agriculture can lead to sustainable farming systems that benefit both farmers and the environment.

### Conclusion

The impending global population increase presents a critical challenge for agriculture, particularly in regions like South Asia. Conservation Agriculture (CA) emerges as a sustainable solution, with its core principles of minimum soil disturbance, permanent organic soil cover, and crop diversification. CA addresses the detrimental impacts of conventional practices, fostering improved soil health, water management, and climate resilience. The success story in Punjab

exemplifies how CA can enhance yields, reduce costs, and promote environmental well-being. While challenges persist, the transformative potential of CA, supported by education and collaboration, offers a promising path forward for ensuring food security and ecological sustainability in the face of evolving global dynamics.

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**Table. 1 Difference between conservation agriculture and conventional agriculture**

| Sr No. | Conservation Agriculture                                                        | Conventional Agriculture                                                                                                            |
|--------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1      | No compaction in the field because Controlled traffic in CA                     | Poor root growth and poor yields and lower earnings due to free-wheeling of farm machinery, increased soil compaction in crop area. |
| 2      | Crop diversification and more effective crop rotation                           | Mono cropping/culture, less efficient rotations                                                                                     |
| 3      | Infiltration rate of water is high because less compaction of field found in CA | Runoff and soil erosion are most common due to low water infiltration and inefficient use of fertilizers leading to pollution.      |
| 4      | Permanently soil covered with surface retention of residues                     | Bare soil surface due to residue burning or removal                                                                                 |
| 5      | Minimum tillage or zero tillage reduce the tillage operation in field           | Heavy soil erosion due to intense mechanical tillage operations                                                                     |
| 6      | Conserve the natural resource with minimum soil disturbance                     | Degrade the natural resource by cultivating land, using science and technology                                                      |

**Table 2. Machinery used for retaining the crop residue on soil surface along with their advantages and limitations.**

| <b>Machinery</b>              | <b>Description</b>                                                                                                                                                | <b>Advantage</b>                                                                                                                                                                                                     | <b>Limitations</b>                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Zero-till Drill               | It is a passive type seeding machine with/without a fertilizer drilling mechanism. It is usually fitted with inverted T-type furrow openers.                      | Used for seeding the crops in an untilled field with/without anchored residue.                                                                                                                                       | Clogging of furrow openers with loose residue<br><ul style="list-style-type: none"> <li>• Poor traction of seed metering drive wheel due to the presence of loose straw</li> <li>• Non-uniform depth of seed placement due to frequent lifting of the implement under heavy residue conditions</li> <li>• Higher infestation of dicots weeds</li> </ul> |
| Mulcher                       | It is an active type residue chopping machine, which cuts the residue into small pieces.                                                                          | After mulching operation, chopped stubbles can be incorporated into soil using rotavator or disc harrow followed by crop sowing with zero-till drill.                                                                | Requires additional field operation                                                                                                                                                                                                                                                                                                                     |
| Straw management system (SMS) | It is an optional attachment, which can be integrated with a combine harvester. It chops the crop straw into small pieces and distributes it on the soil surface. | In SMS operated field, chopped residue can either be retained on the surface or mixed with soil easily.<br>Chopping crop straw into small pieces reduces the clogging of blades/furrow openers of seeder or planter. | Not suitable for small land holding.<br>Increased fuel consumption of about 2.5–3 l h <sup>-1</sup> during combine operation                                                                                                                                                                                                                            |
| Happy Seeder                  | It is an active type seeding machine having flails at the front and seeding attachment at rear.                                                                   | It can be used for seeding the crops in untilled field with anchored and loose residue.                                                                                                                              | Does not work efficiently under moist residue condition<br><ul style="list-style-type: none"> <li>• Low operation window of the machine</li> <li>• Low field capacity compared with conventional seed drills</li> </ul>                                                                                                                                 |
| Rotary Disc Drill             | It is an active type seeding machine having Soil Razor discs at the front and seeding attachment at rear.                                                         | It can be used for seeding the crops in untilled field with anchored and loose residue in rice-wheat and sugarcane-wheat cropping systems.<br>Works on wet residue                                                   | Seed covering issue under dry soil condition                                                                                                                                                                                                                                                                                                            |

(Kumar *et al.*, 2023)

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# Applications of Nano-Agrochemicals in Agriculture

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Agricultural sector is facing enormous challenge of increasing crop productivity and efficiency to meet the ever-increasing demand for the rapidly growing world population under limited arable land. Traditional agricultural practices alone are often unable to meet these demands, leading to the exploration of innovative technologies to enhance agricultural productivity. One such technology that holds great promise is the application of nano-agrochemicals, which have shown tremendous potential in improving the physiological efficiency of agricultural crops. Nano-agrochemicals are a recent development in the field of nanotechnology that involves the synthesis and application of nanoscale materials in agriculture. Their small size (1 to 100 nm) allows for increased surface area and enhanced reactivity, leading to improved solubility, stability, and bioavailability (Das et al., 2023).

Nano-agrochemicals offer several mechanisms by which they can improve the physiological efficiency of crops. Enhancing physiological efficiency is essential to optimize resource utilization, minimize wastage, and reduce the environmental impact of agricultural practices. Nano-agrochemicals can enhance nutrient uptake and utilization by crops. Nanoscale formulations of fertilizers and micronutrients can be engineered to improve their solubility and dispersibility, making them more readily available to plants. Additionally, nano-sized carriers can protect nutrients from leaching and volatilization, ensuring their efficient delivery to plant roots. Furthermore, nanoscale

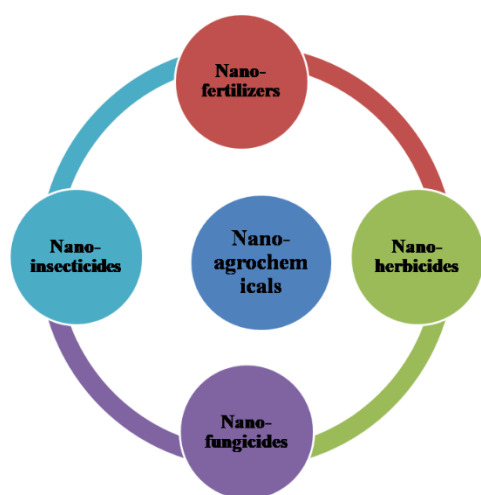
materials can be functionalized to release nutrients gradually, providing a sustained nutrient supply to plants over an extended period. Nano-agrochemicals can enhance crop protection against pests and diseases. Nanoscale formulations of pesticides and fungicides can be designed to have increased efficacy, as their small size allows for better penetration into plant tissues and improved targeting of pests and pathogens. Moreover, nano-agrochemicals can be functionalized with specific molecules to provide controlled release of active ingredients, ensuring prolonged protection and reducing the frequency of applications (Singh and Kalia 2019). Likewise, nano-agrochemicals can enhance crop tolerance to environmental stresses, such as salinity, heat, and heavy metals.

The use of nano-agrochemicals holds great potential in improving the physiological efficiency of agricultural crops and offer innovative solutions to address the challenges faced by modern agriculture. However, it is crucial to ensure on their safety, environmental impact, and long-term effects before their widespread adoption. Continued exploration and development of nano-agrochemicals can pave the way for a more sustainable and productive agricultural future.

## Type of nano-agrochemicals:

**Nano-fertilizers:** It has been getting much attention in field of agriculture over the conventional chemical fertilizers due to its potential to increase yield, improve soil fertility, maintain sustainability of the environments and make a favorable surroundings for soil's beneficial microorganisms. IFFCO Nano

Urea is a nano-fertilizer which provides the nitrogen to the plant. It is nanotechnology based innovative agri-input (fertilizer) which particle size about 20-50 nm. Hence, Nano urea increases the availability of nitrogen to crop by more than 80% resulting in higher nutrient use efficiency, minimizing the environmental pollution and fight with climate change, Through the reducing the loss of nutrients from the field of agriculture in the form of leaching and gaseous emission.



**Fig.1: Diagrammatic representation of type of nano-agrochemicals**

**Nano-herbicides:** In agriculture field nanotechnology has emerged as useful technology to weed control. There have been reported several nano-herbicide for weed control in recent time. It can be premeditated from organic, inorganic, or hybrid materials. These nano-herbicides have distinctive properties such as small size, specific surface area, and the ability to control the release of metal ions and organic molecules in the agricultural science of weeds. Nano-herbicide has better ability to adhesion, spread and longer contact time on the leaves and control release of the herbicide. Several studies have reported the ability of nano-herbicides to provide greater efficiency, environmental

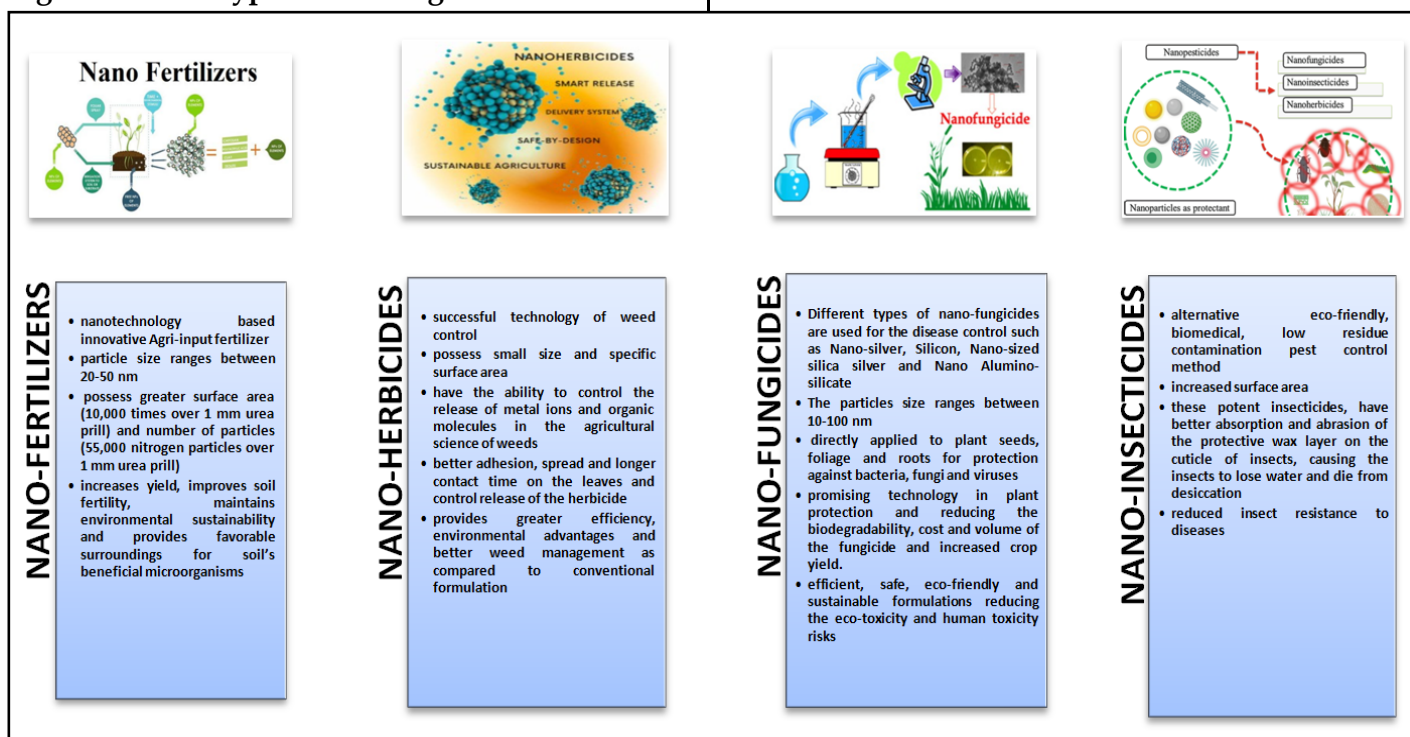
advantages and better weed management compared to conventional formulation.

**Nano-fungicides:** At present time, due to the use of conventional chemicals for the control of disease have shown that a negative impact on environment. So the interest in efficient, safe, eco-friendly and sustainable agriculture fungicide formulations has been developed to reduce the eco-toxicity and human toxicity risks(Jeya et al., 2022). There are different type of nanotechnology based nano-fungicide are used for the disease control such as Nano-silver, Silicon, Nano-sized silica silver and Nano Alumino-silicate. The particles size of the Nano-fungicide are the range between 10-100 nm, and it can be directly applied to plant seeds, foliage and roots for protection against bacteria, fungi and viruses (Jeya et al., 2022). Recently, silver nanoparticles have found potential to control disease and increased in popularity, due to "green synthesis" production in plants, bacteria, fungi and yeast. Silver nanoparticles have shown antifungal inhibition by well diffusion assay. So, it is a promising technology in plant protection and reducing the biodegradability, cost and volume of the fungicide and increased crop yield.

**Nano-insecticides:** Excessive uses of conventional insecticides are the source of contamination and have negative impacts on human health and other species. Thus, it is required to develop alternative pest control methods for a sustainable ecosystem. The Nano-insecticides are the best alternative of the conventional insecticide because it have eco-friendly, biomedical properties, low residue contamination. Potent antimicrobial activities of ZnO NPs synthesized by different methods were due to their increased surface area. As potent insecticides, ZnO NPs can be attributed to the absorption and abrasion of the protective wax layer

on the cuticle of insects, causing the insects to lose water and die from desiccation.

**Fig.2: Different types of nano-agrochemicals**



### Potential of NPs against environmental stresses

#### Abiotic stress

Recent research has shown the promising potential of nanotechnology to improve the agriculture sector by increasing the efficiency of agricultural inputs and offering solutions to agricultural and environment problems for improving food productivity and security. Abiotic stress is the primary cause of crop loss worldwide and reduces the average yield of most major crop plants by > 50%. Abiotic stress leads to morphological, physiological, biochemical, and molecular changes in plants that adversely affect their growth, development, and productivity (Zhao et al., 2020).

It is known that ROS (Reactive oxygen species) are formed by the plants at high levels due to abiotic stress within different organelles and leading to cellular damage. Over-accumulated ROS in plants

results in damaged cell membranes, DNA, protein, and other cell components and therefore the inhibition of plant growth. These ROS can be

scavenged by nanoparticles such as CeO<sub>2</sub>, C60, and Fe<sub>2</sub>O<sub>3</sub> NPs. Thus, plant engineered with these NPs showed better performance under stress conditions. For example, Nano-particle CeO<sub>2</sub> at very low concentrations (5 µM) effectively reduces ROS levels and protect chloroplasts and under high salinity the antioxidant activity of polyacrylic-acid-coated CeO<sub>2</sub>NPs (35% Ce<sup>3+</sup>/Ce<sup>4+</sup>, 10 nm, 17 mV, 50 mg/L) with superoxide dismutase and catalase activities maintained the photosynthetic ability of *Arabidopsis*. Enzyme-mimicking fullerol NP was also alleviate the oxidative stress of sugar beet under drought stress, by serving as an additional intercellular water supply.

#### Biotic stress

Biotic stresses prompted by phytopathogens and pests impose tremendous losses in agriculture and are major threats to worldwide food security. Nanotechnology offers promising solutions to

mitigate biotic stress on plants, increasing plant tolerance to the stressor, for the remediation of environmental contaminants, and to protect plants against pathogens (Silva et al., 2022). Several NPs, such as AgNP, CuNP, AlNP, CNP and MgNP etc exhibit antibacterial and pest control functions.

### Silver based Nano particles

The increasing prevalence of fungi and pests to resistance current pesticide made it clear that new methods (Nano-pesticides) of crop protection were required. So Nano silver is the most studied and utilized nano particles for bio-system. Because, of high antibacterial effects, a broad spectrum of antimicrobial activities and more adhesive on bacteria and fungus hence are better fungicide. For example, Ag@dsDNA@GO (DNA-directed silver (Ag) nanoparticles grown on grapheme oxide composites at 16 mg/L significantly decreased the activity of cultured *Xanthomonas perforans*.

### Copper based Nano particles

Cu ions are well known for antibacterial and antifungal activities. In a greenhouse study,  $\text{Cu}_3(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$  nanosheets (10 mg/L) significantly suppressed fungal disease, as measured by yield and a 58% decrease in disease progression. The insecticidal activity of Cu NPs has also been demonstrated. Effects of CuO NPs on Bt-transgenic cotton and conventional cotton have also been investigated. At a dose of 10 mg/L the particles enhanced the expression of exogenous genes encoding Bt toxin in cotton plant tissues, thereby improving resistance.

### Magnesium based Nano particles

A new MgO nano particles have biologically more active and relatively more environmentally safe pesticide. For example, Zhao *et al.*, (2020) showed that MgO NPs at 200 or 250 mg/L effectively

suppressed *R. solanacearum* which induced tobacco bacterial wilt. *Ralstonia solanacearum*, *X. alfalfa*, *Pseudomonas syringae* and *E. coli* etc. disease-causing organism were significantly control by the MgO based nano particles.

