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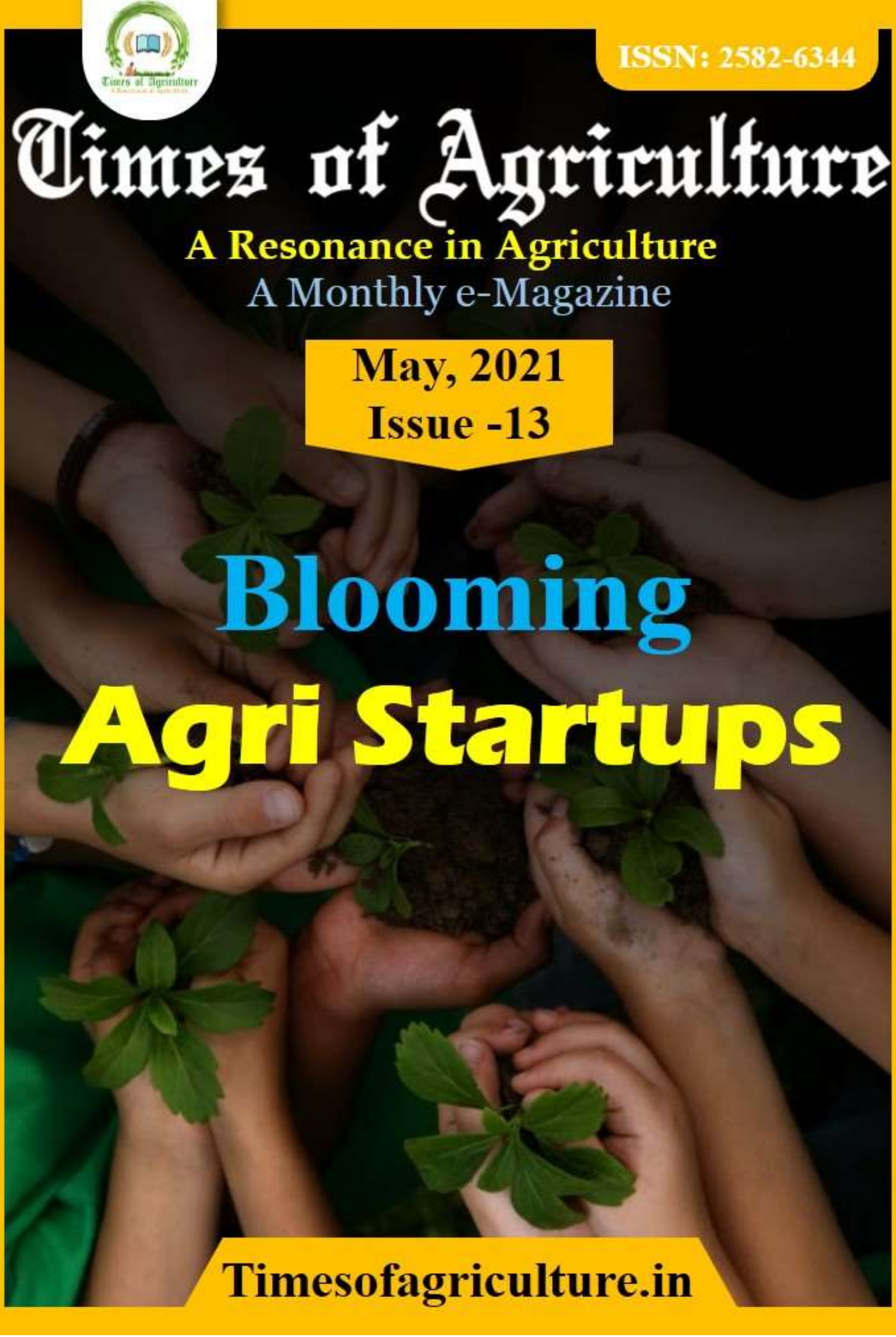
# Times of Agriculture

A Resonance in Agriculture

A Monthly e-Magazine

May, 2021
Issue -13

# Blooming Agri Startups



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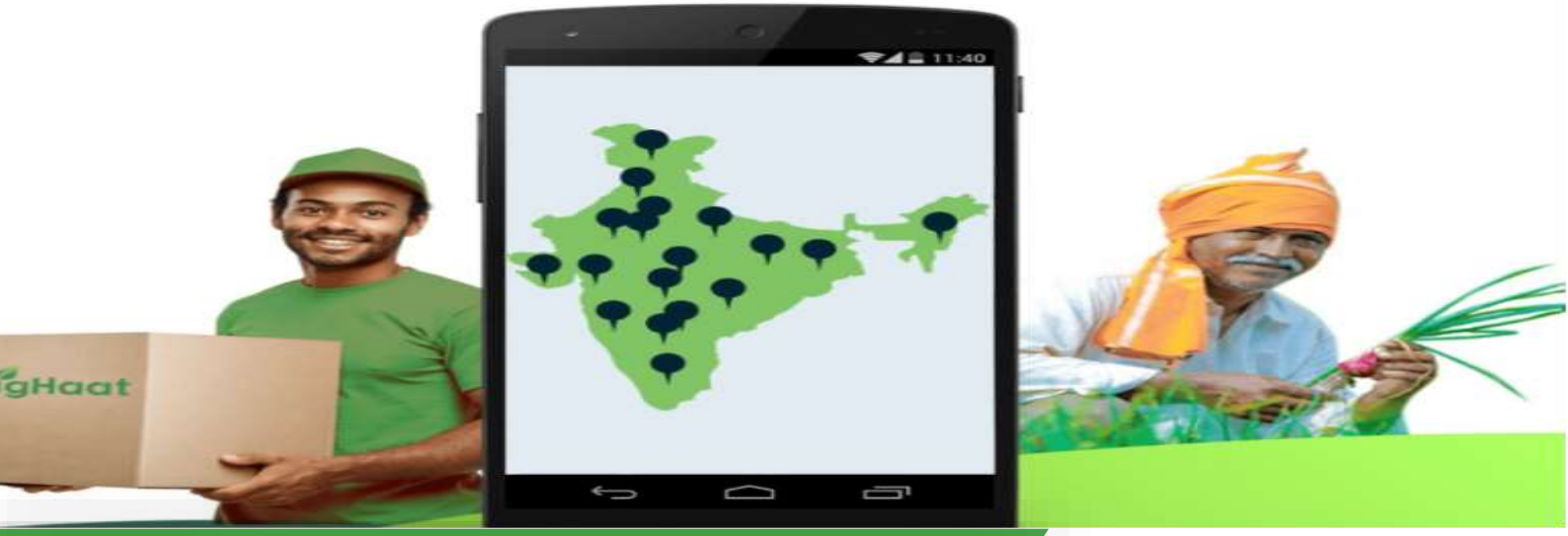



## Cover Story

**Blooming Agri Startups**

# Agriculture Updates

# Central Farm Machinery Training & Testing Institute, Budni (MP) tests the first-ever electric Tractor in the Institute

**Central Farm Machinery Training & Testing Institute, Budni (MP)** has tested the **first-ever electric Tractor** in the Institute. The institute received the application for an electric tractor under Confidential Test initially. Accordingly, the institute has tested the tractor & released the Draft Test Report in February, 2021. After the release of the draft test report, the manufacturer has requested for conversion of the nature of the test from "Confidential to Commercial" and the competent authority has accepted the request of the manufacturer. Accordingly, the Test Report was released as a Commercial Test Report. Electric tractor will be more environment friendly than other types of tractors.

# Union Ministry of Agriculture signs MoU with Microsoft for a pilot project in 100 villages of 6 states


Microsoft has come forward to start a pilot project in selected **100 villages in 10 districts of 6 states (Uttar Pradesh, Madhya Pradesh, Gujarat, Haryana, Rajasthan and Andhra Pradesh)** to develop farmer interface for smart and well-organized agriculture, including post-harvest management and distribution. For this project, Microsoft has joined in with its local partner, Crop Data. In this regard, a MoU and tripartite agreement have been exchanged in the presence of Cabinet Minister Shri Tomar and the two Ministers of State. The project is for one year and both sides inking the MoU will bear the cost on their own. This project will carry out various tasks for the betterment of farmers in the selected 100 villages, which will enhance their income.

# 'मधुक्रान्तिपोर्टल' and 'Honey Corners'

Shri Narendra Singh Tomar launched **"मधुक्रान्तिपोर्टल" and Honey Corners** of NAFED. "मधुक्रान्तिपोर्टल" is an initiative of National Bee Board (NBB), Ministry of Agriculture and Farmers Welfare under National Beekeeping & Honey Mission (NBHM). This portal is being developed for online registration to achieve traceability source of Honey and other beehive products on a digital platform. Technical and banking partner - **Indian Bank**.

**Objective:** The Madhu kranti Portal has been developed for online registration to achieve the traceability source of Honey as well as other beehive products on the digital platform. It will also help in checking the quality and the source of adulteration of honey.

# India Starts Export of Organically Grown Millets of the Himalayas to Denmark

The first consignment of millets grown in the Himalayas from snow-melt water of Ganges in **Dev Bhoomi, Uttarakhand** will be exported to Denmark.

**APEDA**, together with **Uttarakhand Agriculture Produce Marketing Board (UKAPMB)** and **Just Organik** has sourced and processed finger millet or ragi and barnyard millet or jhingora from Uttarakhand farmers for exports that meets the organic certification standards of the EU. The UKAPMB purchased millets directly from the farmers that have been processed in the state-of-art processing unit made by mandi board and run by Just Organic.

# Switzerland's first pilot plant for indigenous forest biomass extraction

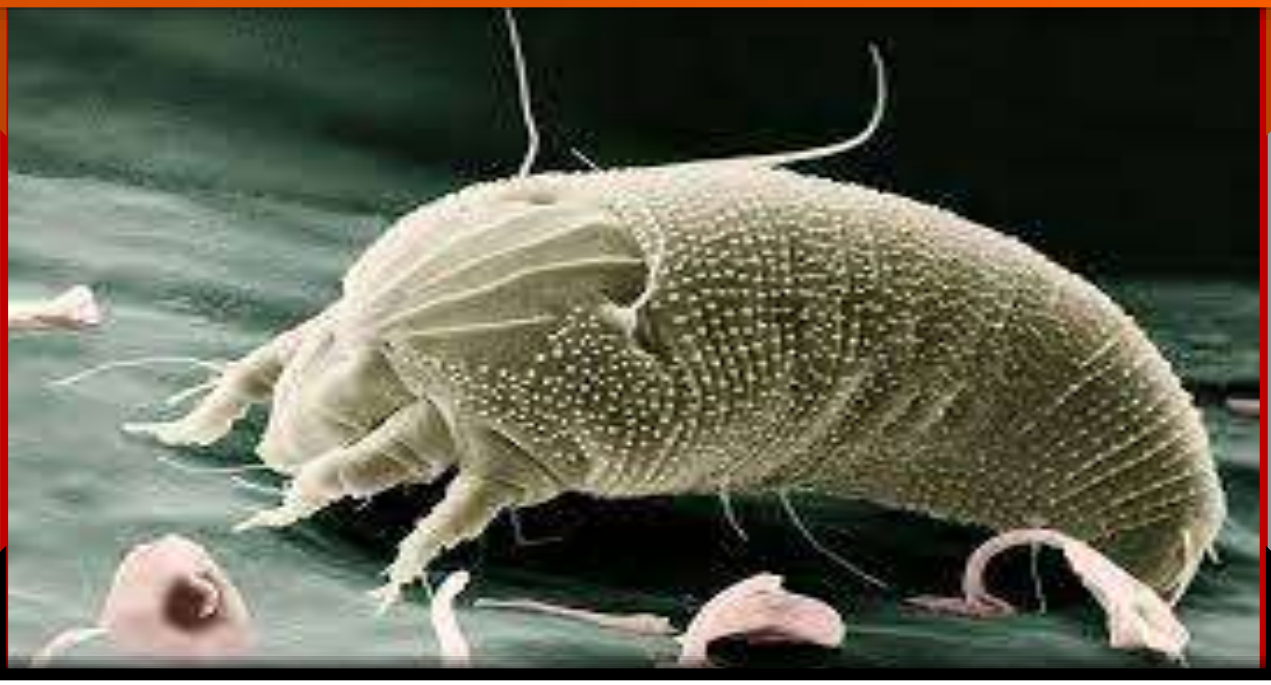
For the first time, it is possible to produce biomass extracts in sufficient quantity and quality for the development of technologically mature applications. Extraction processes are also being tested in a **pilot phase**. The aim is to adapt them to an industrial production scale. From 2015 to 2018, based on the National Research Programme 'Resource Wood's' (NRP 66) Tann Ex project, scientists at BFH demonstrated the chemical composition of conifer bark extracts for the first time. They also determined the influence of the extraction parameters on the chemical composition.