### Nano-fertilization to Enhance Nutrient Use Efficiency and Productivity of Crop Plants

Nano-fertilizers (NFs) are nutrient carriers developed by using the substrates with nano dimensions (1–100 nm), which have extensive surface area and can hold abundance of nutrients to be released slowly and steadily. In the case of conventional fertilizers, nutrient use efficiency hardly exceeds 30–35%, 18–20%, and 35–40% for N, P, and K, respectively, and these estimates remain constant for the past several decade, whereas the nano-clay-based fertilizer formulations are capable of releasing N for a much longer period of time (>1000 h) than the conventional fertilizers (<500 h). Nano-fertilizers may contain NPs (nano particle suspensions) of zinc, silica, iron and titanium dioxides, ZnCdSe/ZnS core-shell QDs, InP/ZnS core-shell QDs, Mn/ZnSe QDs, gold nano-rods, core-shell QDs (quantum dots) etc. Since they provide a larger surface area for reaction and a prolonged availability of nutrients to the crop plant, this situation favors quality parameters, such as protein, oil, and sugar contents, by enhancing the rate of reaction or synthesis process in the plant system, as observed in various crops. The use of NFs not only enhances the nutrient use efficiency but also reduces the frequency of fertilizer application and consequently the soil toxicity and other potential negative effects associated with excessive use of chemicals (Kumar et al., 2023). The favorable effects of use of NFs over CFs (conventional fertilizers) in enhancing physiological processes such as improved germination, seed vigor, establishment and



photosynthesis etc. have been reported. For example, Use of zinc (4%) + iron (4%) NFs have resulted in increased rate of germination, seedling vigor and establishment of red bean seedlings. Use of low concentration ( $10 \text{ g ml}^{-1}$ ) of Ag NFs promoted germination in lentil, while 500 ppm of  $\text{TiO}_2$  resulted in enhanced germination in *Cicer arietinum*. Enhanced photosynthesis by enhanced pigment production and stimulated RUBISCO activity was reported in barley. Nano Fe and Zn application enhancing nitrogen metabolism, cell multiplication, photosynthesis, and auxin synthesis have been also reported in chickpea.

### Conclusion

In order to fulfill sustainable development goals, crop production must be elevated and the pollutants and greenhouse gasses emissions associated with farming pastime need to be decreased. We recommend that advances in the utility of nanotechnology have the ability to improve physiological efficiency crops. Regulated and sustained unleash of nutrients assists in raising the nutrient use efficiencies and as well as improve the insect pest control efficiency over the conventional agro-chemicals. Slow or controlled-release and carrier delivery properties of nano-agrochemicals enhance the crop yields, soil health, and lower nutrient loss compared with traditional fertilizers.

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# Wetland Restoration, Conservation and Management Strategies

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Wetland are defined as "Lands transitional between terrestrial and aquatic ecosystem where the water table is usually at or near the surface of the land it's covered by shallow water. Depending on the climate, soil, vegetation, hydrology, chemistry, and human disturbance they vary widely.

Wetlands are frequently called as "nurseries of life". And thus thousands of species of aquatic and terrestrial plants and animals find their habitat in wetlands. Although they also provide important habitat for waterfowl, fish, and mammals, wetlands are best known for being home to water lilies, turtles, frogs, snakes, alligators, and crocodiles. Wetlands are used by migratory birds as both breeding locations and places to stop and eat when traveling across continents. Therefore, the loss of wetlands has a significant effect on these species. Approximately 6% of the world's geographical surface is made up of wetland habitats (Turner, 1991). They are regarded as one of the most endangered of all the significant natural habitats, and it is suggested that their conservation should be given top priority. The main issues affecting wetlands are alien species invasion, unsustainable harvesting of wetlands and associated ecosystem products, overgrazing, water and industrial pollution, excessive pesticide usage draining into nearby streams, and discharge of industrial effluents. Through land reclamation, pollution, and hydrological changes, 30% to 90% of all wetlands worldwide are in danger of being destroyed, severely altered, or both (Abramovitz, 1996; Moser et al., 1996). Invasions of exotic species and extinctions of native or endemic species are both consequences of the consequent losses of habitat variability, biodiversity, and ecosystem services

(Batzer & Sharitz, 2014; Moser et al., 1996; Ramsar, 2013).

Wetlands are essential for ecosystem function, human survival and economic prosperity, as well as the support of life on Earth. Because they provide food, fuel, fodder, and water for home, irrigational, and industrial uses, wetlands are among the most productive life support systems on earth and are of enormous socioeconomic value (Kaul, 2003). If regulated and utilized effectively, they are essential for reducing poverty. Wetlands serve as sinks for, and converters of, a wide range of chemical, biological, and genetic elements. Because of the roles they play in the hydrologic and chemical cycles and as downstream recipients of wastes from both natural and human sources, wetlands are frequently referred to as "the kidneys of the landscapes." They clean polluted waters, prevent floods and recharge ground water aquifers (Anon, 2005).

## Characteristics of wetland

- ✓ Present and predominance of hydraulic soils.
- ✓ Area inundated are unsaturated by surface or ground water for a considerable period.
- ✓ Prevalence of hydrophilic Vegetation

## Values of wetland

- ✓ The biosphere's most prolific ecosystem, wetland ecosystems are the equivalent of tropical evergreen forests and play a big part in the region's ecology's sustainability today.
- ✓ They are a vital component of human civilization and help to meet many important needs for life on earth, including the production of protein, drinking water, energy,

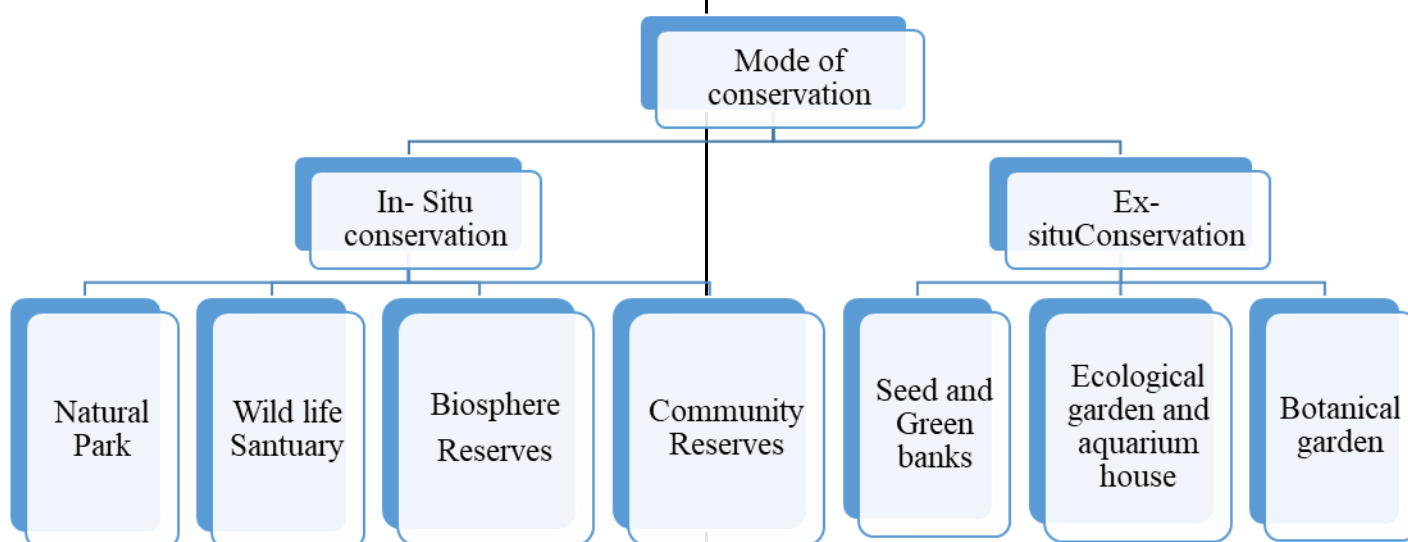
biodiversity, flood control, transportation, recreation, research, and education.

- ✓ Water supply, fisheries, agricultural goods, energy sources, transportation of wildlife resources, recreation, and tourism are just a few of the direct economic advantages that support a wide variety of flora, fauna, and cultural legacy.
- ✓ Wetland ecosystems can not only provide indirect services for humans but also play an indispensable role in controlling the global temperature, managing global hydrological cycles, safeguarding ecosystem diversity, and promoting global wellbeing.

disappeared wetland through ecological technology and ecological engineering.

In order for the primitive wetland to benefit from its own self-recovery activity, it is important to respect the natural characteristics of the wetland ecosystem during the restoration process and avoid interfering too much with it.

Restoration is a process that helps to transform an area that has been impacted by human or natural activity to an area that can sustain native habitats. It takes time and knowledge to restore a region, which is an extensive procedure. Understanding a place's past and how it changed over time will aid in deciding how to repair it. If the



### Restoration

The act or Process of returning something to its god condition or position or to its owner as original form. Restoration is a process that helps to transform an area that has been impacted by human or natural activity to an area that can sustain native habitats.

### Why we need to do Restoration?

Wetland restoration mainly include the restoration or reconstruction of degraded or

ecology can regain its natural dynamics, that is progress. Ecosystems cannot be exactly restored because change occurs naturally. There are different types of wetlands that require different strategies.

Wetland restoration involves taking efforts to restore a former or degraded wetland's physical, chemical, or biological characteristics to return its natural functions.

To carry out this restoration, there are four basic steps:

Step 1: Treatment of invasive species

Step 2: Placement of clean sand and sediment

Step 3: Seeding and planting

Step 4: Maintenance and monitoring

### Principle of the restoration

- ✓ Preserve and protect aquatic resources
- ✓ Restore ecological integrity
- ✓ Restore natural structure
- ✓ Design for self-sustainability
- ✓ Restore native species and avoid non-native species.
- ✓ Monitor and adopt where changes are necessary
- ✓ Involve a multi-disciplinary team
- ✓ Develop clear, achievable and measurable goal
- ✓ Address on going causes of degradation
- ✓ Understand the potential of the watershed.

### Conservation and Management of Wetlands:

The protection, preservation, propagation, and wise population control of rare plant and animal species in their natural habitats are the main goals of conservation, which can be accomplished by intelligent explosion of nature while preserving all of its biological and physical components in their purest forms as well as Particulate.

### Objectives of conservation

- ✓ To study the interrelationship of animals and plants in their natural habitat.
- ✓ For protecting and preserving the rare species of plants and animals from extinction.
- ✓ To preserve the breeding stock of wildlife.
- ✓ To prevent deforestation and water loss.
- ✓ To maintain the balance of nature and their biodiversity.

- ✓ For maintaining the Food Chain and food web of animals.

### Mode of conservation

**The conservation of wetland can be carried out in following five aspects**

### Management and Policy

- ✓ Wetland area limits can be set up to limit the impact on wetland area, in order to control the total area of wetland strictly.
- ✓ Protected area are the most effective way to protect the wetlands e.g. Ramsar Sites.
- ✓ Nature reserves can be set up in the region where national wetland protected or distributed rare and endangered species are concentrated.
- ✓ Wetland Park can be built in the area where wetland with resource need to be both protected and rationally utilized.

### Monitoring

- ✓ Dynamic monitoring system is essential to wetland management and conservation.
- ✓ Remote sensing and field observation can be used to conduct monitoring.

### Restoration

- ✓ The measurement that can be put into place is to scientifically forbid the harvesting of biological processes or resources, and emphasis should be given to the restoration of wetlands with ecological protection objectives like migratory bird habitat and habitat for rare and endangered birds.

### Knowledge

- ✓ The public's understanding of wetland resources and resource distress must be strengthened via education, and wetland protection must be expanded to encompass all of the world's residents.



- ✓ It can be carried out in the following manner:  
Launch wetland Protection celebrated on world wetland day, Birds week, and wildlife protection month etc.

### Funding

- ✓ The prerequisite for the above-mentioned effort to succeed is ensuring the source of funds. The funding source may include public donations, government or nonprofit support, ecological compensation from the influence of wetlands on the local environment, etc.

### Policy interventions required in order to conservation ecosystems – wetlands are:

- Carrying capacity studies of all macrocities
- Boundary demarcation of water bodies
- Bathymetry of water-bodies
- Holistic and Integrated Approaches – Conservation and Management
- Biodiversity Documentation
- Floods mitigation
- Preparation of management plans for individual water bodies
- Implementation of sanitation facilities
- Restoration of lakes
- Riparian and buffer zone vegetation's protection
- Restoration of linkages between water bodies
- Harvesting of rainwater
- Environmental Education

### Management of wetland

Wetland status is not defined by any one administrative jurisdiction. The "Ministry of the Environment and Forest" is in charge of managing these ecosystems on a primary basis.

The management strategies should protect wetlands by controlling inputs, use water quality standards (WQS) to promote normal functioning of wetlands and other inland surface waters from an ecosystem perspective, and still derive economic benefits from sustainable use.

When dealing with such common resources, some of the important factors to be considered for developing a management strategy are described below.

- ✓ This makes it critical to compile a database of information on the different types of wetlands, their morphology, hydrology, and biodiversity, as well as information on land use, hydrogeology, surface water quality, and socioeconomic reliance. Such a database would show the load that these systems are under in the specific situation.
- ✓ Involve institutions, colleges, and regulatory organizations in routinely monitoring the water quality of biological, groundwater, and surface water samples. Such initiatives assist in giving technical assistance and information that improves our understanding of these systems and helps us create all-encompassing restoration, conservation, and management plans.

Development of a water quality database, accessible to all users, for analysing and disseminating information. This can be achieved through:

- ✓ Providing spatial, temporal, and non-spatial water quality database systems;
- ✓ Updating technical guidance and water quality maps at regular intervals and indicating quality determinant parameters;

- ✓ Analyzing and discussing case studies of water quality issues.

Wetland function could be restored by establishing buffer zones to safeguard them and restricting human activity along the wetland's designated corridor. The following factors determine what constitutes an appropriate buffer zone size to safeguard wetlands and other aquatic resources:

- ✓ Identifying the functional values by evaluating resources generated by wetlands in terms of their economic costs
- ✓ Identifying the magnitude and the source of disturbance, adjacent land use, and project the possible impact of such stress in the long term,
- ✓ Identifying catchment characteristics-vegetation density and structural complexity, soil condition and factors.

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## Azolla and its Potential in Organic Agriculture

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Azolla also known as mosquito fern, duckweed fern, fairy moss and water fern is a free floating small aquatic plant. The genus Azolla belongs to the single genus family *Azollaceae* which includes six species of Azolla viz., *A. caroliniana*, *A. nilotica*, *A. filiculoides*, *A. mexicana*, *A. microphylla* and *A. pinnata*. The most common species found in India is *A. pinnata* (Carrapiço *et al.* 2000). Azolla is one of the fastest growing plants on the planet which does not require soil to grow. The uniqueness of Azolla is in its symbiotic relationship with the nitrogen fixing blue green algae, *Anabaena azollae* which has often been considered as the perfect marriage where each partner gives something to this perfect marriage. The delicate fern provides nutrients and a protective leaf cavity for the *Anabaena*, which in turn provides nitrogen for the fern. Azolla is rich in crude protein,

several amino acids, vitamins and minerals. Under suitable field conditions, the fern/alga combination can double in weight every 3 to 5 days and fix atmospheric nitrogen at a rate exceeding that of the legume/*Rhizobium* symbiotic relationship.

Azolla can accumulate up to 2 to 4 kilograms of nitrogen/ha/day which is equivalent to 10 to 20 kg of ammonium sulphate. Azolla has tremendous potential in both crop production and livestock production. Apart from these uses, there is also a potential to utilize Azolla as a phytoremediator and sustainable bioenergy source. Some of the major benefits of Azolla are listed below:

- i. Azolla is one of the promising biofertilizers for a variety of crops particularly rice due to its similar growth habit. Its application improves soil fertility by increasing total nitrogen, organic carbon, available phosphorus as well as many essential elements in the soil.
- ii. Azolla contains many essential amino acids, vitamins (vitamin A, vitamin B<sub>12</sub>, and beta-carotene), growth promoter intermediaries, and minerals like calcium, phosphorous, potassium, ferrous, copper, and magnesium. Therefore, it is also a very good feed for a variety of animals, including pigs, rabbits, chickens, ducks, and fish.
- iii. It suppresses the growth of aquatic weeds by blocking sunlight and by providing a physical resistance to weed seedling emergence through a heavy interlocking azolla mat.

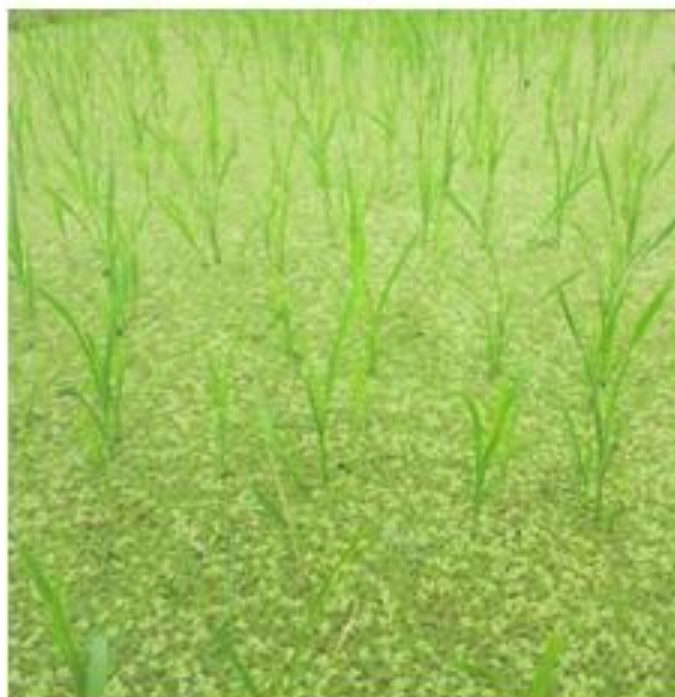


Fig: Dual culture of rice with azolla

- iv. It can also be used in the control of mosquitoes, for a thick Azolla mat on the water surface can prevent breeding and adult emergence.
- v. It plays an important role towards ecosystem management including bioremediation of toxic trace metals and organic pollutants. It can act as a bio filter to remove pollutants. Azolla live biomass acts as potential bio accumulator for toxic pollutants, while the dead biomass regulates pollutant concentration through bio sorption.
- vi. Its application can minimize greenhouse gas (GHG) emission from agriculture as well as mitigate atmospheric GHGs.

### Utilization of Azolla in crop production

Azolla forms the most potential farm grown input in rice cultivation because of the similar growing condition. Azolla can be applied in rice field through two methods, *viz.* as a green manure crop or as a dual crop. Azolla grown along with rice do not decrease/affect the yield of rice. The nitrogen accumulated in the Azolla biomass is made available to rice crop after decomposition. It also adds to the organic matter content of the soil narrowing the C:N ratio. According to Susan and Kaleeswari (2015), the integrated use of 150:50:50 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O + 25 kg ZnSO<sub>4</sub> ha<sup>-1</sup> through inorganic sources + *Sesbania aculeata* @ 6.25 t ha<sup>-1</sup> + Azolla @ 500 kg ha<sup>-1</sup> recorded the highest grain and straw yield of wet land rice and the highest uptake of N, P and K by grain and straw. The higher grain yield under integrated nutrient management treatments could be attributed to the combined effect of nutrient supply synergism and improvement in physical and biological properties of soil. Overall, using Azolla as a surface cover in combination with urea can be an alternative

management practice worth considering as a means to reduce NH<sub>3</sub> volatilization and improve N use efficiency as well as rice yields (de Macale and Vlek 2004).

Field experiments were conducted at Indian Agricultural Research Institute, New Delhi during 2003-2009 to find out suitable organic amendments for sustainable productivity of Basmati rice-wheat-green gram cropping system (Singh *et al.*, 2011). Different treatment combinations comprising of organic amendments such as Azolla @1.0 ton ha<sup>-1</sup>, Blue Green Algae @ 2.0 kg ha<sup>-1</sup>, vermicompost and farm yard manure @ 5.0 ton ha<sup>-1</sup> applied alone or in combination were tested. Results revealed significant enhancement in grain yield of rice over absolute control due to the application of organic amendments like Azolla applied alone or in combination. Optimum yield of Basmati rice (cv. Pusa Basmati 1) can be obtained in all the years with the application of four amendments (Azolla, BGA, vermicompost and FYM) together. Besides, enhancing and sustaining the productivity of organic rice-wheat system, higher productivity of vegetables like cauliflower, broccoli, cabbage and carrot grown after organic rice under organic nutrition were recorded (Singh *et al.*, 2012).

Azolla grown as a monocrop between the wheat and rice crops or applied as an intercrop with rice has a significant beneficial effect on subsequent wheat crops in rice-wheat cropping system. In the case of bananas, Azolla is applied as mulch on the soil surface around the bases of the plants. When there is an overproduction of Azolla, it can be mixed with rice straw to form compost. Incorporation of 6–24 t ha<sup>-1</sup> of fresh Azolla into the soil significantly increased its water-holding capacity, organic carbon, ammonium-N, nitrate-N, and its available phosphorus, potassium, calcium, and magnesium,



while it decreased pH and bulk density. Azolla used as a green manure significantly raised the yield of mungbean (Nuraisyah 2002).

### Conclusion

The application of Azolla as a biofertilizer on agricultural crops, reducing or replacing chemical fertilizers, can play a significant role in maintaining or improving ecological balance. Utilization of Azolla in agriculture also improves social economic status by reducing the agricultural input cost, generating employment opportunities for small-scale industry involved in its propagation. Thus, it can be concluded that Azolla has tremendous potential for replacing chemical fertilizers in organic as well as natural farming.

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# Palmyra Palm (*Borassus flabellifer*)

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*Borassus flabellifer* commonly known as Palmyra palm got its name from Greek roots namely 'Borassus' and 'flabellifer' which mean fruit with a leather covering and fan-bearer. Southeast Asia and the Indian subcontinent are believed to be the origins of *Borassus flabellifer*. It is also regarded as nature's eternal gift because it can thrive in dry and semi-dry environments and can resist any unfavourable environmental circumstances. In India, this plant is known by numerous unusual names, including Neera or padhaneer in Tamil, Tal- Talgachh, and Tarkajhar in Hindi and Bengali. It is referred to as Lulu or Tadi in Telugu. In Malayalam, it is also known as Karimpana'. It is also known as Tala palm, Toddy palm, Fan palm, and Brab tree in English. In Malayalam, it is also known as "Karimpana." The terms "fan palm," "brab tree," "toddy palm," and "tala palm" are also used in English. It is a perennial plant that can grow to a height of 30 metres, has a lifespan of up to 100 years, and begins to bear fruit after 15 years in areas with abundant water sources and after 25 years in arid locations (Veilmuthu, 2020). Despite this, Palmyra trees are being cut down at a level that is unprecedented. The Palmyra trees in these land parcels are also sacrificed when they are swapped for rich farmland or sand dunes by land sharks and real estate agents. The tragic cutting down of Palmyra trees for brick kiln fuel is something we are currently witnessing. We need to focus on one of nature's gifts to us, the palm tree, as we struggle with global warming and the depletion of groundwater resources.

## Origin and geographic scope

A 100-year-old multipurpose tree with favorable ecological and socioeconomic effects is the

Palmyra palm. Typically, palm trees thrive in tropical and subtropical climates, which can be found up to 45° on either side of the equator. This belt spans three continents and 13 African, 10 Asian, and 5 South American nations. It is widely cultivated throughout Asia, particularly in South and Southeast Asia, India, Java, Indonesia, Laos, China, Sri Lanka, and the Philippines. Despite its wide spread, there are no trustworthy current statistics on its area and production from many of these nations. Aman *et al.* (2018) report that there are 10 million palm trees on 25000 ha of land in Sri Lanka, 2.5 million on 25000 ha of land in central Burma, and 1.8 million in central Cambodia. Indonesia has 0.5 million toddy palm trees on 15000 hectares of land. The Palmyra palm (*Borassus flabellifer* Lin) is a traditional source of both culinary and non-edible goods in India. There are 8.59 crore palmyra trees in India, of which 5.19 crore are in Tamil Nadu, according to a census that was conducted in that country. Palm trees grow on non-agricultural grounds, along the sides of streams, rivers, and canals, as well as on sandy, undulating terrain that is typically unsuitable for farming. Due to its widespread dispersion throughout the state and its support to rural living, palmyra was recognised and commemorated in 1978 as Tamil Nadu's state tree. It may flourish in a variety of challenging agroclimatic conditions. It has a maximum lifespan of 100 years and a growth potential of 30 metres (Mariselvam *et al.*, 2021).

According to Jana & Jana (2017), the distribution of *Borassus flabellifer* extends from India to South-East Asia to New Guinea, with concentrations in Burma (Myanmar), India, and Cambodia. Its dispersion most likely followed

ancient Indian trade lines. In Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Bihar, Karnataka, and Maharashtra, palmyra palms adorn the barren landscape. Tamil Nadu is home to half of India's 102 million palm trees (Aman *et al.*, 2018).

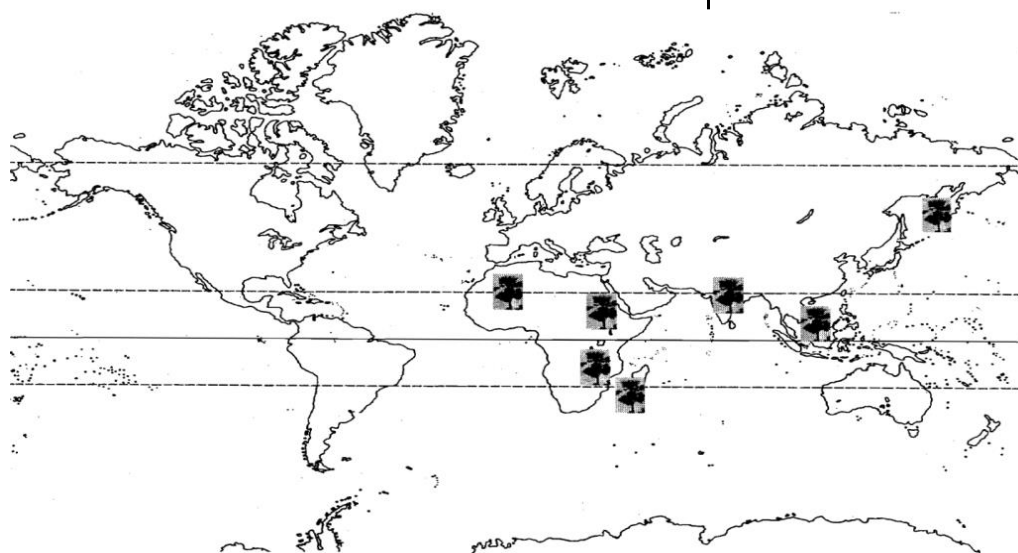


Fig 1. Distribution of *Borassus sp.* in the world

#### Area under Palmyra palm in Tamil Nadu

Smallholders are the principal producers of palmyra palm, which is mostly farmed for sustenance. Production overage could be sold on regional markets. More than half of Tamil Nadu's 51.9 million palm trees are located in the southern districts of Thoothukudi, Tirunelveli, Virudhunagar, and Ramnad, with Ramnad alone accounting for a significant 10 million palms. The palms offer the impoverished in rural areas an opportunity to increase work opportunities as well as a source of income (Aman *et al.*, 2018; Suju and Subu *et al.*, 2020).

#### Cultivation of palmyra:

##### Varieties: SVPR-1:

**Soil:** It is best to use loamy, deep sandy, and dry soils. It's also ideal to remain in dry locations with little rain.

**Propagation:** Germination of 63.25 % are achieved six weeks after sowing.

**Seed sowing:** A high yielder of fruits and nuts, a dwarf, an early and consistent bearer, and free of pests and diseases are all desirable traits for seed nuts. In the stylar region, choose yellow tinch and full fruit brunches. For three weeks, seeds are stored

in the shade. Seeds that are shrivelled, weightless, or bored are rejected. To grow seedlings, seeds can be sown directly in the ground or in nurseries. In trenches (20 cm<sup>3</sup>) that are half filled with a sand and soil mixture and spaced 10 metres apart, 3 to 4 complete fruits are planted for direct planting. Dried

leaves cover the pit. The season of rain is a good time to start sowing. Germination takes place within 3 weeks.

**Nursery transplanting:** Seeds can be planted in a nursery bed made of bricks that is 2 m wide and 60 cm high, or in a mound made by retaining sand to make a bed that is 1 m wide and 60 cm high. In a 10 cm square, seeds are sowed, then covered in sand. A seedling that is around a year old is removed from the nursery and placed in polythene bags. Transplant on the main field after rooted.

**Spacing:** 3m x 3m (1110 palms/ha).

**Manuring:** Sheep penning to the palms is a common practise among farmers. Before planting, apply 10 kg FYM per pit. The dosage can be raised every two years until it reaches 60 kg FYM/tree/year.

**After cultivation:** include basin rectification, inter-plowing, and gap filling within the first few years. Containerized seedlings can be used for gap filling. Before it rains, the basin must be rectified; this

promotes the collection and storage of rainwater (Jana et al., 2017).

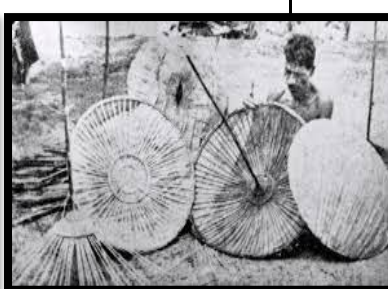
**Pruning:** 30% of the leaves will be removed at a 10% rate in stages.

**Intercropping:** Cowpea, moringa, green gram, Bengal gram, ber, amla, pomegranate, west Indian cherry and guava can be intercropped.

**Growth and yield:** Palmyra is a slow-growing plant. In approximately five months, the first frond appears. Only in the second year may the first fan-shaped tree leaves appear. It begins to flower (13–15 years later) when it reaches a height of 12–18 m for the production of padaneer (sweet sap). For a period of four months, from February to May, an average of 100–200 litres are produced. Individual palms vary greatly in padaneer and fruit yield, according to Jana et al. (2017).

a river, a canal, or some farmland; it serves as a windbreak and raises the level of the ground water. Over 801 uses of this tree have been explored by Palmyra and ancient India. This tree, according to Mahatma Gandhi, is the cure for poverty. Both food and non-edible uses are possible for palmyra products. The stem, leaves, and inflorescence of trees can all be utilised to produce various commercial products. Stem/trunk – It is planted in India to act as a windbreak on the plains. The thick, robust, and durable black lumber from palm trees is highly prized for building, particularly for outdoor structures like fences and boats. Dried, pierced trunk used to construct boats. Dried and holed trunk used to make boats that can transport at least 3 people when fishing. According to Sangarlingam et al. (1999), its leaves can be used to make mats, baskets,

fans, hats, umbrellas, and writing materials. The



construction of 80–90% of rural homes uses these leaves. It provides good fertiliser.

### Traditional uses of palmyra palm

Palmyra is a versatile tree with numerous economic uses that is commonly grown in Tamil Nadu. According to Jana and Jana (2017), it is referred to as a "Karpaha veruksha" in Tamil culture. The tree was planted by one of our ancestors close to

Hindu culture contains a large number of traditional texts that were written on palm leaves. Products made from fibre are commercially useful. It is made from the leaf blade and the petiole. Ropes made of strong, long fibres are used in the construction of homes and watercraft. This type of fibre, which is a



major export from several regions of India, is utilised as a raw material for the manufacture of brushes. The juice is regarded as the main provider of the main source of income among its various components. Neera is the name for the sap that is extracted from the palmyra palm's inflorescence. It is a good source of vitamins, minerals, and calcium (Veilmuthu, 2020).

As long as palm-based work is done, a palm tree has one life. If work on the palmyra is scheduled to cease, the palm tree's condition will be in danger. Therefore, it is important to safeguard both the palmyra and the rural areas' Palmyra business. In contrast to other trees, the palm tree's entire body serves mankind. All of the plant's components—leaves, fruits, stem, petiole, and inflorescence—have uses. In the palm tree, nothing is wasted. Therefore, it was known as the "Karpaga Virutcham" by our ancestors. The palm tree has historical economic, religious, medical, and environmental significance in Tamil Nadu. However, the globalisation phenomenon poses a serious threat to Palmyra and its business today. The economic, medical, environmental, and religious relevance of palm trees has since diminished. For Tamilnadu and the Tamil community alone, this is a big loss. However, because people in Tamil Nadu were unaware of the value of palm trees, they were quickly cut down. Since the government of Tamil Nadu was aware of the palm tree's historical significance in Tamil society, it designated it as the state tree in 1978. However, the Tamil Nadu government is currently likewise shown no interest in enhancing the palmyra palm and its sector. In this stage, we looked at the palm tree as a tree with religious significance,

cultural significance, and environmental significance in order to promote or revive its historic significance for the improvement of Tamil society.

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## Uterine Torsion in Bovines

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Uterine torsion, is rotation of the pregnant uterus on its longitudinal axis. Uterine torsion cases in buffaloes and cattle are 67–83% and 4–28% of the dystocia respectively. Bovines are at a higher risk of uterine torsion around the start of parturition process. Uterine torsion typically happens before or late in the cervical dilatation (first) stage of parturition. Duration and degree of torsion is taken into account while deciding about the survival unborn calf and prognosis of dam as well as the future reproductive health of dam. Prognosis is best when duration of torsion is less than 36 hrs and worsens with the further elapse of time.