# Food grains production target is set at 307 million tonnes for 2021-22

Narendra Singh Tomar inaugurated '**The National Conference on Agriculture for Kharif Campaign-2021'** on 30 April, 2021. Tomar announced the setting of higher production targets of food grains from 301.92 to **307 million tonnes** for the year 2021-22 in comparison to production targets for previous corresponding year 2020-21.

As per 2nd advance estimate the achievements are likely to be **303.34 million tonnes** for year 2020-21. Higher production targets for pulses and oilseeds are the necessity of the nation to reduce our dependency on import and to achieve the dream of Aatmanirbhar Bharat.

# Eriophyid Mite infestation found in Amaranthus



A team of researchers in **Kasaragod** has found **Eriophyid mite**, which damages Amaranthus, a common leafy vegetable cultivated all over the country.

The researchers said such infestation in Amaranthus was being **reported for the first time in India**. The mite causes severe malformation of the shoot, making it fibrous and reducing the yield. The researchers, **Dr. K.M. Sreekumar**, Professor and Head, Department of Entomology, College of Agriculture, Padanekkad; Dr. Srinivasa Nagappa, and N. Sivamoorthy, Project Director, All India Network, Agricultural Acarology, found the mite in Amaranthus.

# ICAR-IISR gets Patent for Seed Coating Composition


For a Seed Coating Composition and its preparation, the **Indian Institute of Spices Research, Kozhikode, Kerala** has received Patent (350698). The Institute has successfully developed, field-tested and commercialized the Seed Coating Technology of PGPR / beneficial microbes for seeds. The technology was developed by a team including ***Dr. M. Anandaraj, Dr. Y.K .Bini and Dr. A.K. Johny***.

The process prevents the **seed desiccation and ensures protection against environmental stress.** It also **protects the seed against storage pests** which, in turn, **enhances the longevity** of the seeds **ensuring the enhanced germination.**

# SWASTIK AGRICULTURAL DATA ANALYSIS SERVICES

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# 64% of world's arable land at risk of pesticide pollution

Around 64 % of land used for agriculture and food crops is at risk of pesticide pollution and almost a third of these areas are considered to be at high-risk, a global study of agricultural land across 168 countries has revealed. Asia houses the largest land areas at high risk of pollution in countries like China, Japan, Malaysia, and the Philippines. Some of these areas are considered 'food bowl' countries, feeding a large portion of the world's population.

*Globally, 34 % of the high-risk areas are in high-biodiversity regions, 19 per cent in low-and lower-middle-income nations and five per cent in water-scarce areas.*

The study, published in ***Nature Geoscience***, highlighted this through a global map of **168 countries** facing pollution risk caused by 92 chemicals commonly used in agricultural pesticides.

Overuse of pesticides might tip the balance, destabilize ecosystems and degrade the quality of water sources that humans and animals rely on to survive, the study said. “Although the agricultural land in Oceania shows the lowest pesticide pollution risk, Australia’s Murray-Darling basin is considered a high-concern region both due to its water scarcity issues and its high biodiversity,” Federico Maggi, co-author and associate professor from the School of Civil Engineering and the Sydney Institute of Agriculture, said.

# Natural paneer by Sid's Farm

Sid's farm, the Telangana based Modern Dairy Brand has launched natural paneer as one of its key offerings in the list of value-added products aimed to provide quality food and ingredients to the customers. The uniqueness comes from the fact that the company does not use any Hormones, Antibiotics, or Preservatives in the milk and due to which Paneer's freshness & softness is maintained.

This newly launched Paneer known as 'Soft & Creamy Paneer' is targeted at vegetarians who are conscious to earn proteins in their daily diet and is a popular ingredient consumed by people across India.

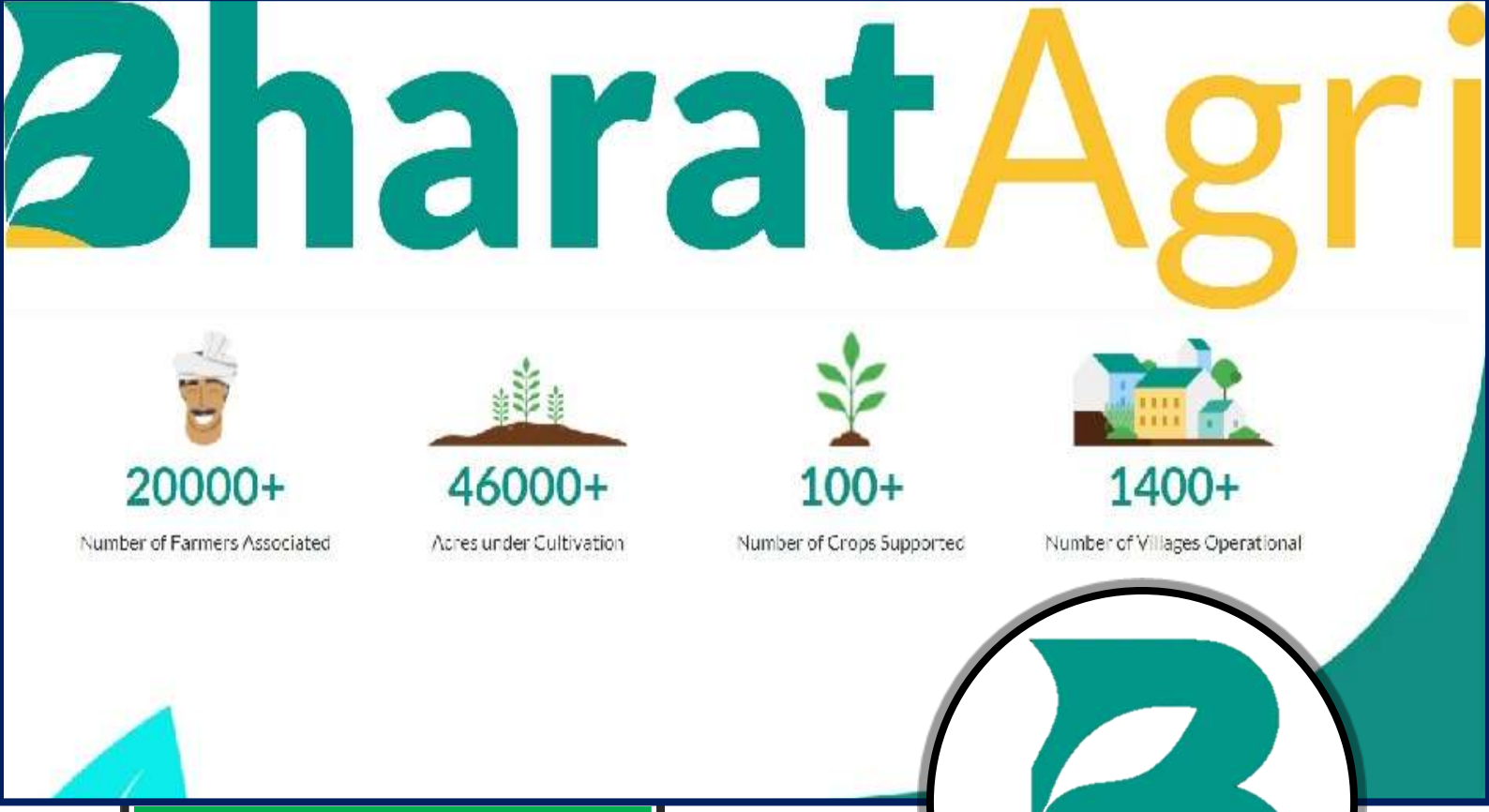

With this launch, the company aims to grab its share of pie from the paneer market in Indian which is worth **INR 75,000 crore**. The local brand within Telangana aims to become a regional brand very soon and target consumers acquire taste of fresh paneer. With the real freshness & softness of Natural Paneer, Indian households can now experience tasty, healthy, and nutritious savory paneer recipes at the comfort of their home. The brand ensures to maintain its freshness of its natural Paneer with the shortest shelf life.

Launching natural paneer, Dr Kishore Indukuri Founder & CEO · Sid's Farm says, ***"Our brand philosophy has been to provide consumers a non-adulterated dairy products and offer consumers to experience the real freshness of dairy products. We are the only company which is introducing healthier dairy products in Telangana and hope to continue adding more products in the consumption basket of the informed consumers.***

Cover Story

# Blooming Agri Startups

*Although India is known as an agriculturally important country, leading producer of pulses, jute spices etc And second largest producer of rice, wheat, sugarcane, groundnut, vegetables, fruit and cotton but somewhere the exponential growth of population and exponential downturn of availability of land the nation is facing multiple Challenges like worsening of soil health, rapidly changing weather conditions, declining of water availability, lack of Updated knowledge in farmers. To combat these challenges growing number of agri-startups in India in last decade is Providing ray of hope .startups are trying to resolve problems in every aspect of Indian agriculture like- [A]improving Efficiency of the supply chain ensuring availability of superior product and also increasing the job opportunities[B]providing crop insurance [C]use of technology and innovative plans to increase the yield, attract investor's interest , enhance number of farm storage and processing units.*




# 1- BharatAgri

It's a **pune** based agritech startup [B2C Subscription Business model] founded in **2017** by **Siddharth dialani and Sai gole** with total funding of 2.5 Mn US Dollars accompanied by **30 team members**. 2021 Capital, Indian quotient were the initial investors in this startup. PLANTIX, FASAL, CROP DATA are primary competitor of this startup. In Recent date it has grown up to a family with **4.5 lakh subscribers** and **45 thousand paid subscribers.**

# BharatAgri

- Technology enabled digital services
- App based platform
- Personalized advises to farmers
- Real time monitoring
- Weather based advisory

**Total Funding**

**$2.5 Mn**

Currently it is helping more than **7 lakh farmers**

Won the UberPITCH competition in March 2017 after which uber invested **Dollar 50,000 [Rs 35 lakh]**

**Founders**

**Siddharth dialani**
**Sai gole**


# 2- Agrowave

It's a **Delhi NCR** based agritech startup **[farm-to-business mobility supply chain of fruits & vegetable]** which was founded in **2017** by **Anu meena** with a team size of 40 members and **700K US Dollar** investment. sekhar puli and daffodil softwares are primary Investors and the startup is handling about **more than 500 clients**. Ninja cart, dehaat and crofarm are the Primary competitors of agrowave.

# Agrowave

The startup focuses on-building farm to market mobile supply chain, buys product from farmers, do grading And sorting and then supply to businesses. It has established mobile pickup station models to obtain more Produce from farm gates. Startup is aiming for more than **1000 MPS** with better rates.