### Factors responsible for torsion

A number of maternal and the fetal destabilizing factors exist for explaining the predisposition of bovine uterus to torsion;

#### Maternal destabilizing factors

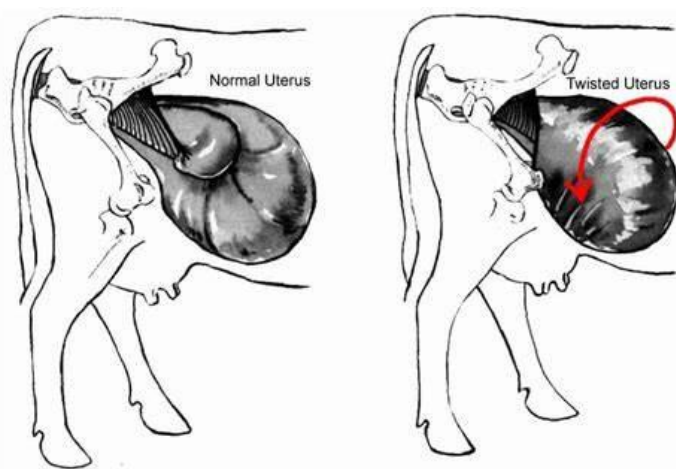
Attachment of the broad ligaments- In mares, torsion of uterus is less frequent because the attachment of broad ligaments is sub-lumbar and the ovaries are fixed in the lumbar region, thus the mobility of uterine horns is minimized. However, bovine uterus is conducive to torsion due to the facts that: (a) bovines have sub-ilial attachment of broad ligaments, (b) broad ligaments are attached along the lesser (ventral) curvature of uterus, thus leaving the greater (dorsal) curvature free, (c) uterine horns are not fixed by the broad ligaments but are lying free, and (d) as the pregnancy advances in bovines, there is a relatively small increase in the length of the broad ligaments but the pregnant horn extends

massively beyond the area of attachment. Higher incidence of uterine torsion in buffaloes than cattle is partly due to the big length of broad ligaments in buffaloes which makes the pregnant uterus less stable. Location of the pregnant uterine horn: For stability, the pregnant uterine horn is usually located inside bursa supraomentalis. However, in uterine torsion, pregnant horn is usually present outside bursa supraomentalis. Unfilled rumen: Presence of rumen on left side increases the incidence of right side uterine torsion. If rumen is unfilled, space in the abdominal cavity is increased and the relatively unstable pregnant uterus gets predisposed to torsion. Type of housing: Confinement of animals in stables for long periods may lead to weakness of the abdominal muscles due to lack of exercise and thus may support the occurrence of uterine torsion. Stall fed pregnant cattle housed in a group is at the risk of torsion of uterus due to the chance of being bumped on its side by the accompanying cattle. Age of the dam: torsion occurs frequently in pluriparous then the primiparous cattle and buffaloes. The proposed reasons include larger abdominal cavity, stretching of pelvic ligaments, loose and long broad ligaments together with loosening of uterine tissue and decreased uterine tone in old aged bovines. Plasma hormonal profiles: high progesterone and low estradiol during pre-partum period may make the uterus flaccid, and hence increases risk of its torsion.

#### Fetal destabilizing factors

Calf birth weight - oversized fetal limbs may get entangled in the uterine wall and the continued

vigorous movements of fetus may lead to rotation of uterus. Fetal presentation- calves from uterine torsion-affected bovines usually deliver in anterior presentation with majority in dorso-iliac (17%) or dorso-pubic (43%) position. Reduced amount of the amniotic fluid: This leads to decrease in distance between the fetus and the uterine wall. Hence, the fetus feels abrupt movements of dam as a painful stimulus and in response, performs strong reflexive movements which may cause the rotation of uterus. Uterine tone: About 90% uterine torsions are encountered during the late first stage of parturition process at this stage, uterine muscles are not in much tone, thus relaxed and unstable uterus may be a cause for the occurrence of uterine torsion. In fact, uterine instability may induce torsion only up to  $180^\circ$ , whereas torsions of  $\geq 360^\circ$  require active fetal movements (Fig 1).



**Fig 1: Uterine torsion; rotation of the gravid uterus on its longitudinal axis**

### **Patho-Physiopathological alterations following uterine torsion**

Rotation of uterus compresses middle uterine vein which results in disturbances in venous circulation and increases carbon dioxide tension in the fetal blood. Consequently, uncomfortable fetus makes vigorous movements that may further increase the degree of uterine torsion. With the

increase in degree of torsion, there is compression of middle uterine artery and oxygen going to the fetus is decreased. Limited arterial perfusion and venous outflow in the twisted uterus leads to ischemia, hypoxia and cell death causing irreversible damage to the endometrium, myometrium and ultimately death of the fetus. Continued failure of blood supply results in loss of uterine wall elasticity and viability, and hence the uterine wall becomes necrosed, brittle, fragile and prone to rupture. Inflammatory changes can cause adhesions of uterus with surrounding abdominal tissues. Ultimately, delay in correction of uterine torsion causes death of the dam due to generalized bacteremia, endotoxemia or cardiovascular failure. Cervical condition of uterine torsion-affected animals is categorized as- Class-A cervix has soft and smooth cervical texture without any lobulations. Histopathology of this type of cervix reveals hemorrhage, congestion, edema, occasional patches of necrosis and intact cervical wall. Class-B cervix is moderately soft and partially lobulated with marked necrosis, fibrosis and tearing of cervical wall. Class-C cervix is described as very hard and completely lobulated. Necrotic changes in cervical epithelium and musculature of class-B and class-C cervix are responsible for their failure to dilate following successful detorsion of uterus. In fact, early correction of torsion may prevent cervical fibrosis.

Uterine-torsion affected buffaloes suffer from normocytic normochromic anaemia due to accumulation of metabolic waste products or relatively large loss of blood during abnormal parturition. The leukogram of these buffaloes reveals lymphocytopaenia, neutrophilia and monocytosis in association with eosinopenia, which continues till day third postpartum in surgically corrected cases of uterine torsion. Following uterine torsion and after

its correction by detorsion or surgical treatment, the activities of AST, ALT, GLDH, CK and GGT are increased, which usually gets stabilized within 10 days after surgical treatment of uterine torsion. Substantial increase in plasma urea and creatinine indicates poor prognosis. In uterine torsion, ureters lying in the broad uterine ligaments are constricted thus the urine output reduces and renal functions may get affected. This hypoproteinemia is associated with liver malfunction and negative nitrogen balance because of reduced protein intake. Occurrence of torsion of uterus is a highly stressful event as revealed by the huge increase in plasma cortisol which increases further by 15–30% following detorsion of uterus through the rolling of dam. Persistently elevated plasma cortisol during post-detorsion period suggesting that continued presence of stress is detrimental for the dam survivability. Presence of low plasma magnesium during post-detorsion period indicates poor prognosis. Hypomagnesaemia leads to decrease in activity of various tissues like heart and skeletal muscle, nerve tissue, brain and spinal fluid and liver, which explains muscle tremor, decreased movement, pain and recumbency following obstetrical interventions.

### Diagnosis

Typical history of a case of uterine torsion will indicate that animal was about to calve, as exhibited by milk letdown and relaxation of pelvic ligaments, but adequate time has passed and still there is neither the rupture of fetal water bags nor the appearance of fetus from vulvar lips. Dam is suffering from tachycardia, tachypnoea, restlessness (frequently gets up and down), and severe abdominal pain, manifested by kicking of the abdomen with her hind legs. If the uterus is not detorted during this period, then the history will indicate that the straining ceased followed by the

tightening of pelvic ligaments and reabsorption of milk, appetite diminishes, rumination ceases and faeces become hard. External signs of uterine torsion like displacement of upper commissure of vulva towards inward, left or right, vulvar edema.

During pre-cervical torsion, the twist of rotated uterus lies on the body of uterus and does not extend beyond the cervix, thus folds on vaginal wall are absent and cervix is approachable during vaginal examination. Side of torsion needs confirmation by rectal examination. In normal pregnant animal, the broad ligaments can be palpated on the sides of uterus, whereas in torsion the broad ligaments are crossed and twisted around uterus. Accurate determination of the direction of torsion through rectal examination is necessary prior to making attempts at correction. The direction of post- or pre-cervical torsion is clockwise (right) or counter-clockwise (left). The broad ligament ipsilateral to the side of torsion is pulled vertically downward beneath the uterus, whereas the contralateral broad ligament is tightly stretched diagonally above the uterus, thus the examiner's hand will move in a pouch formed at either right or left side of uterus. In delayed cases, if adhesions are present, the examiner will not be able to move his hand on the either side of uterus during rectal examination. Degree of uterine torsion is determined by the number of twists present on the body of uterus.

### Treatment

The technique to be selected for detorsion of uterus in bovines varies with expertise of veterinarian, stage of pregnancy, severity of torsion as well as condition of dam, uterus and fetus. The most commonly used techniques are per-vaginal rotation of fetus, rolling of dam and caesarean section.



Sympathomimetic compounds like clenbuterol selectively block smooth muscle contraction, can induce uterine relaxation (tocolytic) and helps in better assessment of the direction of torsion, easier passage of hand through the vaginal folds, easier rotation of fetus through the vagina and easy detorsion of the uterus.

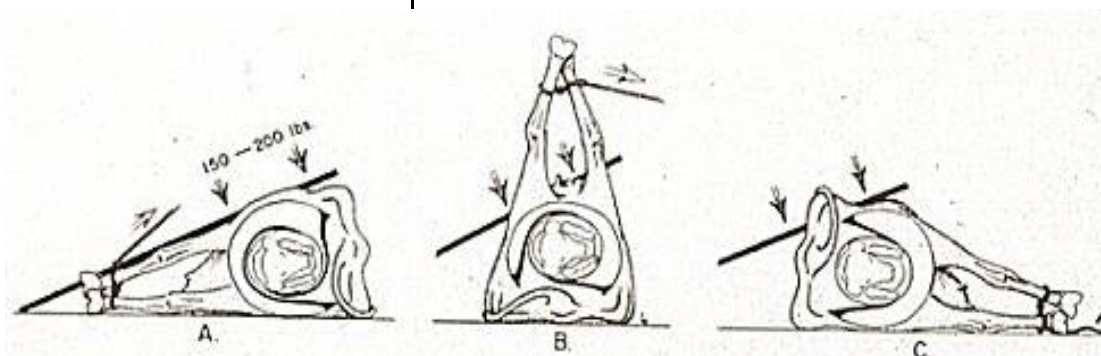
### Per-vaginal rotation of the fetus

With rotations of  $\leq 90^\circ$ , the fetus is easily rocked manually into a normal dorso-sacral position. Success rate is high if dam is standing, cervix is sufficiently dilated to grasp the fetus and the fetus is live.

### Rolling of the dam

Rolling is indicated if the dam is recumbent, the fetus is not approachable due to the severity of torsion, or if the torsion has occurred before the expected time of parturition. However, success rate is 84–90% using Schaffer's method of rolling in which a plank (12 feet long and 10 inches wide) is placed on the upper paralumbar fossa at the time of rolling. In Schaffer's method, theory is to rotate the dam to the same degree and direction to which the uterus has rotated, keeping the fetus fixed by fixing uterus with a plank. Animal is casted carefully in lateral recumbency on the side of direction of torsion and the front and hind legs are secured separately. The plank is placed on the upper paralumbar fossa of dam in an inclined manner with lower end on ground. Next step is to slowly roll over the dam on to its back. At the same time, an assistant stands on the plank to modulate pressure. After each

roll, effectiveness of roll is judged by vaginal or rectal examination. If the roll is successful, disappearance of the vaginal spirals or rectal pouch can be immediately palpated by the examiner. If the roll is not successful, then the dam is returned slowly to her original position and the whole procedure needs to be repeated. However, thick skin of Indian buffaloes causes skidding of the plank at the time of rolling. Moreover, pendulous abdomen of Indian buffalo warrants greater pressure for the fixation of pregnant uterus. Therefore, modifications were made in Schaffer's method and the method is termed as Sharma's modified Schaffer's method (Fig 2). Alteration in the dimensions of plank (length: 11.9 feet, width: 9 inch and thickness: 2 inch) to suite the buffaloes, using this method, the detorsion rate in Indian buffaloes was 90% in comparison to 40% success rate achieved by Schaffer's method. In long standing cases of torsion ( $>72$  h), attempts to achieve detorsion of uterus are usually unsuccessful due to development of adhesions between the uterus and the adjoining abdominal organs. Detorsion of the uterus in these cases is not possible even after detachment of adhesions.



**Fig 2: Sharma's modified Schaffer's method: an assistant stands on the plank to modulate pressure first on A) left side (when animal is casted on right side), followed by B) ventral abdomen and C) lastly on right side.**

### Caesarean section

caesarean is usually attempted in which all other methods of detorsion had failed or there is

failure of complete cervical dilatation subsequent to successful detorsion.

Dexamethasone and antioxidants like Vitamin E and Selenium administration during post-partum period of successfully detorted animals decreases stress and thus increases the chances of survival of dam. With the increase in duration of uterine torsion, plasma and blood volume decreases and animal progresses towards dehydration and toxemia, this suggests the requirement of immediate fluid and electrolyte therapy.

### Prognosis

Survival of a torsion affected bovine depends upon the severity of vascular compromise that

makes uterus friable, duration of uterine torsion and correct diagnosis followed by judicious manipulation. Subsequent fertility is negatively correlated with both the degree and duration of torsion. Bovines with uterine elasticity have better prognosis and bovines with bulging tense and inelastic uterus have a greater casualty rate and lower fertility. Uterine rupture usually occurs when torsion is  $>270^\circ$ . This is due to vascular compromise and resulting edematous changes which weakens myometrial fibers. Following uterine rupture, animals can be euthanized or subjected to corrective surgery depending upon the viability of uterus.

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# Blooming Business: Exploring Floriculture Opportunities in Northeast India

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The North East region of India, comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura, is renowned for its rich biodiversity, vibrant culture and breathtaking landscapes. Amidst its natural treasures, the region also holds a significant place in the world of floriculture. The commercial flower industry in North East India has experienced significant growth and recognition in recent years. The Government of India has acknowledged the importance of floriculture as a sunrise industry and has given it 100% export-oriented status. Some of the key factors contributing to the growth of commercial floriculture in this region are:

1. **Climatic Diversity:** The northeastern states have a varied climate, ranging from subtropical to temperate conditions, which allows for the cultivation of a wide variety of flowers that might not thrive in other parts of India.
2. **Rich Biodiversity:** The region is blessed with diverse flora and fauna, providing a natural habitat for many flowering plant species. This natural diversity can be utilized for both domestic and international flower markets.
3. **Unique Floral Varieties:** The northeastern region is home to several unique and exotic flower species that are in demand in the global market. Orchids, anthuriums, lilies, and rhododendrons are among the flowers that can be cultivated for commercial purposes.
4. **Increasing Demand:** With changing consumer preferences and a growing interest

in ornamental plants and flowers, there is an increasing demand for high-quality, exotic, and unique flowers in the domestic and international markets.

5. **Export Potential:** The northeastern states, due to their proximity to countries like Bangladesh, Myanmar, and Southeast Asian nations, have the potential to become flower-exporting hubs.
6. **Government Support:** Various governmental agencies and departments are recognizing the potential of floriculture in the region and providing support through subsidies, training programs, and infrastructure development.
7. **Tourism:** The natural beauty of the region, combined with its exotic flora, can also attract tourists interested in exploring gardens and flower farms.
8. **Employment Opportunities:** Commercial floriculture can generate employment opportunities for the local population, especially in rural areas, contributing to economic development.

## Diversity in Floral Wealth

The North East region of India boasts a diverse range of climatic conditions due to its hilly terrain, varied altitudes, and distinct seasons. This diversity has paved the way for a rich variety of flora to flourish, including many exotic and indigenous flowers. Some of the most prominent commercial flowers cultivated in this region include orchids, anthuriums, lilies, gladiolus, and roses.

1. **Orchids:** The North East is often referred to as the "Orchid Paradise of India." With its unique climatic conditions and rich biodiversity, the region is home to a staggering variety of orchid species. Many of these species are sought after in the global floral trade for their intricate beauty and rarity.
2. **Anthuriums:** These vibrant and heart-shaped flowers are widely cultivated in the Northeast for their striking appearance and long vase life. They thrive in the region's humid and subtropical climate, making them a popular choice among local farmers.
3. **Lilies:** The cool and moist climate of the North East provides an ideal environment for the cultivation of lilies. These elegant flowers come in various colours and sizes, making them a staple in floral arrangements.
4. **Gladiolus:** Known for their tall spikes of vibrant flowers, gladiolus blooms are cultivated in the region for both local consumption and export. Their range of colours and ease of cultivation contribute to their commercial value.
5. **Roses:** While roses are cultivated in various parts of India, the North East's unique climate allows for the production of high-quality roses with distinct characteristics. These roses are in demand for both domestic consumption and export purposes.

### Challenges Faced

While the commercial flower industry in North East India shows immense promise, it also faces several challenges that need to be addressed to ensure its sustained growth and development.

1. **Infrastructure and Transportation:** The North East region's remote geographical location poses challenges in terms of transportation and logistics. The lack of efficient infrastructure and connectivity can lead to delays in getting the flowers to market, affecting their quality and shelf life.
2. **Market Access:** While the demand for North East Indian flowers exists in international markets, accessing these markets and establishing a strong global presence requires overcoming trade barriers, quality standards compliance, and establishing reliable distribution networks.
3. **Research and Development:** To compete in the global floral market, continuous research and development are essential. This includes developing new varieties of flowers, improving cultivation techniques, and ensuring pest and disease management.
4. **Climate Variability:** Climate change and unpredictable weather patterns can affect flower cultivation. Sudden temperature fluctuations, excessive rainfall, or drought can impact the quality and quantity of flower production.
5. **Awareness and Promotion:** Creating awareness about the potential of floriculture and promoting these products in national and international markets is crucial for establishing a market presence.

### Future Prospects

Despite the challenges, the commercial flower industry in North East India holds a promising future. Governments at both the state and central levels are recognizing the potential of this industry and are taking steps to support its growth.



Initiatives such as providing financial assistance, improving infrastructure, and facilitating market linkages are being implemented to bolster the sector. The region's unique floral biodiversity also offers untapped opportunities. Conservation efforts combined with sustainable harvesting practices can lead to the discovery of new species and varieties that could capture the attention of the global floral market. Moreover, technological advancements can play a pivotal role in overcoming challenges related to transportation and market access. E-commerce platforms can provide a direct link between local farmers and international consumers, eliminating the need for intermediaries and streamlining the supply chain.

### Conclusion

Commercial floriculture in Northeast India holds great promise due to its unique climatic conditions, rich biodiversity, and demand for exotic flowers. With proper support, infrastructure, and technical guidance, the region can establish itself as a significant player in the floriculture industry, contributing to the economic development of the northeastern states. The floriculture industry can not only enhance the region's economic growth but also showcase the floral splendour of the North East to the whole world.