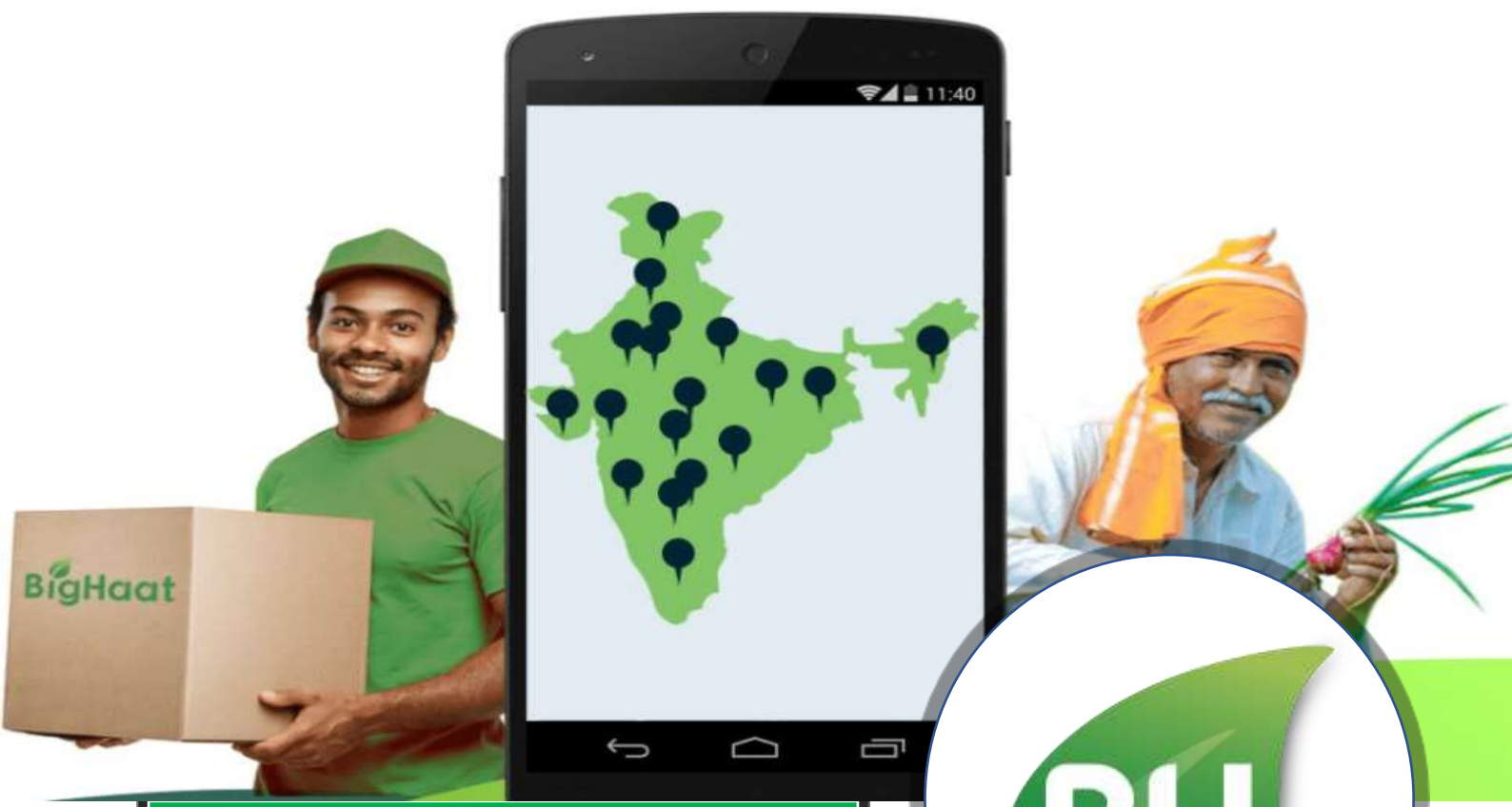
The primary objective of the MPS model is to simplify data collection and help farmers earn more income.

**Turnover**

**$ 3.7 Mn**

## Founder

An IIT Delhi graduate **Anu meena**, who belongs to a small village manoli in Rajasthan teamed up with his batch mate **Payal Jawalkar** and **Arun yadav** in 2017 came up with a startup idea to help struggling farmers by optimizing Agricultural supply chain by eliminating middle men using research, analytics and technology through their Venture. Anu grew up experiencing how her farmer grandfather face challenges in selling his harvested Produce.




# 3- BigHaat

**Bighaat** is a **Bengaluru** based agritech startup **[B2C Market place business model]** founded in 2015 by **Sachin Nandwana and Sateesh N** with the support of 70 team members and total funding of dollar 3 Mn.ankur Capital and beyond next ventures were the primary investors of this startup.

# BigHaat

The startup works by-accepting online orders, sales people directly interact with farmers to help them place Orders, has missed call service to support technologically backward farmers, connects farmers to verified Suppliers directly and reduce travel periods required to obtain the desired product.Bighaat is recently connected to approx 4 Mn farmers.


Founder

Sachin

Sateesh

$52 Bn

Turnover


# 4- Ergos

ergos
empowering participation

It's a **Patna** based Agritech startup firm founded in **2012**, **B2B and B2C Business model** by **Kishor jha and Praveen Kumar** with the team size of 210 members and dollar 14 Mn [equity] and dollar 5 Mn [debt] Funding invested by AAVISHKAAR, Chiratae venture and CDC group pic.the startup is connected to about **45.5K farmers, 213 buyers [food processors] and 6 NBFCs and banks.**

# Ergos

**Work**

Ergos has one of the most unique model of startup .it aims to help small and marginal farmers in India by Digitizing the food grain distribution. It focuses on – building grain banks which will provide door to door Access to post harvest supply chain, enable farmers to convert their grains into tradable digital assets, teach To earn credit against those assets through banks and get better price.

Founder

kishor jha

Praveen Kumar

45+ K

Farmers


# 5- FRESHOKARTZ

It's a **B2B, B2C Business model** agritech startup based in jaipur founded by **Rajendra Lora and Chandrakanta** In **2016** with the aim of providing soil data based crop and fertilizers recommendations to farmers Doorstep. With the team size of 80 members and funding of about dollar 1.6 Mn invested by RVCF and AWE Funds it is now connected to more than **120K farmers** and about **100 B2B customers.** Agrostar and Dehaat are the primary competitors.

# FRESHOKARTZ

**Work**

**The firm works on – on demand procurement model to provide fresh fruits and vegetables that are directly Obtained from farms, connects farmers and consumers directly through online platform, help farmer in Market linkages, financial support and advisory.**

**Turnover**

**$ 1.6 Mn**

**Founder**

**Rajendra Lora Chandrakanta**

## CONCLUSION

With the increasing demand of population, land, management, yield etc. AGRITECH STARTUPS are the ray of hope. As it is known that everything comes with its pros and cons so, besides counting the disadvantages we have to accept the idea of startups to satisfy the exponential growing of demands. Now agritech in India is still at infant stage with just a minimal amount of penetration of the addressable market potential of USD 24Bn. increased investment activity in the last few years has helped to accelerate growth in this sector from last decade. However, for the Indian agritech market to reach its potential stake holders across the startup system need to intervene.

Author
Madhusmita Panda
IGKV,Raipur (CG)

# Nutritional benefits of Black Rice

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Rice has been consumed as a staple food since the ancient time. Rice is grown in different varieties around the world, including colors i.e. white, yellow, brown, and black rice, which are named for the physical appearance of the bran. Rice that is pigmented black is known as black rice. It includes essential amino acids, lipids, dietary fibres, vitamins, and other nutritional and bioactive components. Anthocyanins, phenolic compounds, oryzanols, tocopherols, phytosterols, and phytic acid. Consumption of black rice provides numerous health benefits i.e., reduced risk of 2 diabetes and other metabolic diseases including obesity, hypertension, hyperglycemia, dyslipidemia and cancer. They are experimentally renowned and gathered empirical data regarding the physiological and pharmacological activity of black rice encourages utilization of black rice in nutritional therapy.

## Introduction

Rice is a common cereal food consumed by two-thirds of the world's population. This has a lot of genetic variation and has spread all over the world. Many of these grass types belong to the Gramineae or Poaceae family of grasses. *Oryza sativa* L. and *Oryza glaberrima* Steud are the two most common species. *Oryza sativa* is a rice variety that originated in Asia and has since been exported to other countries. Due to its sensory characteristics, high nutritional availability, and health-promoting bioactive components, black rice is a common pigmented rice variety. In Asia, rice genotypes with black, red, and purple bran layers have long been cultivated. This rice has a long and illustrious tradition, and one of its strains includes the “Imperial rice” variety, which was only intended to be eaten by the Emperor. Another kind of rice, known as "forbidden rice," has been consumed in Asia for thousands of years and was once only available to Chinese royalty. These rice varieties were also thought to be effective medicines that could “cure” a number of diseases, as well as sources of staple foods with good flavor, fragrance, and fluffiness. According to published studies, both spontaneous and chemically induced mutations result in the transformation of white rice grains to pigmented rice grains. Researchers are increasingly interested in black rice because of its high nutritive value and antioxidant properties among the pigmented rice varieties.

**Nutritional composition of black rice**

Black rice is a kind of typical whole grain. The pericarp provides protection for the seed coat and gives colour to the rice, resulting in grains that are light brown, red and black, among others. The endosperm of black rice is made up of around 75 percent carbohydrates, mainly starch, and an outer layer (sub-aleurone) that includes proteins. Other polysaccharides found in small quantities in black rice include dietary fibres (resistant starch, cellulose, hemicellulose, and pectins) and simple sugars (glucose, fructose, and saccharose), which are often found in white rice's outer layers. Proteins and lipids are present in the germ, which accounts for around 2-3 percent of the total weight of paddy rice. Black rice has been shown to have nutritional and functional benefits as compared to white rice (Table.1). This is because a number of nutritious and bioactive ingredients, such as essential amino acids, functional lipids, and other bioactive compounds, are used. In the bran layers and embryo, dietary fibre, vitamins (B complex, A, and E), minerals (K, Fe, Zn, Cu, Mg, Mn, and P), anthocyanins, phenolic compounds, oryzanols, tocopherols, tocotrienols, phytosterols, and phytic acid are present.

**Health benefits of black rice**

- **Anti-inflammatory Properties**

Researches were conducted at the University of Suwon, South Korea in which two groups of animals were taken. Group A animals consumed black rice while Group B animals consumed ordinary, brown, and red rice. They have observed that black rice has shown the skin anti-inflammatory action (Dermatitis) while others varieties have not significant effect.

- **Effect over obesity**

Balck rice consumption helps in weight management. This is because black rice consumed unpolished, it contains fibres which helps in digestibility. It also assists in body detoxification. It provides satiety when consumed enough amount and manages calory intake. It reduces the fatty acids synthesis thus lowers in intracellular accumulation between the tissues.

- **Prevention of cardio-vascular activity**

Early studies showed that black rice bran rich in polyphenols like anthocyanins which are beneficial to Cardiovascular health by lowering LDL (low density lipoprotein) or bad cholesterol and increasing HDL (high density lipoprotein) or good cholesterol levels. Consumption of black rice decreases the chances of both artherosclerosis and heart attack. Simply we can say that anthocyanins prevent the accumulation of bad cholesterol over heart valves and also reduces blood plasma levels of cholesterol.

- **Anti-cancer effect**

Scientists reported that carotenoids reduce the incidence of cancer and cardiovascular disease. It is also found that anthocyanin extract of black rice bran is able to reduce the growth of liver cancer cells. Black rice also has importance in treating skin cancer.

- **Anti-diabetic effect of black rice**

Black rice contains low amounts of sugar and high amounts of fibre. After consumption of black rice, it doesn't fluctuate the blood sugar levels and it is beneficial in management of diabetes mellitus. It is found that rice grains amylose contents are varying and its effect on blood sugar are also varying according to the consumed rice variety.

- **Anaemia:** The reason behind dark colour of Black rice is iron richness. Thus, it is rich source of iron. It shows beneficial effects over anaemia.

- **Other benefits:** It is also useful in allergies thus black rice bran restricts that release of histamine. Which leads in decrease in inflammation. Black rice is rich in fibre so this helps to the patient suffering from constipation by increasing bowel movements. Black rice is ideal for use in the development of products for patients with celiac disease because it is gluten-free. Black rice can also act as a natural antioxidant. These compounds may influence biological functions either individually or synergistically, meaning that foods containing antioxidants, one or more, may deliver greater health benefits than the sum of each antioxidant alone.