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# Grain Discoloration Disease of Rice: An Emerging Threat to The Quality Food Production

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Rice is an important food crop in the world, including in India. Regardless of holding the largest area under rice, in India, the productivity is very low compared to the other rice-growing nations of the world. Among the significant reasons for the lower productivity, biotic stresses due to insect pests and diseases cause substantial yield losses every year. In recent times, rice cultivation is facing an outbreak of several emerging diseases, such as false smut and grain discoloration. Grain discoloration (GD) of paddy, popularly known as glume discoloration/dirty green complex, is an emerging biotic stress of rice in all rice-growing regions of India, threatening rice productivity and its quality. The GD has highly complex etiology in tropical and subtropical countries; it is associated with several fungi and bacterial diseases of rice such as sheath rot (*Sarocladium oryzae*), panicle blast (*Magnaporthe grisea*), brown spot (*Helminthosporium oryzae*), sheath brown spot (*Pseudomonas fuscovaginae*), grain rot (*P. glumae*), bacterial sheath rot (*P. fuscoaginae*, *P. glumae* & *P. syringae* pv. *syringae*), and bacterial brown stripe (*Acidovorax avenae* subsp. *avenae*). However, the complete pathogen profile and their dynamics at different stages of disease development in different paddy-growing ecosystems of India are not understood properly. Therefore, it is very much necessary to characterize the different pathogens and their dynamics during the disease development in selected paddy ecosystems.

This disease is widespread in temperate and tropical areas and more prevalent in areas with low temperature (and humidity) during rice booting and

heading stages. The disease is especially apparent during the rainy season, and the intensity of infection varies from mild to severe. Several pathogenic bacteria have been associated with the cause of this disease in various parts of the world, such as Asia, Africa, Latin America, Europe, and Australia. The bacterial sheath rot of rice caused by *Pseudomonas oryzaicola* was first described in 1955; later, the name changed to *P. syringae* pv. *syringae*. *Pseudomonas fuscovaginae*, which causes sheath brown rot, was first reported. *Burkholderia glumae* (the causal agent of both seedling and grain rot) and *Acidovorax avenae* subsp. *avenae* (A causal agent of the bacterial stripe) have been reported to be associated with this disease. In addition to these bacterial pathogens commonly reported to be involved in sheath rot complex and grain discoloration, bacteria with similar characteristics to *Pseudomonas marginalis*, *Pseudomonas fluorescens*, *Pseudomonas corrugata*, *Pseudomonas auofaciens*, *P. fluorescens* and *P. fluorescens* has been reported pathogenic and was able to induce sheath rot of rice.

In Iran, a few surveys were made in paddy fields of Mazandaran province (the major rice-growing region) to determine the causal agents of this complex disease. In one study, some fungi, including *S. oryzae*, *Cochiobolus miyabeanus*, *A. padwickii*, and *Fusarium* spp., were confirmed to be associated with this disease. The fungi that are reported to be associated with discoloration of grains are *Bipolaris oryzae*, *A. padwickii*, *Pyricularia oryzae*, *F. moniliforme*, *F. graminearum*, *Nigrospora oryzae*, *Epicoccum nigrum*, *Curvularia* spp., *Phoma sorghina*,

*Dichotomophthoropsis nymphacearum* and *Heterosporium echinunulatum* etc. The diversity and population size of phyllosphere prokaryotic will play a significant role in plant defense against pathogens. Although it has been reported in many publications, the key drivers of phyllo microbiome composition and their functions are not completely understood. As per the previous reports, Proteobacteria, Firmicutes, Bacteroides, and Actinobacteria are the predominant phyllo microbiome, which includes the bacterial genera such as *Kineococcus*, *Hymenobacter*, *Acinetobacter*, *Bacillus*, *Citrobacter*, *Curtobacterium*, *Enterobacter*, *Erwinia*, *Frigoribacterium*, *Methylobacterium*, *Pantoea*, *Pseudomonas*, and *Sphingomonas*.

The grain discoloration disease was previously reported in Himachal Pradesh by Sharma and Vaid in 1985. The association of pathogenic fungal microflora causing grain discoloration was reported in India. Ash-gray discoloration (*Alternaria alternata*), light brown discoloration (*S. oryzae*), black, dark purple, dark brown discoloration (*Bipolaris oryzae*), and light pink discoloration (*Fusarium* spp.) have been reported on the stored paddy seeds leading to the abnormal seedling growth and systemic infection leading to the diseases at the later stage of the crop. The association of eight fungal genera (*Curvularia lunata*, *Alternaria*, *Helminthosporium oryzae*, *Drechslera oryzae*, *C. affinis*, *S. oryzae*, *Aspergillus niger*, *Fusarium*, *M. salvinii*) was reported in the discolored grains of paddy collected from rice field during harvesting. The incidence of grain discoloration in all the rice-growing districts of Northeastern Karnataka ranged from 3.17-78.36%. *Pantoea ananatis* was reported to be causing new blight disease of paddy in India. This pathogen has been reported to be associated with grain

discoloration of rice in China, leaf blight and bulb decay of onion in the United States, and leaf blight of rice in Korea. As the pathogen has already been included as an agent causing the grain discoloration disease in China, its association with the Indian condition needs to be ascertained. Recently, many fungal genera, including both pathogenic and saprophytic species such as *A. flavus*, *A. niger*, *Penicillium* spp., *Fusarium* spp., *Alternaria* spp., *Curvularia* spp., *Rhizopus* spp., *Cercospora* spp., *Trichoderma* spp., *Chaetomium* spp., *P. oryzae*, *H. oryzae*, *S. oryzae* and other unidentified fungal genera were reported.

Although many fungi (Pathogenic & Non-pathogenic) and bacteria have been reported from the diseased sample in India, the etiology remains unclear. The dynamics of pathogens during the different stages of disease development/panicle development are not studied in any part of the world. This information is crucial for designing effective management strategies. The management of this disease is trickier as minimum information is available on disease etiology. It is heavily dependent on fungicides/bactericides but with limited success due to a lack of information on the pathogen's profile and its dynamics. Many reports where fungicides have been recommended for controlling this disease. However, fungicides are not compatible with the environment and trade due to their long persistence in the environment and grain. Many of the useful fungicides, such as Carbendazim, have been banned or recommended for the ban shortly. Therefore, the search for effective and eco-friendly strategies will assume significance. Also, the time of appearance of the disease (appears after the grain filling stage) provides relatively no opportunity period for the farmers to take up the control measures. Moreover, many of the reported pathogens are toxigenic

(*Aspergillus*, *Curvularia*, *Alternaria*, etc.,) and the pathogen-specific toxin produced on grain and their impact on rice grain quality is poorly understood. The difficulty in ascertaining the pathogen profile in the past was mainly due to the non-availability of robust and accurate techniques such as advanced genomic tools. Presently, metagenomic-based NGS (mNGS) tools are available. It can be employed to characterize all the associated pathogens and core-phyllo-microbiome in the diseased samples in the shortest possible time. Combining this mNGS with conventional microbiological tools can give an accurate count and diversity of the microbiome.

The disease affects all the cultivated rice varieties in all rice-growing regions in both Kharif and summer seasons. Presently, the minimum threshold for the procurement of discolored grain is kept at 3%, and all the samples above that are either

rejected or procured at a lower price. Moreover, reports on the association of toxicogenic fungi (*Aspergillus* spp. and *Fusarium* spp.) in the discolored grains pose more concern for human and animal health. At present, only fungicides/bactericides have been recommended for controlling the diseases. However, spraying during grain maturity to the harvesting stage leads to more accumulation of fungicide residue in the grain, affecting international trade and the health of domestic consumers. It has also been reported that the GD-affected seeds show poor germination and seedling vigor, leading to crop loss at the early stage of the crop when such seeds are used for sowing in the subsequent year. Therefore, it is necessary to look through all these lacunas to research the present status of grain discoloration diseases of paddy in India.

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# Physiological Disorders of Cut Flowers

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## Rose

### Blind Shoots

#### Symptoms



- Failure to develop a flower on the apical end of the stem and the sepals and petals are present, but the reproductive parts are absent or aborted.

#### Causes

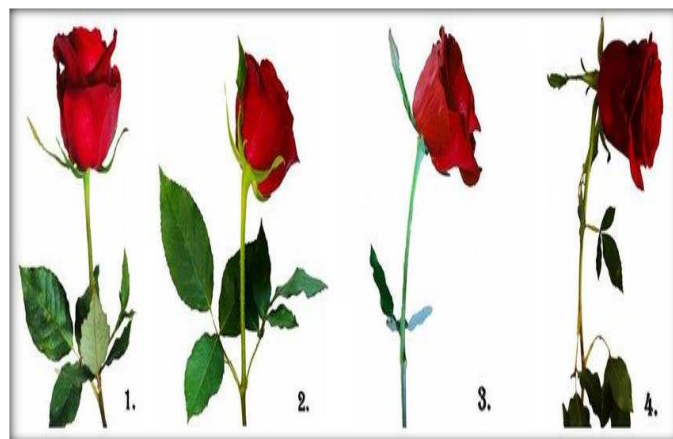
- Low temperature, Insufficient light, Chemical residues, Insect pests and other factors.

#### Remedies

- Provide optimum temperature and light.
- Can be reduced by bending over technique.
- Compared with vase shaped rose plants, trellised roses are found to reduce percentage of blind shoots.
- These blind shoots pinched back hard by 1 or 2 nodes in November resulted in production of flowering stems.
- Lighting with sodium lamps is also found to decrease the number of blind shoots significantly.
- CO<sub>2</sub> enrichment ( 1000 v.p.m) from Nov-Feb is helpful in reducing blind shoots.

- Foliar spray of ascorbic acid at 1000 ppm also reduces blind shoots production.

### Bent Neck



The Rose Back Neck Symptoms, causes and remedies is given in table 1.

### Petal Blackening

#### Symptoms



- Accumulation of anthocyanin in petals of roses and most red roses suffer from this problem blackening of external petals.

#### Causes

- Low temperature and high anthocyanin content.

#### Remedies

- Provide optimum temperature.
- If it is not possible to put different covers for different cultivars grown in the same

greenhouse, growers should use nylon bud nets to block the UV rays

### Bull Heads



#### Symptoms

The center petals of the bud remain only partly developed and the bud appears flat

#### Causes

- Observe mainly in low temperature during night.
- It occurs due to abnormal production of cytokinin's and gibberellins, the hormones responsible for cell elongation and stem elongation.
- Lack of carbohydrates.
- May be due to thrips infestation

#### Remedies

- Provide optimum temperature and control thrips infestation.

### Balling

#### Symptoms

- The inability of a bud to open into a bloom due to excess moisture causing the petals to stick together is called balling.

#### Causes

- Usually occurs in areas with cool, damp nights.
- Roses with many petals are more susceptible to balling

### Black Flower edges

This phenomenon is observed in some rose cultivars, especially red colored ones.

#### Colour fading

##### Symptoms

- Yellow varieties develop petals of green or dirty white.
- Pink or red varieties develop bluish colored flowers.

##### Causes

- Organic phosphate and various other kinds of insecticides.

##### Remedies

- Reduce use of chemicals, raising the night temperature.

### Gerbera



#### Bent-neck

- Insufficient floral stem tissue hardening or maturation
- below harvested flower resulting into stem collapse.

- Loss of turgidity and Ca deficiency are responsible for the neck bending.
- It is the problem where the flowerheads at neck bent from where it may break easily.
- Bent neck occurs due to poor winter growing conditions.
- Harvesting of flowers at lower temperature or when their stems are immature should be avoided.
- Sometimes leaf yellowing similar to mineral deficiency occurs due to poor drainage or because of root infection with some insect-pests or diseases which should be rectified after ascertaining the cause.

### Preharvest stem break

- Preharvest stem break occurs when plants are allowed to wilt during the day or when temperature increases rapidly during bright sunny weather.
- Under such conditions, the flower stem is subjected to stress and wilts.
- After watering of cooler growing conditions, the water to the stem is rapidly replenished and the stem becomes turgid again.
- During rehydration, extreme conditions are imposed on cells in the stem where rapid elongation is occurring.
- This part of stem accumulates the highest water content.
- Keeping soil moist during the heat of the day or reducing air temperatures can minimize preharvest stem break.
- If wilting still occurs the plant should be rewatered, not during the hottest part of the day but early morning or evening to prevent rapid surges of water into the wilted stems.

- It is a result of high root pressure and high atmospheric humidity.

### Premature flower wilt

- Premature wilting of the flowers occurs while stems are still attached to the plants and often develops just as petals are in full expansion.
- The cause of problem is suspected to be a lack of storage carbohydrates needed to attain the integrity of the rapidly developing flower.
- It occurs mostly after the period of cloudy days with low intensities followed by a clear sunny day.
- If possible, screening of the varieties should be done and planting of cultivars lesser effective to this disorder is advisable.

### Double stemmed flowers, double faced flowers, flower heads with calyx like growth at the centre

- Caused by imbalance of nutrients, usually observed when plant shifts from vegetative phase to generative phase.

### Bushiness

- An abnormality characterized by numerous leaves, short petioles and small laminae, which give some cultivars of gerbera a bushy appearance known as bushiness.
- Nodes are not clearly distinguished and no internode elongation is seen.

### Carnation

#### Calyx splitting

- It is a major problem in carnation as the flower buds open and petals reach to their full size, the calyx may split down either half or completely. The petals are deprived of their support, which results in bending down

of petals. Thus, the regularity of shape and structure of the flower get destroyed.

- A number of factors like genetic, environmental, nutritional and other cultural practices and boron deficiency are responsible.
- Besides these, low nitrate, high ammoniacal nitrogen or low boron levels also enhance calyx splitting.
- High nitrate to ammoniacal nitrogen ratio during low light periods are recommended to reduce splitting.
- Cultivars greatly differ in their susceptibility to splitting.
- Cultivars with short and broad calyxes are less likely to split than those with long and narrow ones.
- Selection of cultivars that are less prone to splitting, regulation of temperature and maintenance of optimum fertility levels can minimize this disorder.
- Several devices are used or repair splitting. Rubber bands, ties, plastic collars or pints are placed on calyx to hold it tighter
- Cultivars like Espana, Carburet, Red Corso, Pamir, Raggio-di-sole are less prone to this problem.
- Spray borax @ 1g/l at fortnightly intervals till flower bud appearance and after that at weekly intervals.

### Slabside

This disorder may arise during cooler period and buds do not open evenly, so that petals protrude on one side only giving an asymmetrical and lopsided shape to the flower.

- This can be overcome by gradual increasing of temperature to the optimum.

### Grassiness

- Grassiness refers to failure of plants to produce flowers.
- This is genetic disorder which varies from variety to variety.
- Removal and destruction of affected plants should be done.

### Sleepiness

- Sleepiness causes huge post-harvest losses in cut carnation.
- Flower petals cup upwards and do not open.
- It occurs due to exposure of flowers to ethylene or water stress.
- Also, the incidence of sleepiness has been found to be higher when the flowers are stored for a longer period or when they are exposed to high temperature.
- Spraying of STS 0.4 Mm before harvesting will correct this disorder.
- Keep ethylene absorbent tablet (purafil pad) during transport.

### Gladiolus



#### Tip burn(scorching)

- This physiological disorder occurs due to high levels of aerial fluorides as it is a fluoride pollution indicator(1part/billion) in the atmosphere as well as in irrigation water.
- Fluoride accumulates at the leaf tips and it results in discoloration and drying up of tips of leaves of gladiolus.



- Some of the saprophytic fungi also start invading the necrotized tissue.
- Crop should be grown away from the polluted area, especially the industries to avoid fluoride toxicity.
- Use of irrigation water and phosphate fertilizers containing high fluoride, especially rock phosphate, should be avoided.
- To overcome this problem, spraying with 5% lime or magnesium sulphate as well as a spray of blitox 50 WP (0.3%) should be given at initiation of symptoms and repeated once more if required.

### Geotropic bending of spikes



- The tips of gladiolus spikes show tendency to bend against gravity if placed horizontally for longer periods.
- This is primary due to the lateral downward movement of auxin, IAA and its accumulation on the lower portion of the spike.
- IAA causes asymmetrical elongation of cells in this region, thereby causing the upward bending of the spike tips.
- The bending of the tip does not affect the vase life of the spike but reduces its market value considerably, as the spikes do not fit well in the flower arrangements.

- It is suggested that the tip of the spike should be clipped if it shows bending.
- To prevent bending of tips, the spikes should be held vertically in storage as well as during transportation.

### Blindness and floral blasting

- It is observed in crops receiving less than minimum of 10 hours of sunlight.
- Hence season should be adjusted or light substitution should be given. **Spike topple:**
- Spike topple and bud rot of spikes due to low calcium content in stalk tissues when spikes are kept in vase solution.
- In this case  $\text{CaCO}_3$  @ 0.2 – 0.3 % spraying is recommended.

### Anthurium



### Flower abortion, flower deformation, rosette formation

- The flower spadix aborts and growth of the spathe is stunted and the stem of the flower is also short.

- This occurs under conditions in which the plant builds up a strong root pressure that cannot be processed by the above ground.
- This problem is mainly genetic dependent, but can be prevented by restricting root pressure and promoting plant activity.
- Excessive root pressure can be restricted by growing plants drier and by raising the EC.
- A small substrate volume also has a positive effect.
- The plant activity can be promoted by encouraging and by doing away with extremes of climates.
- That will result in maximum use of possibilities such as reduction in temperature, rapid ventilation, plant cooling and humidification.

### Folder ears



The basal lobes of the flowers are not fully unfolded in this disorder.

- The problem

probably occurs during the early stage.

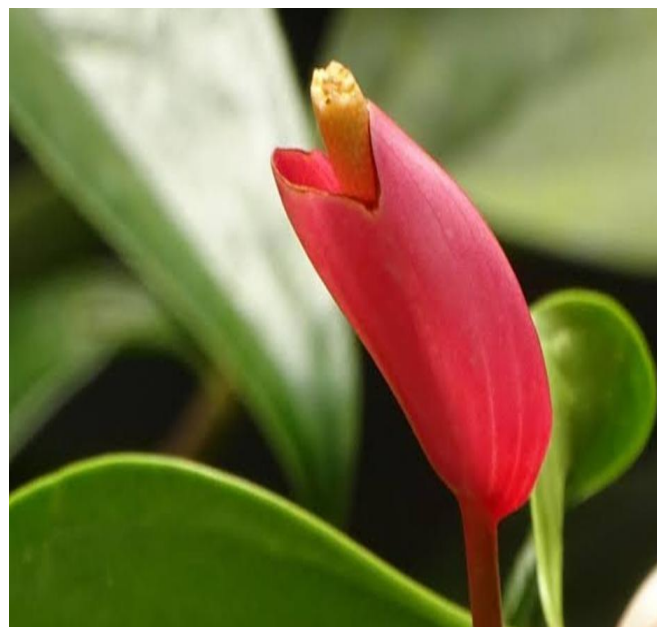
- There is no known solution.
- This physiological disorder is mainly dependent on variety and not observed in all the cultivars of anthurium.

### Sticking

- The flower does not open because the spathe is stuck as a result of sticking.

- It is a variety dependent disorder and occurs especially during periods in which the growth is rapid.
- A low RH seems to have a negative effect.
- During an early stage, the flowers can be loosened carefully by hand.

### Jamming



- It is a very strong dependent characteristic but more frequently occurs under arid conditions.
- It occurs more frequently in cultivars with long sheaths.
- The flower jams in the sheath, since this leaf is wound very tightly around the flower.
- Flowers that let loose of their own accord often seem to have damage in the shape of cracks on the underside of the spathe.
- Humidifying at top layer of the substrate can provide a more favourable microclimate, whereby the phenomenon would appear less frequently.

### Cracks

- |                                                                                                                                                                          |                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• This disorder occurs at the sides of the spathe.</li> <li>• In their most serious form, both sides could be damaged.</li> </ul> | <ul style="list-style-type: none"> <li>• This has to do work with active growth during a period with a (temporarily) higher RH.</li> <li>• Lower humidity during the night is effective to reduce the cracks in anthuriums.</li> </ul> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Table 1: Rose Back Neck Symptoms, causes and remedies**

| Symptoms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Causes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Remedies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1. Bending of stems of cut rose flowers after harvesting and is an important factor in determining post-harvest quality.</p> <p>2. Bent neck or rose neck droop is a very problem among cut roses in greenhouse cultivation.</p> <p>3. It is a typical bending of rose bud to one side of the flower pedicel.</p> <p>4. The pedicel shows swelling and is quite flat in the bending point, the sepal is deformed and much bigger, seems to be pulling the floral bud towards itself.</p> | <p>Insufficient water absorption.</p> <p>1. Too soft growth, premature bud harvest and excessive water loss during handling.</p> <p>2. Exposure to high temperature, Low humidity, Ethylene, High microbial growth and incorrect use of floral preservatives.</p> <p>3. The cells in the neck area loose turgidity due to lack of mechanical strengthening tissues, such as lignified water conducting vessels or collenchymatous tissue present within the stem at that point.</p> <p>4. Air blockages of the water conducting tissues, physiological plugging or direct or indirect microbial plugging affect the water balance problem in which the rate of water lose from the rose exceeds the rate of water uptake.</p> | <p>1. As the water is lost through stomatas, therefore lower 1/3<sup>rd</sup> of the leaves should be removed from the cut flower stems.</p> <p>2. Should be recut under water and submerged in warm water for few hours.</p> <p>3. Use of 200 ppm cobalt nitrate along with 10% sucrose in floral preservative at pH-6.0.</p> <p>4.Changes in K/Ca ratio have no differential effect on incidence of bent neck.</p> <p>5.Fumigation with methyl bromide at 50°C reduces the incidence of bent neck.</p> |

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# Agro-Ecological Transitions Through Spingshed Based Watershed Development

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Challenge is changes in the climate, especially in the way it rains, earthquakes, and the damage to the environment caused by changing how land is used for infrastructure development, are putting a lot of stress on mountain aquifer systems. With less rain in the winter, the problem of dying springs is becoming more noticeable in the mountain regions of the country.

An emerging concern in the field of natural phenomena is the transition of a perennial spring into a seasonal spring, ultimately culminating in the transformation into a dried spring.

Springs have been a source of water for mountain towns for hundreds of years, and bringing them back to life is very important for the region's long-term growth.

In the mountainous part of India, where many people live, springs are the main way they get water. A rough estimate of nearly 200 million Indians who depend on spring water in the Himalayas, Western Ghats, Eastern Ghats, Aravallis, and other mountain ranges means that spring water is important to more than 15% of India's population. (Source: Niti Ayog).

Water is increasingly becoming a critical ingredient for sustainable development, village water sources have been traditionally playing a vital role in providing water security to nearly 80 percent of the rural households. These springs get recharge from the sub-surface flow or from the rainwater that percolates down.

However, over the years, many of these springs are drying up or becoming seasonal and the discharge during the lean season is declining. These have reduced the sponge action of the land and consequently limited water rainwater percolates down creating a hydrological imbalance in some of the watersheds. It has been estimated that less than 15 percent of the rainwater is able to percolate down through deforested slopes to recharge the springs, while the remaining flows down causing floods, it has also been forecasted that global warming and climate change will further adversely affect the spring water resources.

## What is a Watershed?

A watershed is synonymous to a catchment area and it is an independent Hydrological unit. It can be defined as the drainage basin or catchment area of a particular stream or river. It refers to the area from where the water to a particular drainage system, like a river or stream, comes from. A watershed may be small, consisting of a few hectares, or huge, covering several thousands of hectares.

## What is Watershed Development

Watershed development refers to the conservation, regeneration, and judicious use of human and natural (like land, water, plants, and animals) resources within a particular watershed.

## Why Watershed management

It aims at controlling runoff to reduce soil erosion, increase soil moisture security for the field crops and recharge groundwater.



### What is Spring

Spring: In India's mountainous areas, groundwater naturally flows out as springs. These springs form where a water-bearing layer (called a "perched aquifer").

### What is a Springshed

A springshed is an area within a ground or surface water basin that contributes to the springs flow, the boundaries of springshed are dynamic-they change based on the level of the aquifer.that means a springshed may cover different areas at different times,depending water level.

Spings are drying up also become seasonal.so, the springshed development focuses on:

1. Increasing the discharge of the spring
2. Increasing the duration of discharge of the spring.

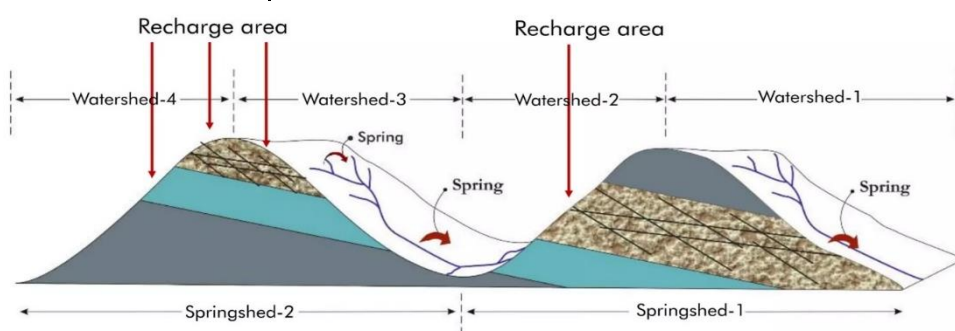
The point where the spring emerges is based on the relationship of the aquifer to the watershed surface. A springshed is a set of watersheds and aquifers that integrate into a system that supplies water to a group of springs.

The boundaries of springsheds are dynamic – they change based on the level of the aquifer (otherwise known as its potentiometric surface). Also spring sheds are the areas within ground-water and surface-water basins that contribute to the discharge of a spring. An aquifer is very much like an underground watershed. Unlike plain areas, in hilly areas, the spring shed is the fractured rocky area under the hills which contribute to flow of water as the springs at the drainage outlet. The direction of the flow of water / spring shed outlet depends on the type of rocks and their geological formation.

### What is Springshed development

Water flows from point of higher elevation to point of lower elevation through a force of gravity. Springs are a “window” in the groundwater flows which emerge to the surface as a spring.

The underground flows within a land area that contribute water to a spring vent or outlet comprise the springshed. Implementation of water recharge structures such as dug-out farm ponds, continuous or staggered trenches, water absorption trenches, etc., in the catchment area of springsheds is known as spring shed development.



**Figure 1: Springshed.**

Source: Indiawaterportal

### Data Requirement

- Web based platform for database
- National Spring Information System (NSIS)
- Spring Coordinate for Atlas & Inventory of Springshed data (Slope % and slope aspects, Landuse/ Land Cover, Vegetation, soil type, Rock type, Household dependence etc.)
- Rainfall
- Spring discharge
- Water quality
- Water demand Vs availability calculation

### Why springshed management

The springsheds in hilly regions are life line for the rural community. They provide water for both irrigation as well as drinking water.

1. Revival of dying springs for irrigation and drinking water purpose.
2. Enrichment of soil fertility through control of soil and water erosion.
3. Afforestation for restoration of ecological balance.
4. Dryland Horticulture for the creation of alternate livelihood opportunities for the poor tribal families.
5. Promotional sustainable farming practices like organic farming, etc.
6. Rainwater harvesting.
7. Community organization and community development and
8. Gender development and landless, labor, development.

### Core components of the programme

- i) Soil, land management, and springshed development (conservation and use).
- ii) Water management (conservation and use).
- iii) Afforestation.
- iv) Livestock management, Pasture (Fodder) development.
- v) Agricultural development.
- vi) Rural energy management.
- vii) Human Resource Development Socio-economic development (community development).

### Criteria for selection of spring shed based watersheds under NABARD source of Funding

#### A. Physical characteristics

- i. Villages with noticeable soil erosion, land degradation, resource depletion or acute water scarcity problems.
- ii. Villages in the upper part of drainage systems.
- iii. The size of a watershed project i.e., treatable area should be around 300 ha. but normally it should not be less than 100 ha. (the geographical area of the springshed based watershed can be more than 300 ha).
- iv. Well defined watersheds with the village boundaries coinciding to the extent possible with the watershed boundary.
- v. Watersheds are expected to have treatable area more than 50% of the total geographical area. Watersheds with less than 50% of treatable area may be selected only with specific justification in terms of its impact and sufficiency of treatment measures to achieve desired impact / result.

#### B. Socio-economic characteristics:

- i. Predominantly poor villages.
- ii. High proportion of SC/ST in the total population.
- iii. There should not be much difference in the size of the land holdings.

#### The eligible agencies for the project execution can be:

- i. Civil Society Organizations / NGOs.
- ii. Grama Panchayats (GP).
- iii. Krishi Vikas Kendras (KVKs)/ ICAR institutes and Institutions under SAUs.
- iv. Institutions/Societies/Trusts promoted by State Governments.

(Traditional Community-based institutions recognized by Government can also act as PFA when other suitable PFAs and GPs are not available).

**Key principles are emphasized again and have to be adhered**

- i. People's participation at all stages and the community shall own and implement.
- ii. Ridge to valley - treat every hectare that is required to be treated.
- iii. Particular care is to be taken for the involvement of the forest department in the treatment of forest areas on the ridge lines and the implementation of a joint forest management scheme with the community.
- iv. Survey number-wise planning involving every farmer.
- v. Uninterrupted flow of funds for implementation
- vi. Arrangements for providing half-yearly requirements in advance and claiming subsequent requirements after exhausting 60% of the amounts released previously.
- vii. Financial releases based on field monitoring and satisfactory progress. Maintenance arrangements to be built in through community involvement and contribution
- viii. Use of technology tools, such as GIS, GPS, and Remote Sensing for watershed planning, designing, management, monitoring, etc.

### Project Measures

The actual selection of the activities will be based on the net planning and location specific needs of the areas identified for development.

- i. Strengthening of bench terraces.
- ii. Control of stream bank erosion.
- iii. Rainwater harvesting in Syntax/cement structures.
- iv. Organic farming including vermicompost production.
- v. Afforestation.

- vi. Orchard development.
- vii. Loose boulder checks.
- viii. Gabion structures.
- ix. Check dams – depending of hydro-geological suitability.
- x. Construction of water diversion structures from smooth handling of runoff.
- xi. Construction of staggered / continuous trenches for recharge of springs.
- xii. Digging Farm ponds for recharge of springs.
- xiii. Alternate livelihood enterprises like dairy, fishery, poultry, piggery, goatery, sheepery, etc.
- xiv. Off farm livelihood enterprises like bamboo crafts, candles, pickles, broom grass, etc.
- xv. Promotion of SHGs/JLGs/FPOs.
- xvi. Cent percent financial inclusion with the opening of bank account for all the beneficiaries etc.

### Benefits of Springsheds

- Reduced Lean flow period.
- Higher Plant Survival Rate.
- Increased Biomass production.
- Increased Fodder availability.
- Household water quality.
- Increased life of downstream.
- Storage structures.
- Increase drinking water availability.
- Reduce migration and improve income generating activities.
- Improve irrigation facilities.
- Increased lifestyle of vulnerable community.
- Increase NTFPs collection.
- Reduce wasteland and improve land productivity.

| Steps  | Activity                                                  | Objective                                                                       | Equipment                                                                                                               | Outcome                                                                |
|--------|-----------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Step-1 | Spring Mapping                                            | To locate spring emergence point/ geo-tagging                                   | GPS Device/ Android Phone                                                                                               | Spring Atlas/Inventory                                                 |
| Step-2 | Spring Discharge                                          | To measure spring discharge                                                     | A bucket whose volume is known, Stop watch                                                                              | Spring Hydrograph                                                      |
| Step-3 | Rainfall                                                  | To measure rainfall                                                             | Rain Gauge                                                                                                              | Spring Hydrograph                                                      |
| Step-4 | Water Quality                                             | Water quality monitoring                                                        | Tracer, on spot water quality testing kit                                                                               | Water quality report                                                   |
| Step-5 | Base-Line (Socio-economic)                                | Base line survey                                                                | Formats, structured Questionnaire                                                                                       | Village water resource map, Demand & Supply status, Vulnerable springs |
| Step-6 | Hydrogeological Mapping                                   | To collect hydrogeological data from the field survey                           | GPS, Brunton, Clinometer, Hammer Google Earth and Sketch up (Softwares)                                                 | Hydrogeological Conceptual layout & spring site cross section          |
| Step-7 | Designing recharge interventions and management protocols | Physical and biological measures, social fencing, Behaviour change              | Tools for community mobilisation experts as SARAR kit                                                                   | Spring recharge and protocols for springshed management                |
| Step-8 | Impact assessment of springshed works                     | Measurement of benefits from springshed works with other socio-economic aspects | A Bucket whose volume is known, Stop Watch, Tracer, on spot water quality testing kit, Formats structured Questionnaire | Improvement in water availability water quality                        |

**Table 1: Steps of methods for Springshed development**

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# Electromyography - An Overview

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EMG can be a very useful analytical method if applied under proper conditions and interpreted in light of basic physiological, biomechanical, and recording principles. If ergonomic studies are correctly conducted and the limits of the interpretation process are accepted, EMG may be an effective tool for evaluating labour performance. Before considering the use of EMG, the ergonomist should be aware of which muscles will be impacted by the task. The ergonomist should be aware of the following: 1) Unless the work environment conditions exhibit a number of key characteristics, or 2) Unless specific additional measurements of the work positions are made simultaneously, The key to successful EMG use is understanding the nature of the signal collected, thereby separating the useful information of the signal from the noise and artefact. As a result, processes call for instrumentation, data processing, and interpretation. The same goal may be achieved using EMG as long as several body muscles are evaluated while a task is being performed. EMG is used more frequently, nevertheless, to assess lighter, repetitive labour when it is important to monitor the activity of certain muscles. This approach is frequently used in ergonomic study to compare the particular musculoskeletal stress (in given muscles) related to different work positions, postures, or activities, as well as to validate ergonomic concepts. Input for biomechanical models that explain the cooperative effects of muscle actions on a joint is also utilised. Therefore, the use of EMG is suitable when it is believed that a particular muscle or set of muscles is negatively impacted by the layout of the workplace. The complexity of muscle testing rises as the

information gleaned from an EMG signal becomes more quantitative and meaningful. Applied ergonomic studies may entail a review of worker practises, workplace organisation, productivity, or tool design. Building an empirical foundation for preventative efforts requires an understanding of patterns of exposure to these biomechanical elements across a variety of body areas and agricultural activities.