## Conclusion

Cereal foods have been always inevitable part of human diet. Rice is alone providing more than half of the world nourishment. Pigmented variety of rice has increased the physical, chemical, functional and health benefits many folds. Essential amino acids, functional lipids, dietary fibre, vitamins (B complex, A and E), minerals (K, Fe, Zn, Cu, Mg, Mn, and P), anthocyanins, phenolic compounds, -oryzanols, tocopherols, tocotrienols, phytosterols, and phytic acid are among the nutritious and bioactive components contained in the bran layers and embryo. There are sufficient data available which supports all the health benefits from black rice. The availability of different nutrients which help in reducing the many health related problems. Furthermore, the use of black rice in such products could help to meet the growing demands of the food industry. We could conclude this if any modification in food is providing us better nourishment welcome it with open heart.

**Further reading**


- Ito, V. C., & Lacerda, L. G. (2019). Black rice (*Oryza sativa* L.): A review of its historical aspects, chemical composition, nutritional and functional properties, and applications and processing technologies. Food chemistry, 301, 125304.
- Agrawal, A. (2020). Black Rice the New black gold of India. Food and Agriculture Spectrum Journal, 1(03), 96-99.


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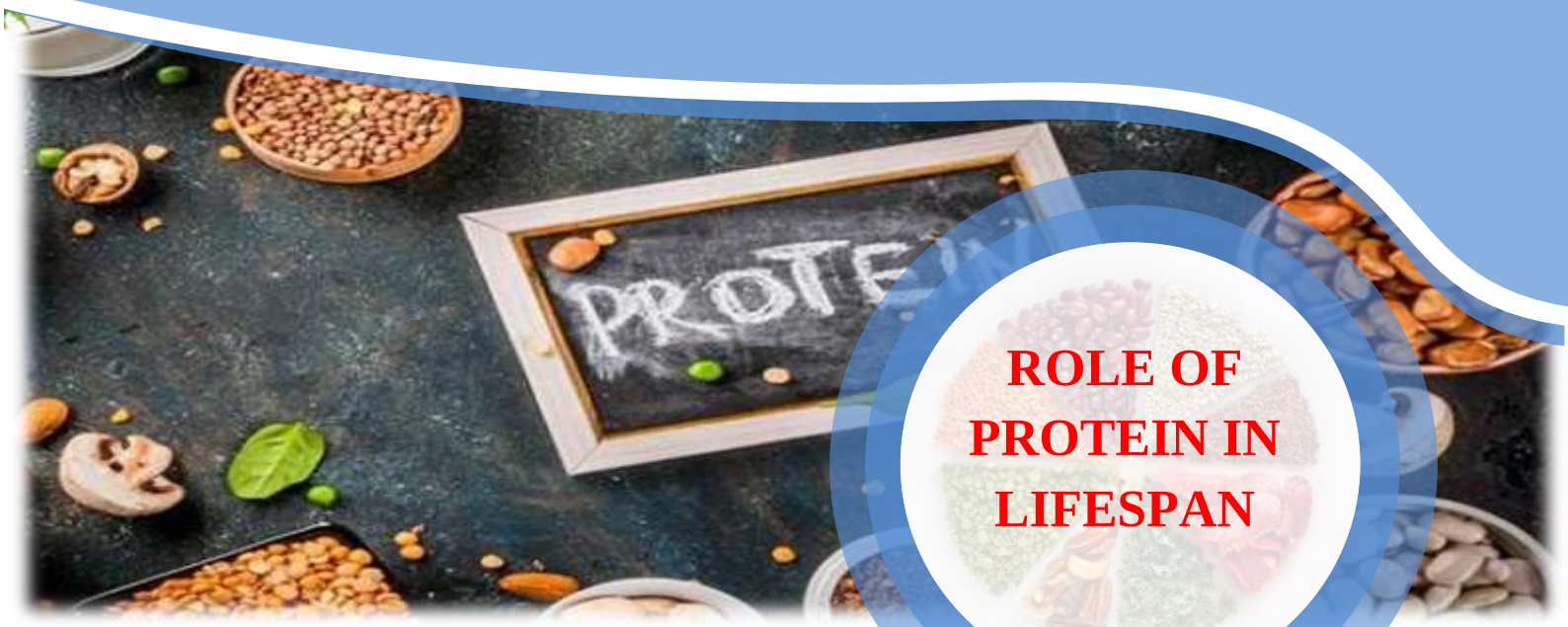

# ROLE OF PROTEIN IN LIFESPAN

**Akanksha Singh***

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Proteins are linear polymers built of monomer units called amino acids. Proteins are the embodiment of the transition from the one-dimensional world of sequences to the three-dimensional world of molecules capable of diverse activities. Proteins contain a wide range of functional groups. Proteins can interact with one another and with other biological macromolecules to form complex assemblies. Some proteins are quite rigid, whereas others display limited flexibility. An overview of the pathway from early nutrient deficiency to long-term brain function, cognition, and productivity, focusing on research from low- and middle-income countries. Animal models have demonstrated the importance of adequate nutrition for the neurodevelopmental processes that occur rapidly during pregnancy and infancy, such as neuron proliferation and myelination. However, several factors influence whether nutrient deficiencies during this period cause permanent cognitive deficits in human populations, including the child's interaction with the environment, the timing and degree of nutrient deficiency, and the possibility of recovery. Oxidative damage to cellular macromolecules has been postulated to be a major contributor to the ageing of diverse organisms. Oxidative damage can be limited by maintaining high anti-oxidant defenses and by clearing/repairing damage efficiently. Protein turnover is one of the main routes by which functional proteins are maintained and damaged proteins are removed. Protein turnover rates decline with age, which might contribute to the accumulation of damaged proteins in ageing cells.

## Introduction

Proteins are the most versatile macromolecules in living systems and serve crucial functions in essentially all biological processes. They function as catalysts, they transport and store other molecules such as oxygen, they provide mechanical support and immune protection, they generate movement, they transmit nerve impulses, and they control growth and differentiation. Indeed, much of this text will focus on understanding what proteins do and how they perform these functions. Several key properties enable proteins

to participate in such a wide range of functions. Proteins are linear polymers built of monomer units called amino acids. The construction of a vast array of macromolecules from a limited number of monomer building blocks is a recurring theme in biochemistry. Does protein function depend on the linear sequence of amino acids? The function of a protein is directly dependent on its three dimensional structure. Remarkably, proteins spontaneously fold up into three-dimensional structures that are determined by the sequence of amino acids in the protein polymer. Thus, proteins are the embodiment of the transition from the one-dimensional world of sequences to the three-dimensional world of molecules capable of diverse activities.

Proteins contain a wide range of functional groups. These functional groups include alcohols, thiols, thioethers, carboxylic acids, carboxamides, and a variety of basic groups. When combined in various sequences, this array of functional groups accounts for the broad spectrum of protein function. For instance, the chemical reactivity associated with these groups is essential to the function of enzymes, the proteins that catalyze specific chemical reactions in biological systems. Proteins can interact with one another and with other biological macromolecules to form complex assemblies. The proteins within these assemblies can act synergistically to generate capabilities not afforded by the individual component proteins. These assemblies include macro-molecular machines that carry out the accurate replication of DNA, the transmission of signals within cells, and many other essential processes. Some proteins are quite rigid, whereas others display limited flexibility. Rigid units can function as structural elements in the cytoskeleton (the internal scaffolding within cells) or in connective tissue. Parts of proteins with limited flexibility may act as hinges, springs, and levers that are crucial to protein function, to the assembly of proteins with one another and with other molecules into complex units, and to the transmission of information within and between cells.

**1. Role of protein in brain development**

When a child is adequately nourished from conception through infancy, the essential energy, protein, fatty acids, and micronutrients necessary for brain development are available during this foundational period, establishing the basis for lifetime brain function. Abnormal interactions and misfolding of synaptic proteins in the nervous system are being extensively explored as important pathogenic events resulting in neurodegeneration in various neurological disorders. These include Alzheimer’s disease (AD), Parkinson’s disease (PD), and Dementia with Lewy Bodies (DLB).

Lipoprotein receptors have important roles in pathological processes that lead to Alzheimer's disease (AD). Previously, they were believed to act mainly by modulating the neuronal metabolism of cholesterol and apolipoprotein E, major risk factors for spontaneous AD. However, recent findings point towards an unexpected new function for lipoprotein receptors in regulation of intracellular transport and processing of the amyloid precursor protein (APP) to give amyloid-β peptide, the principal component of senile plaques. Here, we will discuss how lipoprotein receptors might modulate distinct steps in neuronal trafficking of APP, and how an intricate balance between opposing receptor activities might be a crucial determinant of APP processing, and of onset and progression of neurodegeneration (Andersen and Willnow, 2006).

**Food and protein/energy supplementation**

Children who experience severe acute malnutrition, chronic malnutrition, and low birth weight tend to face other disadvantages that also affect brain development, such as poverty, poor housing and sanitation, poor healthcare, and less stimulating home environments, making it difficult to draw a causal link from observational studies. The results of randomized trials of maternal and child food supplementation, which

provide stronger evidence of causation, are mixed (Table 2). Such trials that provided supplements to both mothers during pregnancy and children throughout the first 2 years of life showed the strongest evidence for long-term positive effects regarding cognition. In a large trial in Guatemala, pregnant women and their children up to the age of 7 years were provided with a milk-based high protein and energy drink with micronutrients or a low protein and energy drink with micronutrients. Children who received the high protein and energy drink had higher cognitive scores at 4–5 years of age, higher scores on tests of numeracy (math), knowledge, vocabulary, and reading achievement at 11–18 years of age54 and on reading and IQ scores (among women) at 22–29 years of age, 101 and a 46% increase in average wages (among men) at 26–42 years of age. While some of the effects on school-age performance were found in the late exposure group (after the age of 2 years), most of these effects were only found among individuals who began supplementation before the age of 2 or 3 years, including the effect on average wages. In contrast, few long-term effects have been reported when supplementation was provided only to mothers or only to children, though some such trials have demonstrated short-term cognitive and motor effects (Table 1).

**Table 1: Randomized trials of food supplementation with micronutrients and/or balanced protein and energy to mothers and/or children and their effect on brain development**

| Study location | Intervention | Age at intervention | Age at assessment | Results |
|---|---|---|---|---|
| New York City (Rush, D., 1984) | High protein and energy drink with increased amounts of micronutrients versus moderate protein and energy drink with standard amounts of micronutrients | Maternal supplementation throughout pregnancy until birth | 12 months | No effect was found on the BSID mental or motor scores at age 12 months, but children whose mothers had received the high protein/energy drink scored higher on two information processing measures (visual habituation and dishabituation) and one of five measures of play (length of play episodes). |
| Taiwan (Joos *et al.*, 1983) | High protein and energy drink with micronutrients versus no protein, low energy drink with micronutrients | Maternal supplementation throughout pregnancy and lactation | 8 months | A positive effect was found on BSID motor but not mental scores. |
| | | | 5 years | No effect on IQ or mental age (mental ability expressed in years of age by comparison with a norm reference group). |
| Guatemala (Hoddinott *et al.*, 2008) | High protein and energy drink with micronutrients versus no protein, low energy drink with micronutrients | Maternal and child supplementation throughout pregnancy and until age 7 years | 11–18 years | Positive effects were found on tests of math and knowledge scores. Positive effects on vocabulary and reading achievement were found only in children who received supplementation before 2 years of age. |
| | | | 22–29 years (women) | A positive effect was found on reading and IQ scores. |

| Study location | Intervention | Age at intervention | Age at assessment | Results |
|---|---|---|---|---|
| | | | 26–42 years (men) | The high protein and energy drink resulted in a 46% increase in average wages. |
| Colombia (Super and Herrera, 1991) | Families who were provided with food (e.g., oil, dried milk, and bread) versus families who did not receive food | Throughout pregnancy and until age 3 years | 3 years | A positive effect was found on Griffith's Developmental Quotient. |
| | | | 5–8 years | A positive effect was found on reading readiness but not arithmetic or knowledge. |
| Indonesia (Pollitt *et al.,* 1997) | Children in daycare centers who were provided with snacks containing protein and energy versus children in daycare centers not provided with snacks | Children between ages 6 and 20 months at enrollment for 3 months of intervention | 9–23 months | A positive effect was found on BSID motor but not mental scores. |
| | | | 8–9 years | A positive effect was found on a test of working memory but not on reaction time, recall, emotionality, vocabulary, or arithmetic |
| Indonesia (Pollitt *et al.,* 2000) | High protein and energy milk plus micronutrient tablet (treatment 1) versus low protein and energy milk plus micronutrient tablet (treatment 2) versus low protein and energy milk plus placebo (control) | Children age 12 or 18 months at enrollment for 12 months of intervention | 24 or 30 months | Positive effects of the two treatments versus the control were found on several measures of motor development and activity levels. An effect of the high protein and energy milk was found on one of several measures of cognitive development. |
| Jamaica (Walker *et al.*, 2007) | Stunted children assigned to supplementation with high protein and energy milk or psychosocial stimulation or both supplementation and stimulation versus non-stunted controls | Children age 9–24 months at enrollment for 2 years of intervention | 33–48 months | A positive effect of supplementation was found on Griffith's Developmental Quotient as well as the locomotor and performance subscales |
| | | | 7–8 years | No effect of supplementation on a battery of cognitive tests |
| | | | 11–12 years | No effect of supplementation on a battery of cognitive tests |
| | | | 17–18 years | No effect of supplementation on cognition or mental health |

## 2. Role of protein in learning disabilities

Institute of Molecular and Cell Biology (IMCB) have identified the precise role of the protein, SNX27, in the pathway leading to memory and learning impairment. The study broadens the understanding of the brain's memory function and could be used to explain defects in the cognitive development of those with Down's syndrome. The newly established knowledge could potentially facilitate exploration of strategies to improve memory and learning abilities in Down's syndrome.

Down's syndrome is a genetic condition characterized by the presence of an additional copy of chromosome 21. About one in eight hundred new-borns is diagnosed with Down's syndrome. It is a condition that leads to impairments in both cognitive ability and physical growth that range from mild to moderate developmental disabilities. Yet, there is still no treatment for it. In an earlier study published in Nature Medicine, an international team of scientists discovered that the additional copy of chromosome 21 in Down's syndrome reduces the production of SNX27 in the brain and results in synaptic dysfunction. Synapse, a structure that permits nerve cells to pass chemical signals to each other, is known to have an important role in memory formation and its dysfunction could result in impairment. By re-introducing SNX27 into the brain, memory could be restored hence suggesting that SNX27 is an essential protein for memory and learning.

The protein's role in the pathway leading to memory impairment, however, remained unclear until scientists from IMCB utilised live-cell imaging techniques to elucidate the mechanism of memory impairment and illustrated how SNX27 attributes to synaptic dysfunction. The correlation established between SNX27 levels and memory could explain why individuals with Down's syndrome encounter memory and learning difficulties. Identifying the target and its role is a crucial first step to therapy -- having known the role of SNX27 in memory impairment, future research on Down's syndrome could focus on developing strategies which can effectively re-introduce the protein into the brain to restore memory and learning abilities.

Protein malnutrition induces structural, neurochemical and functional changes in the central nervous system leading to alterations in cognitive and behavioral development of rats. The aim of this work was to investigate the effects of postnatal protein malnutrition on learning and memory tasks. Previously malnourished (6% protein) and well-nourished rats (16% protein) were tested in three experiments: working memory tasks in the Morris water maze (Experiment I), recognition memory of objects (Experiment II), and working memory in the water T-maze (Experiment III). The results showed higher escape latencies in malnourished animals in Experiment I, lower recognition indexes of malnourished animals in Experiment II, and no differences due to diet in Experiment III. It is suggested that protein malnutrition imposed on early life of rats can produce impairments on both working memory in the Morris maze and recognition memory in the open field tests.

## Role of protein in ageing

Although the molecular mechanism of aging is unknown, a progressive increase with age in the concentration of damaged macromolecules, especially proteins, is likely to play a central role in senescent decline. In this paper, we discuss evidence that the progressive decrease in protein synthesis and turnover can be the primary cause of the increase in the concentration of damaged proteins with age. Conversely, protein damage itself is likely to be the cause of the decrease in protein turnover. This could establish a positive feedback loop where the increase in protein damage decreases the protein turnover rate, leading to

a further increase in the concentration of damaged proteins. The establishment of such a feedback loop should result in an exponential increase in the amount of protein damage- a protein damage catastrophe- that could be the basis of the general deterioration observed in senescent organisms (Ryazanov and Nefsky, 2002).

Pan and Finkel (2017) review three sets of key proteins and their corresponding downstream pathways that have been linked to extending lifespan and promoting health span in awide range of organisms. In particular, we review the biology of the sirtuin family of proteins, the insulin/insulin-like growth factor (IGF) signaling (IIS) pathway, and themechanistic target of rapamycin (mTOR). Using insights derived from simple model organisms, mice, and humans we discuss how these proteins and pathways may potentially alter the rate of aging. We further describe how knowledge of these pathways may lead to the rational design of small molecules that modulate aging and hence alter the propensity for a host of age-related diseases.

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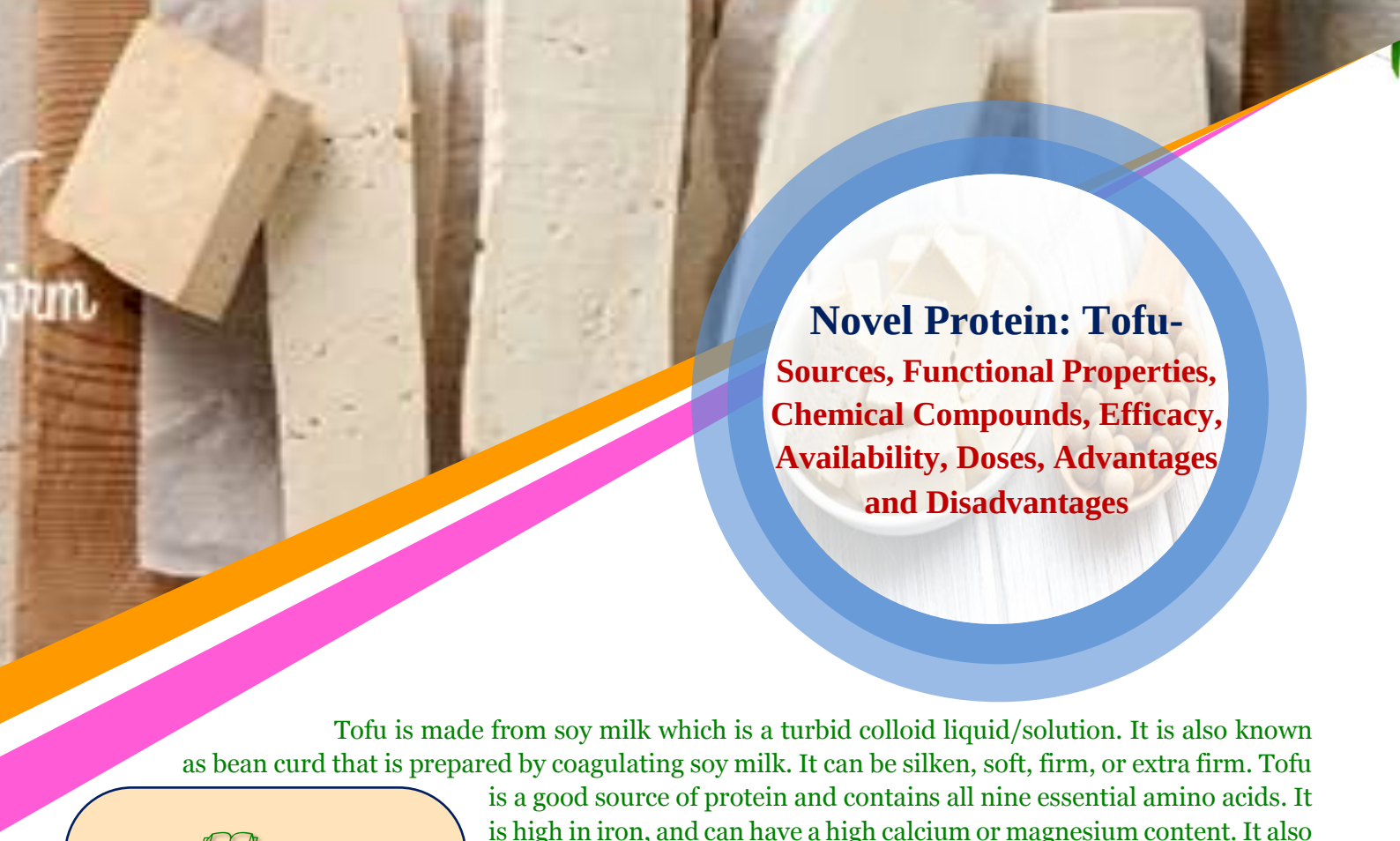

# Novel Protein: Tofu-

## Sources, Functional Properties, Chemical Compounds, Efficacy, Availability, Doses, Advantages and Disadvantages

Tofu is made from soy milk which is a turbid colloid liquid/solution. It is also known as bean curd that is prepared by coagulating soy milk. It can be silken, soft, firm, or extra firm. Tofu is a good source of protein and contains all nine essential amino acids. It is high in iron, and can have a high calcium or magnesium content. It also contains magnesium, copper, zinc and vitamin B1. Tofu may reduce the risk of heart disease, high intake of legumes, including soy, is linked to lower rates of heart disease. Tofu can be served instead of meat or incorporated into a variety of dishes. It is beneficial in various diseases like, cardiovascular diseases, breast and prostate cancer, type 2 diabetes, kidney function, osteoporosis, menopause, liver damage, age related brain diseases. There are some disadvantages with consumption of tofu that are: hay fever, asthama, cystic fibrosis, kidney stone, hypothyroidism, milk allergy and kidney failure.

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### Introduction

Tofu, also known as bean curd, is a food prepared by coagulating soy milk and then pressing the resulting curds into solid white blocks of varying softness; it can be *silken*, *soft*, *firm*, or *extra firm*. Beyond these broad categories, there are many varieties of tofu. It has a subtle flavour, so it can be used in savory and sweet dishes. It is often seasoned or marinated to suit the dish and its flavors, and due to its spongy texture it absorbs flavours well. It is most often treated as a meat substitute. It is a traditional component of East Asian and Southeast Asian cuisines, and has been consumed in China for over 2,000 years.

Nutritionally, tofu is low in calories, while containing a relatively large amount of protein. It is high in iron, and can have a high calcium or magnesium content

depending on the coagulants e.g. calcium chloride, calcium sulfate, magnesium sulfate that is used in manufacturing.

**Sources of Tofu**

Tofu is a good source of protein and contains all nine essential amino acids. It is also a valuable plant source of iron and calcium and the minerals manganese and phosphorous. It also contains magnesium, copper, zinc and vitamin $B_1$.

**Functional Properties of Tofu**

It contains no cholesterol and is an excellent source of iron and calcium. It is an important source of protein, especially for vegans and vegetarians. Tofu is available for purchase in health food stores and online. It also contains isoflavones such as phytoestrogens.