## History of EMG

Francesco Redi's documentation from 1666 served as the impetus for the creation of EMG. According to the paper, the electric ray fish's highly developed muscle produces electricity. In 1773, Walsh was able to show that the muscle of eel fish could produce an electrical spark. A. Galvani published a book in 1792 titled "De Viribus Electricitatis in Motu Musculari Commentarius" in which he demonstrated how electricity may cause muscular spasms. DubiosRaymond discovered that it was also feasible to capture electrical activity during a voluntary muscular contraction six decades later, in 1849. In 1890, Marey made the first recording of this activity and coined the name "EMG." An oscilloscope was utilised by Gasser and Erlanger in 1922 to display the electrical impulses coming from muscles. The myoelectric signal is stochastic, hence its monitoring could only provide a basic understanding of the situation. From the 1930s through the 1950s, the capacity to detect electromyographic signals progressively increased, and researchers started using better electrodes more often for the study of muscles. In the 1960s, surface EMG was first used clinically to treat more specialised illnesses. The first users of sEMG were

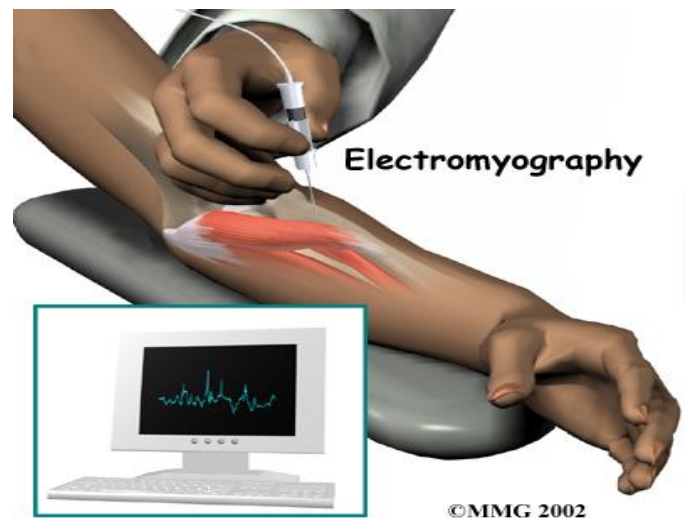
Hardyck and his team in 1966. Early in the 1980s, Cram and Steger developed a clinical technique for employing an EMG sensing device to scan a number of muscles. It wasn't until the middle of the 1980s that electrode integration methods had improved enough to enable batch manufacturing of the necessary compact and light-weight amplifiers and instruments. There are now several appropriate amplifiers on the market. Early in the 1980s, wires that create artefacts in the desirable microvolt range were made accessible. The characteristics of surface EMG recording have improved throughout the previous 15 years of study. In clinical procedures, surface EMG has become more often employed in recent years to record from superficial muscles, whereas intramuscular electrodes are exclusively utilised for deep muscle [2,3,5,6,7].

### Classification of EMG

EMG, which depicts neuromuscular activity, is a measurement of the electrical potential that is present on the skin as a result of muscle contraction [1]. There are two ways to measure it: by placing electrodes on the skin's surface (noninvasive) or by inserting a needle into a muscle (invasive). Surface EMG (sEMG) and intramuscular EMG (imEMG) have been shown to have equal classification performance for data of a comparative nature (unmodulated), even though imEMG offers additional advantages to overcome the limitations of sEMG, such as maintaining robust electrode contact with the skin and the ability to record from profound muscles with little EMG crosstalk [4]. However, when evaluated on modulated data, imEMG's performance declined in comparison to surface [6, 7]. Since imEMG recordings depend on the recruitment of motor units, the greater selectivity of imEMG compared to sEMG is caused by wires that are only exposed at the tip. However, this may also be a

drawback because the signal may provide local rather than global information; it is also possible that insufficient information was captured at low amplitude/frequency.

Source: Stival, F. 2015 and



<https://learn.adafruit.com/getting-started-with-myoware-muscle-sensor>

### Application of EMG

EMG may be applied in a wide variety of situations. Clinically, EMG is used to diagnose neurological and neuromuscular issues. Gait laboratories and physicians skilled in biofeedback or ergonomic evaluation utilise it for diagnostic purposes. EMG is also employed in a variety of research settings, such as biomechanics, motor

control, neuromuscular physiology, movement disorders, postural control, and physical therapy.

### Electrical noise and factors affecting EMG signal

Prior to amplification, the EMG signal's amplitude range is 0–10 mV (+5--5). EMG signals pick up noise as they pass through various tissues. Understanding the properties of electrical noise is crucial. The following forms of electrical noise can be characterised as having an impact on EMG signals:

1. All electrical devices produce noise due to their inherent design. Using high-quality electrical components will only help to lessen this noise, which cannot be completely eradicated.
2. Ambient noise: This type of noise is produced by electromagnetic radiation. On the surface of the planet, it is almost impossible to escape exposure to the electric-magnetic radiation that continually bombards the surfaces of our bodies. The amplitude of the ambient noise may be one to three orders of magnitude larger than the amplitude of the EMG signal.
3. When motion artefact is added to the system, the information is distorted. Inconsistencies in the data are brought on by motion artefact. Motion artefact primarily comes from the electrode interface and electrode cable. By properly designing the electrical circuitry and setup, motion artefact may be decreased.
4. Signal instability that is inherent: The amplitude of an EMG is essentially random. The firing rate of the motor units, which in most circumstances fire in the frequency range of 0 to 20 Hz, has an impact on the EMG signal. The elimination of the noise is crucial since this form of noise is regarded as undesirable.

1. Causative factors: These have an immediate impact on the signals. Two types of causal factors can be distinguished:

- a. Extrinsic: This is because of the design and location of the electrodes. The EMG signal is primarily influenced by factors like the size of the detection

surface, the shape of the electrode, the spacing between electrode detection surfaces, the location of the electrode in relation to the motor points in the muscle, the orientation of the detection surfaces in relation to the muscle fibres, and the location of the electrode in relation to the surface of the muscle.

b. Intrinsic parameters include the number of active motor units, the make-up of the fibres, blood flow, the depth and location of the active fibres, and the quantity of tissue between the muscle's surface and the electrode.

2. Physical and physiological phenomena that are impacted by one or more causal causes are considered intermediate factors. The band-pass filtering characteristics of the electrode alone and its detection volume, the superposition of action potentials in the recorded EMG signal, and the velocity at which the action potential travels over the membrane of the muscle fibre are possible causes of this. Even close muscle crosstalk might result in Intermediate Factors.

3. Intermediate Factors have an impact on deterministic factors. The information in the EMG signal and the measured force are directly influenced by the quantity of active motor units, motor firing rate, and mechanical contact between muscle fibres. The motor unit action potential's amplitude, duration, and form might also be to blame.

The following methods can be used to maximise the quality of the EMG signal

There should be as little noise contamination and as much information from the EMG signal as feasible in the signal-to-noise ratio.

2. Signal peaks should not be distorted, and notch filters are not advised. The distortion of the EMG signal should be as small as feasible. The EMG signal processing only looks at positive values. Positive data is retained and all negative data is deleted during half-wave rectification. During fullwave rectification, each data

point's absolute value is utilised. Full-wave rectification is typically recommended for rectification.

### Conclusion

EMG signal carries valuable information regarding the nerve system. So the aim of this paper was to give brief information about EMG and reveal about history, classification of EMG, application of EMG and electrical noise and factors affecting EMG signal.

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# Review Paper on Jackfruit

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Jackfruit is an exotic fruit grown in tropical regions of the world. It is native to South India. Jackfruit (*Artocarpus heterophyllus*) is a species of tree of the mulberry family (Moraceae) is known by other names like Kathal, Panas (Hindi), Kanthal (Beng.), Palaa (Tamil), Phanas (Gujarat) and Chakka (Malayalam). Jackfruit has a spiky outer skin and is green or yellow in color. It is native to Western Ghats of India, Malaysia and also found in central and eastern Africa, south-eastern Asia, the Caribbean, Florida, Brazil, Australia, Puerto Rico and many Pacific Islands. It is a large, evergreen tree, 10-15m in height, indigenous to the evergreen forests and cultivated throughout the hotter parts of India.

Jackfruit (*Artocarpus heterophyllus* Lam) produces heavier yield than any other tree species, and bear the largest known edible fruit (up to 35 kg). The jackfruit tree has several uses. Flakes of ripe fruits are high in nutritive value; every 100 g of ripe flakes contains 287-323 mg potassium, 30.0-73.2 mg calcium and 11-19 g carbohydrates. In Bangladesh, it is commonly referred to as "poor man's food" as it is cheap and plentiful during the season. The nutritious seeds are boiled or roasted and eaten like chestnuts, added to flour for baking, or cooked in dishes.

## Taxonomical classification

**Kingdom:** Plantae - planta, plantes, plants, vegetal  
**Subkingdom:** Tracheobionta - vascular plants  
**Division:** Magnoliophyta - angiosperms, flowering plants, phanerogames  
**Class:** Magnoliopsida - dicots, dicotyledones, dicotyledons  
**Subclass:** Hamamelidae

**Order:** Urticales  
**Family:** Moraceae - mulberries  
**Genus:** Artocarpus - breadfruit  
**Species:** Artocarpus heterophyllus Lam.

## Morphology

### Size and form

Jackfruit is a medium size, evergreen tree that typically attains a height of 8-25 m (26-82 ft) and a stem diameter of 30-80 cm (12-32 in). The canopy shape is usually conical or pyramidal in young trees and becomes spreading and domed in older trees. The tree casts a very dense shade. Heavy side branching usually begins near the ground. All parts of the tree exude sticky white latex when injured.

### Fruit

Jackfruit has a compound or multiple fruit (syncarp) with a green to yellow brown exterior rind that is composed of hexagonal, bluntly conical carpel apices that cover a thick, rubbery, whitish to yellowish wall. The acid to sweetish (when ripe) banana flavored flesh (aril) surrounds each seed. The heavy fruit is held together by a central fibrous core. Fruits are oblong cylindrical in shape, typically 30-40 cm (12-16 in) in length.

### Seeds

Seeds are light brown, rounded, 2-3 cm (0.8-1.2 in) in length by 1-1.5 cm (0.4-0.6 in) in diameter, and enclosed in a thin, whitish membrane. Up to 500 seeds can be found in each fruit. Seeds are recalcitrant and can be stored up to a month in cool, humid conditions.

## Pharmacological uses of jackfruit tree

### Antioxidant effects

Ethanol extract of the defatted jackfruit seed and the pulp shown to be effective in ABTS and FRAP assays (Soong & Barlow, 2004). Ethanol extract of the dried mature fruits scavenged DPPH radicals in vitro (Soubir, 2007). The methanolic, ethanolic, acetone and aqueous extracts of ripe pulp shown to possess free radical scavenging effects in DPPH, FRAP, DMPD assays (Jagtap et al., 2010). Cycloheterophyllin and artonins A and artonins B also inhibited the copper-catalyzed oxidation of human low-density lipoprotein, iron-induced lipid peroxidation in rat brain homogenate, scavenged the DPPH radicals, the peroxy radicals and hydroxyl radicals (Ko et al., 1998).

### Anti-inflammatory effect

Cycloheterophyllin, artonins B, and artocarpanone inhibited the superoxide anion formation in fMLP-stimulated rat neutrophils (Wei et al., 2005). Dihydroisocycloartomunin inhibited release of beta glucuronidase and histamine from rat peritoneal mast cells stimulated with P-methoxy-N-methylphenethylamine (Wei et al., 2005). Artocarpanone inhibited the release of lysozyme from rat neutrophils stimulated with formyl-Met-Leu-Phe. Artocarpanone inhibited LPS-stimulated production of NO and expression of iNOS in RAW 264.7 cells (Wei et al., 2005). Artocarpesin, norartocarpetin and oxyresveratrol isolated from the fruits caused a dose dependent decrease in the production of LPS-induced production of nitric oxide in vitro (Fang et al., 2008). Artocarpesin was effective in inhibiting the production of prostaglandin E<sub>2</sub> (PGE<sub>2</sub>), reactive oxygen species and to decrease the levels of cyclooxygenase 2 (COX-2) and inducible nitric oxide synthase (iNOS) protein expression in the LPS-stimulated RAW 264.7 cells (Fang et al., 2008). Protease fraction and artocarpain also possess anti-inflammatory effects in

carrageenan induced rat paw oedema and Cotton pellet-induced granuloma model (Chanda et al., 2009).

### Antibacterial effects

The methanolic extracts of stem, root, barks, heart wood, leaves, fruits and seeds as well as their various fractions evaluated for antibacterial effects. The butanol fractions of the root bark and fruits were most effective (Khan et al., 2003). The aqueous extract as well the aqueous and ethyl acetate fraction of jackfruit leaves studied for the antibacterial effects by the agar diffusion and broth dilution methods. The activity varied from organism (Loizzo et al., 2010). The ethanolic and methanolic extracts of the jackfruit seed powder were observed to be effective on multidrug resistant Methicillin resistant *Staphylococcus aureus* (Karthi et al., 2009).

### Anticariogenic effects

Methanolic extract of the leaves and the phytochemicals artocarpin and artocarpesin, possess inhibitory effects on the primary cariogenic bacteria in vitro (Sato et al., 1996).

### Antifungal activity

The extract of the jackfruit leaf shown to be ineffective (Khan et al., 2003). However, the chitin-binding lectin present in the seeds (denoted as jackin) is reported to inhibit growth of *Fusarium moniliforme* and *Saccharomyces cerevisiae* (Trindade et al., 2006)

### Wound healing

The ethanol extract of dried leaves and its various fractions (petroleum ether, butanol, butanone and methanol) possess wound healing effects in rats. The methanol fraction was observed to possess the best effect (Patil, Jadhav, and Joshi, 2005)

### Jackfruit cultivation in India

Jackfruit (*Artocarpus heterophyllus* Lam.) is native to India and grows wild in the rain forests of Western Ghats of India (Reddy, Patil, Shashikumar, and Govindaraju, 2004). Jackfruit grows in many parts of Asia but is abundant in India and Bangladesh. Its distribution is continuous on the western coast of India with high rainfall up to Konkan and sporadic in the areas with low rainfall. In Western Ghats, it is found up to 1500 m and has tremendous diversity (Muralidharan, Ganapathy, Velayudhan, and Amalraj, 1997).

In India, the fruit is popular in the eastern and southern parts. Flakes of ripe fruits are rich in nutritive value, containing 18.9 g carbohydrates, 0.8 g minerals, and 30 IU vitamin A and 0.25 mg thiamine for every hundred grammes (Samaddar, 1985).

### **Jackfruit application in food industry**

#### **Jackfruit seed as a substrate supplement for production of edible pigments**

Jackfruit seed as a substrate supplemented with carbon sources like mannitol, lactose, starch and fructose and nitrogen sources like yeast extract, peptone, ammonium sulphate and ammonium nitrate to produce pigments by *Monascus purpureus* in solid-state fermentation (SSF).

The interest in red pigments produced by *Monascus spp.* for use in the food industry has been mounting given the flexibility in production and easy down streaming process. *Monascus* is reported to produce non-toxic pigments, which can be used as food colorant. Besides to adding color, it enhances the flavor of the food and acts a food preservative. The use of jackfruit seeds for substrate is cost-effective as well as environment friendly.

#### **Jackfruit seed starch and its application as a thickener and stabilizer in chilli sauce**

Rengsutthi *et al.*, (2010) stated that jackfruit seed starch (JFSS) is suitable as a thickener and stabilizer in chilli sauce because chilli sauce with JFSS had the lowest serum separation and highest viscosity during storage compared with control chilli sauce and sauce containing cornstarch (CS). In addition, sensory evaluation demonstrated that chilli sauce containing JFSS received the highest score in terms of color, mouth feel, homogeneity and overall quality.

#### **Agro-industrial potential of jackfruit byproducts as a source of food additives**

The entire body of Jackfruits is rich in bioactive compounds, such as phenolic constituents, carotenoids, vitamins, and dietary fiber. However, the fruit processing industry deals with the large percentage of byproducts, such as peels, seeds, and unused flesh, generated in the different steps of the processing chains.

Soong and Barlow (2004), evaluated the antioxidant capacity and phenolic contents of seed and pulp of jackfruit, using ABTS (2,2-azinobis-3-ethylbenzothiazoline-6-sulfonic acid), FRAP (ferric-reducing antioxidant power) and FCR (Folin-Ciocalteu reagent) methods. This study showed that the seeds of this fruit had a higher antioxidant capacity and phenolic content than the pulp. The ABTS, FRAP and FCR values for the seeds of jackfruit were 7.4  $\mu\text{mol}$  of ascorbic acid/g; 2.8  $\mu\text{mol}$  of gallic acid equivalents/g and 27.2 mg of gallic acid equivalents/g, respectively. The ABTS, FRAP and FCR values for the pulp of jackfruit were: 3.0  $\mu\text{mol}$  of ascorbic acid/g; 6.8  $\mu\text{mol}$  of gallic acid equivalents/g and 0.90 mg of gallic acid equivalents/g, respectively.

#### **Value added products from jackfruit bulbs**

The bulbs of jackfruit possess a desirable texture and a rich appetizing taste. The Pulp of ripe jackfruit can be eaten fresh, made into various local delicacies including chutney, jam, jelly or can be preserved as candies and fruit leather among others (Crane, 2005 and ICUC, 2003). The potentiality of some of the processed product from jackfruit bulb is reviewed below.