**Nutritive Value of Tofu per 100 gram**

| Nutrients | Amount |
|---|---|
| Moisture | 83.7% |
| Energy | 77 Kcal |
| Carbohydrate | 3.0 g |
| Protein | 8.0 g |
| Fat<br>• Fatty acids, saturated<br>• Fatty acids, mono-unsaturated<br>• Fatty acids, poly-unsaturated | 4.5 g<br>0.65 g<br>0.99 g<br>2.5 g |
| Fiber | 0.4 g |
| Ash | 0.84 g |
| Isoflavones | 35 mg |
| Calcium | 162 mg |
| Iron | 1.45 mg |
| Magnesium | 46 mg |
| Phosphorous | 147 mg |
| Potassium | 176 mg |
| Sodium | 8 mg |
| Zinc | 1 mg |
| Copper | 0.24 mg |
| Manganese | 0.72 mg |
| Selenium | 9.4 µg |
| Vitamin C (ascorbic acid) | 0.20 mg |
| Thiamine (vitamin $B_1$) | 0.093 mg |
| Riboflavin (vitamin $B_2$) | 0.1 mg |
| Niacin (vitamin $B_3$) | 0.01 mg |
| Pantothenic acid (vitamin $B_5$) | 0.065 mg |
| Pyridoxine (Vitamin $B_6$) | 0.061 mg |
| Folic acid (Vitamin $B_9$) | 33 µg |
| Retinol (Vitamin A) | 1.0 µg |

[Source: USDA Nutrient Database for Standard Reference]

**Chemical Compounds of Tofu**

Tofu is made from soy milk which is a turbid colloid liquid/solution. Tofu structure is related to soy milk components, particularly colloid components such as protein particles and oil globules. Protein particles content increases with the increase of the globulin ratio in the soybeans. Tofu varieties ensue from adding coagulants at various concentrations.

Tofu is made from the soybean mixtures having different 11S/7S ratio by adding coagulants of various concentrations. The tofu having high 11S/7S ratio showed a hard texture at low coagulant concentration, and the tofu having low 11S/7S ratio needed more coagulant for the maximum hardness. Before the tofu reached maximum hardness, the tofu structure had a large cell and thin wall of network and after it reached the maximum hardness, its network structure showed a large cell with many holes and no flat wall. However, the tofu structure near maximum hardness had fine and even cells with the coagulant concentration of a changing point from increase of hardness to constant. Therefore, tofu from soybeans having larger 11S/7S ratios could have a fine structure with lower coagulant concentration.

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**Efficacy of Tofu**

Tofu may reduce the risk of heart diseases, high intake of legumes, including soy, is linked to lower rates of heart disease. Tofu, which is also known to contain soy isoflavones, can help to reduce blood vessel inflammation and improve their elasticity.

**Availability of Tofu/Soy**

It is a traditional component of East Asian and South East Asian cuisines, and has been consumed in China for over 2,000 years. India is now world's fifth largest producer of soy, with production centered in regions like Vidarbha and Madhya Pradesh where planting experiments took place in 1935.

Tofu is categorized by texture, or consistency. The texture is determined by the water content present in the tofu. The more water, the softer or 'silkier' the tofu; with less water, the tofu is firmer. Tofu is categorized as silken, regular, firm, extra-firm and super-firm. Silken, the softest type of tofu can be compared to a young white cheese. Firm tofu, the most common, has the same consistency as feta, while the texture of super-firm can be compared to that of meat.


1. **Silken:** Silken tofu, also known as Japanese-style tofu, is silky, creamy and has the highest water content. If you try to hold it, it will fall to pieces. Silken tofu looks like a very young cheese such as burrata (a kind of mozzarella), can be used as a thick cream, fresh cream cheese or ricotta in cheesecakes, smoothies, dips or even ravioli fillings. You usually prepare dishes with silken tofu when it is wet.
2. **Regular:** This type of tofu is used primarily in Asian dishes. It is a little more compact than silken but still soft. Regular tofu easily soaks up the flavours of sauces and broths and so is often used in noodle soups and stews. You can also make delicious spreads using regular tofu, or 'scrambled' tofu, a vegetarian take on scrambled eggs. Don't pan-fry or deep-fry regular tofu as it is likely to crumble.
3. **Firm:** Of all the types of tofu, firm tofu is the most widely available in supermarkets. Firm tofu is quite compact and is often packaged soaked in liquid – the amount depends on the type of packaging. Firm tofu is like feta: it doesn't crumble when you pick it up and it is easy to chop. In the kitchen, firm tofu is the most versatile of the tofu types. It can be pan-fried, stir-fried, deep-fried, put in a stew, used as a

filling or to make spreads. Be sure to fully dry firm tofu before cooking, to ensure it can absorb the marinade and will splatter less in the pan. Firm tofu can also be bought smoked or seasoned.

4. **Extra-firm:** Extra-firm tofu has less water than firm tofu, which you notice in the difference in texture. The culinary possibilities of firm and extra-firm are almost the same, but extra-firm tofu doesn't absorb marinades as well. On the other hand, extra-firm is easier to pan-fry, stir-fry or deep-fry. Follow your personal preference.
5. **Super-firm:** If you look at super-firm tofu you can easily mistake it for meat because it is so dense. In fact it is a great meat substitute! Cut the tofu into regular-sized slices, sticks or cubes, mix with a hot marinade and pan-fry, stir-fry or deep-fry. Super-firm tofu is not widely available but is easy to make.
6. **Seasoned tofu:** Tofu is also available pre-seasoned. This makes it easier to prepare as you can start as soon as you open the packet! Seasoned tofu is available in different flavours; tamari and tomato/basil are widely available. Seasoned tofu is mostly firm and can be pan-fried, stir-fried, deep-fried, grilled, roasted in the oven, barbecued or eaten raw.
7. **Smoked tofu:** This tofu is extra-firm and has a smoky flavour. Smoking is generally an artisanal process. Originally, tofu was smoked above tealeaves, but today it is mostly done over beech wood, which gives it a great aroma. You can pan-fry or stir-fry smoked tofu, but it is best eaten raw, such as in a winter stew or a summer salad.

8. **Tofu à la minute:** These small tofu pieces are pre-marinated and pre-cooked. All you have to do is add them to a (stir-fry) dish, or pan-fry the tofu à la minute in oil until crispy and add to dishes such as salads and stews. Tofu à la minute can be purchased in a variety of flavours including Asian-spiced, Italian-spiced and Mexican-spiced.
9. **Pressed tofu:** When tofu is pressed under high pressure, very little water remains, giving it a meat-like texture that can be compared to that of super-firm tofu. There are two types of pressed tofu: natural and pre-seasoned.
10. **Fermented tofu:** If you pickle tofu in a mixture of salt, rice wine and water it will ferment. This fermenting gives a tofu deep, savoury flavour called umami. In Chinese cooking, fermented tofu is not used as an ingredient but as flavouring. Don't buy fermented tofu in plastic packaging as only glass stops the fermentation process and so guarantees the flavour.
11. **Tofu skin:** When heating soya milk, a skin forms on the surface of the liquid, just as with regular milk. Fresh tofu skins are not widely available, but dried skins are. These skins are similar to filo pastry and can be pan-fried (after marinating), filled and deep-fried like spring rolls, or used to make dim sum.
12. **Tofu sticks:** Tofu sticks are sun-dried, rolled tofu skins. Tofu sticks are a great filling for your miso soup.
13. **Fried tofu:** These slices of tofu are first firmly pressed and then deep-fried. They are soft and sponge-like and quickly soak up marinades and sauces. In the countries of origin (Japan, China and Korea) you can find two versions: abura-age (oblong slices that are cut into strings and served in soups or over rice) and sushi-age (small squares filled with sushi rice and, as the name suggests, served as sushi). Abura-age and sushi-age taste similar. Fried tofu is usually sold pre-seasoned.
14. **Tofu pockets:** Fried tofu is often sold under the name 'tofu pockets'. First place them for a few minutes into boiling water, then pat dry and cut like an envelope.

**15. Tofu puffs:** These tofu balls are frozen first and then deep-fried. They are soft and sponge-like and so ideal for quickly soaking up marinades and sauces. Tofu puffs are already cooked and do not need to be cooked for too long. They are also delicious raw: fill them or dip them into chilli sauce, for example.

**Doses of Tofu**

The following doses have been studied in scientific research:

1. **Adults: by mouth:**

a. **For Type 2 Diabetes:**

- Touchi extract 300 mg three times daily for 3-6 months. Touchi is a traditional Chinese food prepared from soybeans.
- Fibrous soy hulls 26 grams daily for 4 weeks. Single doses of soy fiber 7-10 grams have also been used.
- 30 grams of soy protein, containing 132 mg of phytoestrogens, daily for up to 12 weeks.

b. **For Diabetes during Pregnancy:** Protein 0.8 grams/kg daily for 6 weeks, consisting of 35% soy protein as textured soy protein (Sobhan), 35% animal protein, and 30% other plant proteins.

c. **For High Cholesterol:** 20-50 grams per day of soy protein.

d. **For High Blood Pressure:** 18-66 grams of soy protein, containing 34-143 mg of isoflavones, daily for up to 12 weeks has been used. Also, 4.5 grams of black soy peptide daily for 8 weeks has also been used.

e. **For Irritable Bowel Syndrome (IBS):** Soy containing 40 mg isoflavones daily for 6 weeks has been used.

f. **For Long-Term Kidney Disease (Chronic Kidney Disease or CKD):** A diet limited to 700-800 mg/kg soy protein daily has been used.

g. **For Menopausal Symptoms such as Hot Flashes:**

- 15-60 grams per day of soy protein providing 34-80 mg isoflavones.
- Concentrated soy isoflavone extracts providing 35-200 mg/day of isoflavones.
- Genistein, a soy isoflavone: 54 mg per day.

h. **For Menopausal Symptoms such as Depression:** 100 mg of soy containing 50 mg of isoflavones has been used along with sertraline 50 mg daily.

i. **To Reduce Body Weight during Menopause:** Soy isoflavones <100 mg daily for up to 6 months have been used.

j. **For Metabolic Syndrome:** 30 grams of soy nuts per day as part of a diet high in fruit and vegetables for 8 weeks has been used.

k. **For Weak Bones (Osteoporosis):** 40 grams per day soy protein containing 2-2.25 mg isoflavones per gram has been used for 3-6 months to prevent osteoporosis. Soy extract 1 gram containing 80 mg of isoflavones has been used for one year.

2. **Children: by mouth:**

a. **For Diarrhea:** Soy fiber-fortified formula containing 18-20 grams of soy protein per liter has been used in infants.

Soy foods contain variable amounts of isoflavones. Soy flour contains 2.6 mg isoflavones per gram of soy flour, fermented soybeans contain 1.3 mg per gram, boiled soybeans contain 0.6 mg per gram, soymilk contains 0.4 mg per gram, soybean curd contains 0.5 mg per gram, fried soybean curd contains 0.7 mg per gram, soybean paste contains 0.4 mg per gram, and soy sauce contains 0.016 mg per gram.

**Advantages of Tofu**

Tofu can be served instead of meat or incorporated into a variety of dishes. A diet that contains a variety of plant-based foods appears to contribute to overall health and wellbeing, and a lower risk of conditions such as obesity, diabetes, and heart disease. It can enhance the skin and hair, boost energy, and help maintain a healthy weight. Research has linked tofu, with its high levels of isoflavones, to a lower risk of several age- and lifestyle-related diseases.

1. **Cardiovascular Disease:** Soy isoflavines have been found to help reduce levels of LDL or "bad" cholesterol, although it does not seem to increase HDL or "good" cholesterol levels. Studies have indicated that daily consumption of soy may decrease markers for cardiovascular disease risk, including weight, body mass index (BMI), and total cholesterol. The FDA has set 25 g a day of soy protein as the minimum intake needed to impact cholesterol levels. Consuming tofu as an alternative to animal protein can help lower levels of LDL cholesterol. This, in turn, decreases the risk of atherosclerosis and high blood pressure.
2. **Breast and Prostate Cancer:** Several clinical and experimental investigations have suggested that genistein, the predominant isoflavone in soy, has antioxidant properties that may inhibit the growth of cancer cells. In the past, confusion has arisen about the safety of consuming soy after a breast cancer diagnosis. This is because isoflavones have a chemical structure similar to that of estrogen, and high levels of estrogen can increase the risk of breast cancer.
3. **Type 2 Diabetes:** People with type 2 diabetes often experience kidney disease, causing the body to excrete an excessive amount of protein in the urine. Evidence from one study has indicated that those who consumed only soy protein in their diet excreted less protein than those who only consumed animal protein. The researchers propose that this could benefit patients with type 2 diabetes.
4. **Kidney Function:** Protein, and particularly soy protein, may enhance renal function, and it could have benefits for people who are undergoing dialysis or kidney transplantation. One meta-analysis of nine trials showed a positive effect of soy on some biomarkers of those with chronic kidney disease. This may be due to its protein content, but also because of its impact on lipid levels in the blood.
5. **Osteoporosis:** Soy isoflavones may help reduce bone loss and increase bone mineral density, especially after menopause. They have also been reported to reduce some other symptoms of menopause.
6. **Symptoms of Menopause:** Some research has suggested that consuming soy products may help relieve symptoms of menopause, such as hot flashes, because of the phytoestrogens they contain. While symptoms may differ between women, hot flashes appear to be far less common in Asian countries, where people consume more soy. Conflicting results have been produced, but there is evidence that consuming soy products that are rich in genistein may help reduce the frequency and severity of hot flashes.
7. **Liver Damage:** One study in rats has suggested that any type of tofu that has been curdled with various coagulants may help prevent liver damage caused by free radicals.
8. **Age-Related Brain Diseases:** Population studies have indicated that, in regions where people consume more soy, there is a lower incidence of age-related mental disorders. When the same group carried out a further small study, involving 65 people over the age of 60 years with Alzheimers, they did not find that soy isoflavines offered any cognitive benefits. However, findings published in 2017 suggested that soy products may help people with Alzheimers due to their lecithin content, which helps the body produce the phospholipids phosphatidic acid (PA) and phosphatidylserine (PS). PA and PS play an important role in the functioning of neurones.

**Disadvantages of Tofu**

1. **Hay Fever (Allergic Rhinitis):** People with hay fever are more likely to be allergic to soy hulls.
2. **Asthma:** People with asthma are more likely to be allergic to soy hulls. Avoid using soy products.
3. **Breast cancer:** The effects of soy in people with breast cancer are unclear. Some research finds that soy might "feed" certain breast cancers because it can act like estrogen. Other studies have found that soy seems to protect against breast cancer. The difference in effects might have something to do with the amount taken. Because there isn't enough reliable information about the effects of soy in women with breast cancer, a history of breast cancer, or a family history of breast cancer, it's best to avoid using soy supplements until more is known.
4. **Cystic Fibrosis:** Soymilk can interfere with the way children with cystic fibrosis process protein. Don't give these children soy products.
5. **Diabetes:** Soy might increase the risk of blood sugar levels becoming too low in people with diabetes who are taking medication to control blood sugar.
6. **Endometrial Cancer:** Long-term use of concentrated soy isoflavone tablets might increase the occurrence of precancerous changes in the tissue lining the uterus. However, conflicting evidence exists. Use supplements containing soy isoflavones cautiously if you are at risk for endometrial cancer. Soy foods are likely safe.
7. **Under-Active Thyroid (Hypothyroidism):** There is a concern that taking soy might make this condition worse.
8. **Kidney Stones:** There is some concern that soy products might increase the risk of kidney stones because they contain large amounts of a group of chemicals called oxalates. Oxalates are the main ingredient in kidney stones. Another concern is that people with serious kidney disease aren't able to process some of the chemicals in soy. This could lead to dangerously high levels of these chemicals. If you have a history of kidney stones, avoid taking large amounts of soy.
9. **Milk Allergy:** Children who are very allergic to cow's milk might also be sensitive to soy products. Use soy products with caution.
10. **Kidney Failure:** Soy contains a chemical called phytoestrogens. Very high levels of phytoestrogens can be toxic. People with kidney failure who use soy products might be at risk for blood levels of phytoestrogens becoming too high. If you have kidney failure, avoid taking large amounts of soy.
11. **Urinary Bladder Cancer:** Soy products might increase the chance of getting bladder cancer. Avoid soy foods if you have bladder cancer or a high risk of getting it (family history of bladder cancer).

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# CURRY LEAF:

# A NUTRITIVE LEAF

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## Introduction

Curry leaf (*Murraya Koenigii* L. Sprengal) belongs to Rutaceae family. It is widely used as a culinary spice in Indian cookery in curries, pickles and chutneys. Parts of curry leaf plant including leaves are used in Indian traditional medicinal formulations for the treatment of various ailments. The main Nutrients found in curry leaves are carbohydrates, energy, fiber, phosphorous, magnesium, copper, and minerals. They are rich in Vitamin A, B, C and B2. Curry leaves are also said to be good source of iron and calcium. They also contain vitamins like nicotinic acid, antioxidants, amino acids and flavonoids. Curry leaves possess high protein (6.1%) fat (1.0%), calcium (810.0 mg), phosphorus (600.0 mg), Iron (3.1 mg), carotene (12600 IU), Nicotinic acid (2.3 mg) and vitamin C (4mg) per 100g leaves. Curry leaf is extensively used in South India and Sri Lanka for its authentic flavor. Dehydrated curry leaf powder is also commonly consumed.

## Soil and Climate

Red sandy loam with good drainage will be ideal for its normal and fleshy growth, which will result in better leaf yield. The Optimum temperature requirement is 26 to 37$^{o}$C. The annual growth pattern of curry peaks in monsoon and summer and its growth is very limited during winter seasons. However, the demand for fresh curry leaf is throughout the year.

## Season of Sowing

Curry leaf plants can be growth from seeds, cuttings, suckers around and adult tree. The plant grown from seeds takes a year for planting. However, plants developed through cuttings and suckers are fast growing. The main season of availability of curry leaf fruits is July-August. The sowing is done within 3-4 days of collection of fruits. The seeds should be pulped and sown in nursery beds or poly bags. The hard wood cuttings of about 5mm thickness and about 10-15 cm having 5 set of leaves are cut from the mother plant. Remove the lowest set of leaf and plant the cuttings on the medium to sprout. In 10-15 days the new bud starts emerging from the cutting. Treating of cuttings at IBA 2000ppm enhances rooting per cent and survival per cent. Cuttings taken in spring (March-April) perform better as compared to cuttings taken in Monsoon (July-August). Application of 1.0% IBA+2% Captan$^{R}$+2% sucrose-talc to the lateral cuttings resulted in the highest 26.67 per cent rooting during spring. Suckers emerged around adult tree is uprooted

without damaging root system and planted in the poly bags filled with mixture of soil, FYM and Sand at 1:1:1: ratio.

**Planting**

The field is ploughed 3-4 times to get a fine tilth. Before last ploughing, well decomposed FYM is applied @ 20 tonnes/ha. Pits of 30x30x30xcm are dug one to two months before planting at a spacing of 1.2 to 1.5m. One year old seedlings are suitable for panting. One seedling is planted at the centre of the pit. Farmers adopt different spacings practice ranging from 0.45m to 1.2m. By growing curry leaf under the high density planting system, higher productivity could be achieved. Planting of curry leaf at a spacing of 0.6 x 0.9m registered higher green leaf yield per plant (450.87 g) however the closer spacing (0.45 x 0.45m) recorded the highest significant leaf yield per plot (137.60 kg) and leaf yield per hectare (14.77t).

**Varieties**

- **Sen Kaambu:** It is a local variety. Most popular among farmers of Tamil nadu, Karnataka and Andhra Pradesh and Telangana. The petiole is purplish red in colour. The leaves have good aroma and flavor due to high essential oil content.
- **Dharwad-1 & Dharwad-2:** These varieties are developed by UAS, Dharwad. They yields higher leaf and contains higher essential oil content.

**Fertilizers:** In general no fertilizer is applied for curry leaf as it is grown in homestead. However, after each harvest, 20kg of FYM/plant is applied and mixed with soil for better shoot growth. Under commercial cultivation, a dosage of 150:25:50kg NPK/ha is recommended for higher yield. Foliar spray of three percent panchagavya at 30 days intervals for two times per season was found to be economical and enhances fresh curry leaf yield and quality.

**Irrigation and Inter Cultivation**: Immediately after planting the pits are irrigated. On the third day the second irrigation is given. The seedlings are irrigated once in five to seven days up to three years and once in 15 days afterwards. Periodical hoeing has to be given. During first year, one intercrop like pulses can be taken. After attaining 1 m height, the terminal bud is cut off to encourage basal branching. In total, 5-6 branches are maintained per bush. Ten to twelve months after planting, the first harvest starts.

**Plant Protection**

**Pests:**

**Citrus butterfly**: Hand picking and destruction of the larvae.

**Psyllid bug and scale**: Psyllid bug and scales can be controlled by spraying Dimethoate @ 1 ml/lit.

**Diseases**

**Leaf spot**: Spray carbendazim @ 1 g/1 of water. Spraying sulpur compounds should be avoided.

## Harvesting and Yield

Different types of harvesting influences on green leaf yield per plant and green leaf yield per hectare of curry leaf. Yield of curry leaf increases as the age of the crop increases. At the end of first year 250-400 kg of leaves/ha can be harvested. In 2$^{nd}$ year, once in 4 months, every time 1800 kg/ha, @ 5400 kg/ha/year. In 3$^{rd}$ year, crop yields 5400 kg/ha. In 4$^{th}$ year, about 2500 kg/ha can be harvested once in 3 months, which work out to 10,000 kg/ha/year. From 5$^{th}$ year onwards, about 5000 kg/ha obtained at once in 3 months harvest, which work out to 20,000 kg/ha/year.

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# TRANSGENIC CROPS FOR NUTRITIONAL TRAITS

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GM technology could help tackle both poverty and health problems facing developing countries. If only those who oppose GM crops would relax their stance and weigh up the technology costs and benefits.

**Transgene**

It is a foreign gene or genetic material that has been transferred naturally or by any of a number of genetic engineering techniques from one organism to another.

**Transgenesis**

The phenomenon of introduction of exogenous DNA into the genome to create and maintain a stable and heritable character.

**Transgenic plants:** The plant whose genome is altered by adding one or more transgenes are known as transgenic plants.

**Golden rice is now within reach**

Global staple food and is especially important in Asia. Cultivated for over 10,000 years. Rice provides as much as 80 percent or more of the daily caloric intake of 3 billion people, which is half the world's population. To provide pro-vitamin A to third world i.e, developing countries where malnutrition and vitamin A deficiency are common. It is generally consumed in its milled form with outer layers removed. The main reason for milling is to remove the oil-rich aleurone layer, which turns rancid upon storage. As a result, the edible part of rice grains consists of the endosperm, filled with starch granules and protein bodies, but it lacks several essential nutrients such as carotenoids exhibiting provitamin A-activity. Vitamin A deficiency is a serious health problem in at least 26 countries in Asia, Africa and Latin America.

**Golden Rice – A golden opportunity ?**

- Vitamin A deficiency often occurs where rice is the staple food since rice grain does not contain provitamin A i.e., β-carotene.
- Rice produces β-carotene in the leaves but not in the grain, where the biosynthetic pathway is turned off during plant development.
- The resulting transgenic rice 'golden rice' contains good quantities of βcarotene, which gives the grain a golden colour.