### Jackfruit Jam and Jelly

The increasing demand for dietary compounds with antioxidant action has focused interest on fruits as natural sources of these compounds, but also fruit products, such as jams, can be good source of biologically active compounds with considerable antioxidant potential (Wicklund et al., 2005; Kim and Padilla-Zaokur, 2004; Amakura et al., 2000).

Appreciable amounts of pectins are found in all parts of jackfruit. The pectin content (as % calcium pectate) is 3.2 - 5.8 in bulbs, 1.02-2.66 in aborted flowers (fleshy ribbon like structure), 3.06-4.6 in seeds, 2.86-3.64 in rind and 1.95-2.23 in cores (Haq, 2006) Low ester pectins can form into gels in the presence of a small quantities of divalent ions (Vilasachandran et al., 1982).

### Jackfruit leather

Fruit leathers are pectic gels obtained by dehydrating fruit purees to produce restructured, attractive flexible sheets which retain shape and are eaten as snack or dessert. These products add variety to a healthy diet and possess dietary fibre, vitamins and minerals while providing a good energy intake (Natalia et al., 2012). Various earlier studies described the technique for processing of fruit leather.

### Jackfruit toffee

The confectionery products are highly popular among the children throughout the world due to their taste and flavor. Toffee is one of the sugar-based products which is largely consumed by the children. The conventional toffees are generally made from sugar, skim milk powder and other synthetic colors and flavors. Jackfruit pulp incorporated toffee was prepared successfully by GRAMA, a Non-Government Organization of Bharananganam (India) (APPARI, 2012).

### Other jackfruit products

CFTRI (1977) standardized nectar from jackfruit pulp. Jackfruit nectar was standardized successfully from the two popular varieties of jackfruit available in Kerala individually and by blending with other fruit pulp.

TFnet (International Tropical Fruit Network) reported about the processing methods for some jackfruit value added products like canned jackfruit slices, jackfruit cordials, frozen jackfruit and vacuum fried jackfruits.

Datta and Biswas (1972) described the process for making vinegar from fruit juice. They mentioned that jackfruit vinegar recovered from the ripe fruits yielded 7 % alcohol and 6 per cent acetic acid upon fermentation. Moreover, Khader (1999) standardized a method for preparation of vinegar from jackfruit. The vinegar processed in this standardized process found to have a shelf life of one year.

Sharma et al. (2012) optimized the fermentation process for making jackfruit wine. Various studies had successfully attempted to standardize the process of making jackfruit finger chips. Kotoky et al. (2014) studied the quality attributes of chips prepared from jackfruits of



different maturity stages and reported that unripe mature jackfruit (140 days from fruit setting) was found to be superior for processing of jackfruit finger chips. The chips prepared from this maturity stage was best in terms of colour, taste, appearance and crispness.

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Effect of Carbon and Nitrogen Sources on Stimulation of Pigment Production by *Monascus purpureus* on Jackfruit Seeds R.S. Subhasree, P. Dinesh Babu, R. Vidyalakshmi and V. Chandra Mohan

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# Success Story of Rice-Based Cropping System

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Kumbi village is situated at 24°25'29.1"N and longitude of 93°48'13.3" with an altitude of 2502 ft from mean sea level in Moirang Sub-Division of Bishnupur district, Manipur. It receives a total annual rainfall of 1146.9 mm in *kharif* and 366.5 mm during *rabi* season. Though the total amount of rainfall received could be utilized for double cropping, farmers lack technical know-how of cultivating pulse crops during the *rabi* season and as such most of the land remain fallow during *rabi* season. After assessing the problems in the village, Krishi Vigyan Kendra, Bishnupur District, Manipur made interventions by introducing low water requirement pulse crop such as chickpea and lentil under cluster demonstration programme of *rabi* pulses under National Food Security Mission to follow rice-chickpea and rice-lentil cropping system so as to increase the cropping intensity of the farmers as well as to earn more income in a year.

## KVK intervention

- In order to enhance the cropping intensity of the village by introducing cropping system of rice-chickpea and rice-lentil
- Advising the villagers to harvest the crops as soon as it matures so that the residual soil moisture could be utilised for the *rabi* crops in time.
- Double cropping instead of mono cropping as there is no profit in rice cultivation.
- Use of short duration rice variety.
- Use of low water requirement of pulse crop.

Front line demonstrations were organized in this area during *rabi* 2015-16 with the aim of increasing the cropping intensity of the farmers by promoting low water requirement pulse crops viz. Chickpea and lentil in the system. As a precursor to organizing the FLDs, a training programmes related to the technology with major focus on cropping system of rice-chickpea and rice-lentil was organized for the farmers of village Kumbi, Oinam, Ithai, Tronglaobi and Kabowakching. During the training, farmers were advised to harvest the rice crop as soon as it matures so that the residual soil moisture could be utilized for the *rabi* crops in time. Also use of short duration rice variety in order to practice double cropping as there is no profit in monocropping of rice only. This was followed by hands-on training on growing of chickpea var. JG-16 & lentil var. HUL-57 after rice in the field of Shri Wahengbam Panchamani of Kumbi village (one of the selected farmers for conducting cluster demonstration of *rabi* pulses under NFSM) having 1 ha area (0.5ha for each of the crops) and ten other farmers of these villages in the month of November, 2015 and laying out of demonstration of in rice-chickpea and rice-lentil cropping system in 10 ha area in the village cluster.

## Impact of intervention

Mr. Wahengbam Panchamani of Kumbi Village, Moirang Sub division of Bishnupur district, Manipur practice only mono-cropping of rice and his land remain fallow during *rabi* season due to uncertainty of rain, lack of irrigation facility and moreover the field was occupied with paddy up to the month of November. He could earn Rs. 63000/- only in a year with net profit of Rs. 35500/- only, sometimes no profit at all. So with the introduction

of low water requirement pulse crops such as chickpea and lentil having water requirement of 400 mm only during the cropping season of each in the system, he could now earn a net income of Rs. 54889/- to 80,784 i.e. total Rs. 1,03,005 to 1,29,000 in a year. Moreover cropping intensity increases upto 150% in each system. Mr. Panchami is now a successful progressing farmer showing paths to his neighbouring and other farmers of the district. Only mono-cropping of rice gives benefit cost ratio of Rs. 2.29:1 but with the introduction of the rice-chickpea cropping system, benefit cost ratio increases to 2.67:1 although B:C ratio of rice-lentil cropping system is low to monocropping of rice.



**Fig 1: Training and Visiting the field of Rabi Pulses Demonstration under NFSM by former Director, ATARI, ZONE-III, Umiam.**

Before the technology, the gross income of the farmer was 63000/- only with net profit of Rs. 35500/- but with the introduction of the technology he could earn gross income of 103005 to 129000/- with net profit of 54889/- to 80784/-.



**Fig 2: CFLD on Chickpea var. JG-16 & HUL-57 after rice crop (rice-chickpea) at W. Panchamani's field.**

### Conclusion

Mr. Wahengbam Panchamani earned a net income of Rs. 80784/- in a year through rice-chickpea cropping system introduced by SMS Agronomy of KVK-Bishnupur. Thus introducing low water requirement pulse crop (chickpea and lentil) in the system, better utilized the residual soil moisture after rice harvest which could have been wasted. Also it is one of the Resource Conservation Technology which could be taken up by other farmers having situation specific of double cropping.

**Table 1: Economics**

| Crop                      | Production n in terms of Rice Equivalent yield (kg/ha)                                                                | Gross expenditure (Rs./ha) | Gross income (Rs./ha) | Net income (Rs./ha) | B: C ratio | Cropping intensity |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------|---------------------|------------|--------------------|
| Monocropping of rice only | 4200                                                                                                                  | 27,500                     | 63000                 | 35500               | 2.29:1     | 100%               |
| Rice-chickpea             | 8600<br>(Rice yield- 4200 kg/ha; price of rice- Rs. 15/kg; chickpea yield- 1100 kg/ha; price of chickpea – Rs. 60/kg) | 48216                      | 129000                | 80784               | 2.67:1     | 150%               |
| Rice-lentil               | 6867<br>(Rice yield- 4200 kg/ha; price of rice- Rs. 15/kg; lentil yield- 400 kg/ha; price of chickpea – Rs. 100/kg)   | 48116                      | 103005                | 54889               | 2.14:1     | 150%               |

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## Moringa Leaves as A Fish Feed Ingredient

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The rapid development of aquaculture systems to meet the growing demand of fish has opened up the pathways for intensification of the culture practices. In the commercial aquaculture practices being adopted by the farmers, the single most important recurring expenditure is the feed, which accounts to nearly 60% of the total operational cost (FAO, 2018). The cost of the formulated feed is in turn dependant on the protein source used for the formulation of feed. If, the source of the protein is from animal origin, certainly the cost of the final feed is much higher than that of plant origin.

Besides, the cost of the basic feed ingredients that are being used for formulation of fish feed is increasing day by day, due to increase in the bovine and avian population, so also the increase in different methods of fish culture and diversification of aquaculture practices (Ali et al., 2003). Therefore, in the recent pasts, many research activities were conducted worldwide to formulate fish feed using alternate protein sources instead of fish meal or blood meal with an aim to reduce the cost of the feed.

Also, the rapid expansion of aquacultural practices has given rise to increase the risk of disease incidence which act as a constraint in the aquaculture production system resulting with stress to the cultured animal and mortality which reflects on the production of fish (Priyadarshini *et al.*, 2013). To combat the incidence of disease in the farming system, antibiotics and other synthetic chemicals are being used as therapeutic agents (Lim et al., 2013). However, the continuous application of antibiotics leads to the development of resistant strains that are difficult to be controlled, so finding alternatives for antibiotics is an urgent need (FAO, 2002). As an



alternative to the use of antibiotics, many farmers at present are adopting methods for disease prevention by use of immunostimulants, immune modulators etc., which are mostly of synthetic origin (Bennett et al., 2003 Harikrishnan et al. 2011). The indiscriminate and continuous use of synthetic hormones, antibiotics, vitamins, immune-stimulants, growth promoters and other chemicals have led to the development of disease resistant strains and have several inherited negative impacts on environment as well as human health (FAO, 2002).

As an alternative to the conventional synthetic drugs and chemicals, emphasis is being given these days on the application of natural and more specifically herbal products, to obtain the desired traits in a safe and sustainable manner (Harikrishnan et al. 2011). As an alternative to the conventional synthetic drugs and chemicals,

emphasis is being given these days on the application of natural, and more specifically herbal products, to obtain the desired traits in a safe and sustainable manner (Harikrishnan *et al.* 2011).

Many plant products have been reported to stimulate appetite, promote growth, act as immune-stimulants, and also serve as the source of antibacterial, antiviral and anti-parasitic (protozoans, monogeneans) agents in aquaculture (Jena *et al.*, 2018). These activities are observed due to the presence of many bioactive compounds such as phenols, sulphur, terpenoids, alkaloids, flavonoids, and saponins etc. (Bennett *et al.*, 2003). Drumstick (*Moringa oleifera*) is one such fast-growing tropical and subtropical plant with numerous medicinal properties besides its nutritional values. All most all parts of drumstick tree viz., bark, seed, fruits, leaves and roots have nutritional as well as medicinal values, such as anti-oxidant, anti-diabetic, anti-bacterial, anti-fungal, etc. (El-Gawad *et al.*, 2020), for which the tree is now getting recognised as “the miracle tree” (Ashfaq *et al.*, 2012)

*Moringa oleifera* (Drumstick / Moringa / Miracle tree) of family *Moringaceae*, a highly valued plant of Indian origin is characterized by seasonal fluctuations in the yield (Gopalakrishnan *et al.*, 2016). It is preferred for human consumption in the Indian market throughout the year (Kumar *et al.*, 2004). It can withstand both severe drought and mild frost conditions and hence widely cultivated across the world (Gopalakrishnan *et al.*, 2016). India is the largest producer of moringa with an annual production of 1.1 to 1.3 million tonnes of tender fruits from an area of 38,000 ha (Bharathi *et al.*, 2018).

Besides the health promoting values, moringa leaves acts a source of nutrition owing to the presence of a variety of essential phyto-chemicals namely, carotenoids, glucosinolates, isothiocyanates,

polyphenols, and vitamins (El-Gawad *et al.*, 2020), which makes it virtually an ideal dietary supplement. In fact, moringa leaves is said to provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach (Udikala *et al.*, 2017; Rockwood *et al.*, 2013).

However, the leaves of moringa possesses the anti-nutritional factors (ANFs) namely alkaloids, flavonoids, polyphenols, phytic acids, tannins, saponins etc. These ANFs hinders the digestion as well as utilization of major nutrients when consumed in higher quantity (Stevens *et al.*, 2016). A number of methods have been tried to reduce the ANFs present in drumstick leaves, such as heat treatment (Tagwireyi *et al.*, 2014); boiling (Sallau *et al.*, 2016); blanching (Indriasari *et al.*, 2016); simmering (Sallau *et al.*, 2016); fermentation using different purified microbial strains, such as *Bacillus subtilis* (Ali *et al.*, 2016); *Aspergillus niger* and *B. subtilis*, (Wang *et al.*, 2018); *A. niger*, *C. utilis* and *B. subtilis* (Shi. *et al.*, 2016) and got encouraging results.

### Conclusion

Moringa (*Moringa oleifera*) is a good source of nutrients. *M. oleifera* leaf meal can be incorporated up to a certain level fish diets for improved growth performance. It could be an alternative source of protein in the fish diet. Further study is required to analyze the effect of medicinal values of Moringa leaves on the health status of the cultured fishes.

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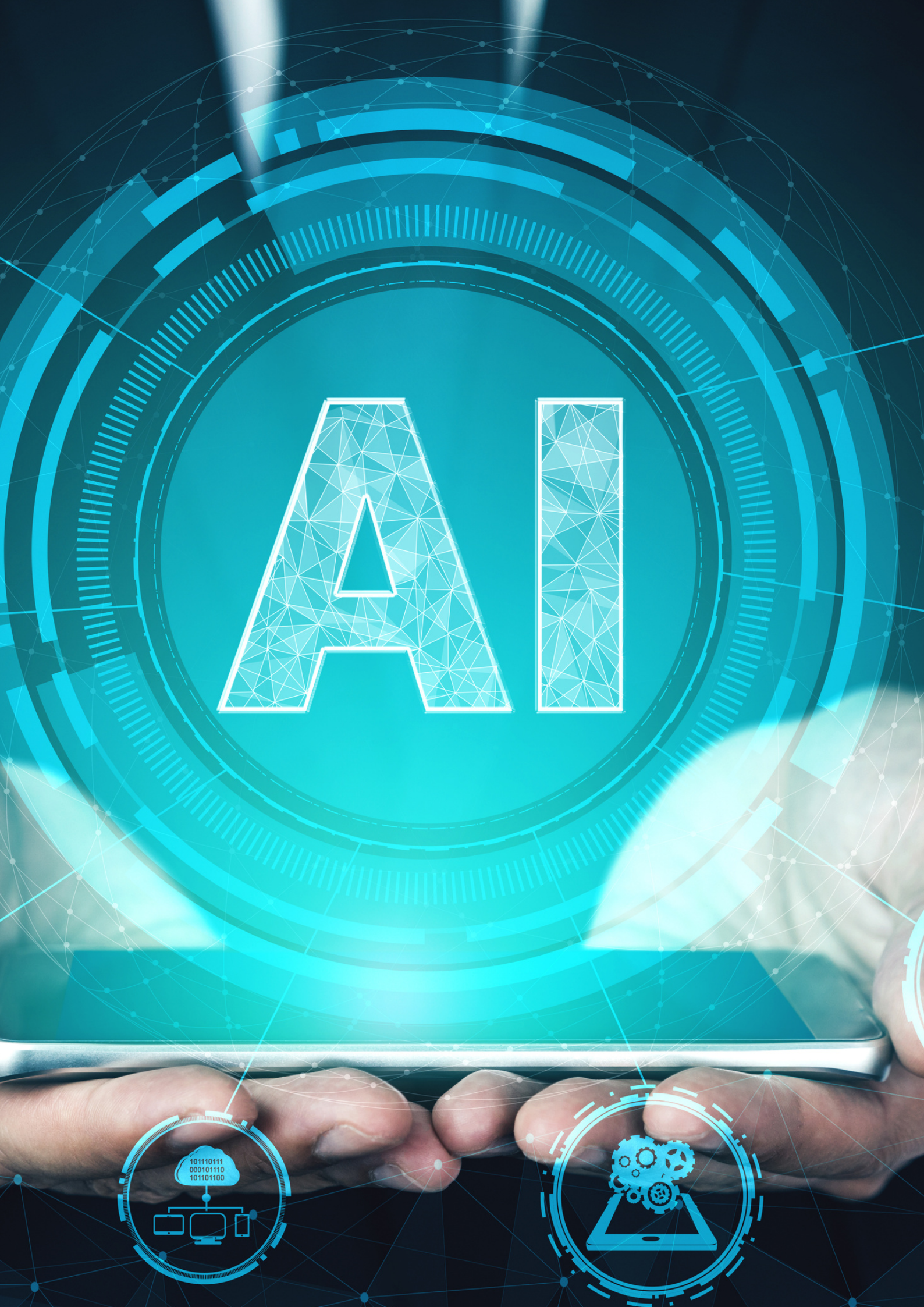
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