**How does it work?**

- The addition of 3 genes in the rice genome will complete the biosynthetic pathway. Phytoene synthase (psy) gene –derived from daffodils (Narcissus pseudonarcissus) fused to rice endosperm-specific glutelin (Gt1) promoter.
- (Phytoene synthase is a transferase enzyme involved in the biosynthes of carotenoids. It catalyzes the conversion of geranyl geranyl pyrophosphate to phytoene).
- Three steps required to convert: phtoene to β-carotene Phytoene desaturase (pds) and ζ-carotene desaturase to introduce double bonds to form lycopene.
- **Lycopene cyclase –** from soil bacteria Erwinia uredovora form rings in the beta-carotene (biosynthesis of carotenoids in the endosperm). Bacterial carotene desaturase capable of introducing all four double bonds can be substituted for the Phytoene desaturase and ζ-carotene desaturase.
- Manipulation of Golden rice would require the introduction of 3 genes: Phtoene synthase, Carotene desaturase, Lycopene beta-cyclase.
- The daffodil psy gene rice glutelin promoter construct was inserted into the vector pZPsC, along with the bacterial carotene desaturase gene, (crt1) controlled by the 35S promoter.
- Both enzymes were targeted to the plastid (the site of GGDP synthesis): psy gene by its own transit peptide and the crt1 gene by fusion to a pea ribulose-1,5-bisphosphate carboxlase/oxygenase small subunit (rbcs) transit peptide sequence.
- The lycopene β-cyclase gene with a functional transit peptide was inserted into vector pZLcyH under the rice endosperm-specific glutelin promoter along with hygromycin resistance marker gene.

**A new Golden Rice generation Golden Rice 2**

Further work by Syngenta to optimize beta-carotene production showed that the daffodil phytoene synthase was rate limiting and psy gene from maize was much more effective (resulting in the greatest accumulation of total carotenoids and β-carotene) After trying with psy genes from different sources it turned out that the maize and rice genes gave the best results. In the process, Golden Rice lines were obtained that accumulated up to 37 µg/g carotenoids, of which 31 µg/g was β-carotene (as compared to the first generation Golden Rice (original golden rice was called GR1) where only 1.6 µg/g were obtained.

- Transformation of rice with the construct pSYN12424 resulted in a 23 fold increase in carotenoids compared with the original Golden Rice and has been named Golden Rice 2.
- To construct Golden Rice 2, the phytoene synthase gene (psy) from maize and the carotene desaturase gene (crtI) from Erwinia uredovora were inserted into rice.
- Gt1p, crtI, nos, Zea mays phytoene synthase (psy), Zea mays polyubiquitin Ubi–1 promoter with intron, E. Coli phospho-mannose isomerase (pmi) selectable marker.

**Improve level of iron and zinc in rice grains**

- Iron deficiency is the most widespread micronutrient deficiency world-wide.
- Affecting an estimated one-third of the world's population and causing 0.8 million deaths annually worldwide.
- Anemia caused by iron deficiency triggers serious disorders such as abortion, brain damage in infants, increase susceptibility to infection.
- Rice is a poor source of most of many essential micronutrients, especially iron (Fe) and zinc (Zn), for human nutrition.
- According to the World Health Organization (2010), approximately two billion people suffer from iron deficiency.

- The polished rice contains an average of only 2 mg kg-1 Fe and 12 mg kg-1 Zn (IRRI, 2006), whereas the recommended dietary intake of Fe and Zn for humans is 10-15 and 12-15 mg per day, respectively.
- Rice actually has a lot of iron, but only in the seed coat. Because unpeeled rice quickly becomes rancid in tropical and subtropical climates, the seed is removed for storage.
- A major cause is the poor absorption of iron from cereal and legume-based diets high in phytic acid.
- Besides having inherently low levels of Zn, wheat grain is also rich in substances limiting utilization (bioavailability) of Zn in the human digestive tract, such as polyphenols and phytic acid.
- Phytic acid is the major storage compound of phosphorus in grain. By binding Zn, phytic acid reduces solubility of Zn in food and restricts its utilization and retention in human body.

**Approaches for increasing the amount of iron absorbed from rice-based meals**

1. Introduced a ferritin gene from Phaseolus vulgaris into rice grains, increasing their iron content up to twofold.
2. To increase iron bioavailability, introduced a thermotolerant phytase from Aspergillus fumigatus into the rice endosperm.
3. As cysteine peptides are considered a major enhancer of iron absorption, overexpressing the endogenous cysteine-rich metallothionein-like protein.

**Plant Genes Help to Mobilize and Store Iron**

One gene encodes nicotianamine synthase, the enzyme that produces nicotianamine. Nicotianamine chelates (metal ion) iron temporarily and facilitates its transport in the plant. Nicotianamine synthase is expressed under a constitutive promoter. The second gene encodes the protein ferritin (consists of 24 subunits), which functions as a storage depot for up to four thousand iron atoms per protein molecule in both plants and humans. Since the ferritin gene is under the control of an endospermspecific promoter, ferritin comprises a sink for iron in the center of the endosperm. The synergistic action of these two genes allows the rice plant to absorb more iron from the soil, transport it in the plant, and store it in the rice kernel. A third gene encoding phytase was also engineered into this rice line. Phytase degrades phytate, a compound that stores phosphate and binds divalent cations like iron and thus inhibits their absorption in the intestine.

**Feed Crops with Improved Proteins and Amino Acids**

- Seeds of higher plants contain large quantities of storage proteins.
- These proteins have been classified on the basis of their solubility in various solvents.
- Albumins (soluble in water) Globulins (soluble in salt solution) Prolamins (alcohol soluble) Glutelins (soluble in acidic or basic solution) Wheat, barley, maize, sorghum accumulate major storage proteins which are low in lysine.
- Storage proteins of legumes are insufficient in sulfur containing amino acids.
- Barley, rice, wheat, sorghum are also low in threonine and maize in tryptophan.

**Three molecular approaches are being used in altering amino acid sequence**

1. Identification of naturally occurring seed storage plant with high levels of desired amino acids, followed by cloning the corresponding gene and expressing it at high levels in the species distinctly differ from the sources of genes.

2. Modification by recombinant DNA technologies so that they encode proteins similar to wild type proteins but possess higher levels of desired amino acids.

3. Modification in the pool size of the desired amino acids for the synthesis of seed storage proteins by an alternative metabolic pathway.

**Examples of expression of recombinant storage proteins with desirable amino acid profiles:**

- Expression of pea (*Pisum sativum*) legumin, which has a high lysine content, in rice and wheat grains.
- The expression of sunflower seed albumin, which is rich in methionine, in the laboratory model lupin.

**Protein-rich potato**

- In India, a genetically modified potato has been developed by a coalition of charities, scientists, government institutes and industry as part of a 15-year plan to combat malnutrition amongst India's poorest children.
- The 'protato', contains a gene AmA1 from the South American amaranth plant, resulting in an increased protein content of 2.5 per cent. AmA1 gene from the Prince's feather (*Amaranthus hypochondriacus*), which encodes seed albumin, was expressed in potato and was shown to double the protein content and increase the levels of several essential amino acids.
- The protato has high levels of essential amino acids, lysine and methionine.
- GM maize with increased lysine (LY038) was developed by inserting a cordapA gene from a common soil bacteria *Corynobacterium glutamicum*.
- Enhanced production and accumulation of free lysine (Lys) in the GM corn kernel made body weight gain, feed conversion and carcass yields of experimental poultry and swine comparable with animals fed with Lys supplemented diets, and higher than those fed with conventional maize diets.
- Lys-enriched maize with the gene sourced from potato, was also found to be safe as conventional maize.
- LY038 has been commercialized and incorporated in feed meals since 2006.
- A maize γ-zein gene encoding a sulphur amino acid rich protein was used to transform alfalfa and trefoil (*Lotus corniculatus*) under CaMV 35S promoter and RUBISCO small subunit promoter.
- Expression level was rather low to the extent of 0.05% of alcohol soluble protein. To increase methionine level, a new methionine-rich zein, normally expressed at low levels was expressed at a high level using the 27 kDa zein promoter.
- This protein called the high sulphur zein (HS 7) was 21 kDa and contained 37% Met.
- Biotechnology offers great potential for the production of novel design crops, which are the sole solution to safeguard the supply of sufficient quantities of safe & healthy food tomorrow.

## Conclusion

Genetically-modified foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid causing unintended harm to human health and the environment as a result of our enthusiasm for this powerful technology.

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# MICRONUTRIENTS (Fe & Zn) EVALUATIONS IN PEARLMILLET AND THEIR UTILIZATION FOR BIO-FORTIFICATION


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Fe and Zn is the two most important micronutrient in human diet and their deficiency is widespread over the 2 billion of peoples around worldwide especially among the developing countries So the pearlmillet is the cheapest source for Fe and Zn and it contributes 30-40% of micronutrients.

## Introduction

Inadequate consumption of macronutrients like carbohydrate, proteins and fats lead chronic hunger where as it was mostly met out with consumptions of large quantity of foods. In case of micro nutrients are not like that it is needed only as a trace quantity of amounts. Since it is played vital role in physiological functions of humans, insufficient intake makes us deficient to micronutrients causes the hidden hunger. Fe and Zn is the two most important micronutrient in human diet and their deficiency is widespread over the 2 billion of peoples around worldwide especially among the developing countries (Webb *et al.*, 2018). So the pearlmillet is the cheapest source for Fe and Zn and it contributes 30-40% of micronutrients (Rao *et al*., 2006). Apart from this pearlmillet grain is having worthy energy base compared to rice and wheat. So the bio-fortification is the tool for one time and fixed cost breeding for nutritional quality in existing cultivars.

## Nutritional importance of pearlmillet

1. Normally it having the high ion content about 8mg/100g and zinc about 3.1mg/100g, so it may highly useful for increasing the blood haemoglobin content in anaemia patients.
2. Pearlmillet also having the low glycemic index of 54% and glycemic load about 6.06, so its helpful to the diabetic patients for maintaining their blood sugar levels.
3. It also has niacin, B group vitamins and pyridoxine leads good health benefits.

**Dhanashakti**

**Genetic diversity of pearlmillet for Fe and Zn content**

Pearl millet is one of the most important grain and fodder crops among millets in semi-arid tropics and supplies around 80-90% of calories for millions of poor communities (Burton 1972), and normally includes high Fe with fairly Zn rich as compare with rice and wheat. The micronutrient of Fe is ranged from 46 to 56 mg /kg in existing cultivars, whereas in the commercial hybrids its varied about 42 mg/kg of Fe and 31 mg/ kg of Zn (Rai, 2016). In most of the pearlmillet genetic materials with high Fe and Zn is based on the early maturing and large seeded land race called *iniari* germplasm (Velu *et al.* 2007) and its grain ion content ranged of 51-121 mg/kg and the zinc of 46-87 mg/kg.

The world's first high Fe pearlmillet about 71 mg/kg was released as Dhanashakti by using of variability existing in intra population of ICTP 8203. In the case of hybrids AHB 1200 Fe (ICMH 1202), HHB 299 (ICMH 1203), and Phule Maha Shakti (ICMH 1301) were released in India with more than 70 mg/kg of Fe and 35 mg/kg of Zn.

**Genomic regions / QTLs for Fe and Zn**

Mapping of the genomic regions associated with the high grain Fe and Zn is highly useful tool to enhance the micronutrient content of the normal cultivars for bio-fortification. Anuradha *et al*., (2017) using the marker trait association mapping and using of 114 SSR polymorphic markers with 130 diverse breeding lines for identification of genomic regions for Fe and Zn in pearl millet. There are three main marker regions namely *Xpsmp 2261, Xipes 0180, Xipes 0096* with the phenotypic variation of 13.34%, 11.40% and 11.38% for all over the three locations were evaluated.

Genome wide association study of pearlmillet carried out by Pujar *et al*., (2020) for identification of marker trait association (MTAs) revealed SNPs for Fe and Zn genomic regions. A total of 61 significant MTAs, 18 were identified for Fe with 5.07 to 8.23% of PVE were identified on chromosomes of chromosome Pgl01 (1), Pgl02 (4), Pgl04 (7), Pgl05 (3), Pgl06 (2), and Pgl07 (1). Maximum of 8.23% of PVE is existed with genome region of Pgl05_135500493. Whereas for Zn total of 43 MTAs were reported with PVE by SNPs is ranged from 5.09 to 8.00%. A total of four SNPs namely Pgl04_64673688, Pgl05_135500493,

Pgl05_144482656 and Pgl07_101483782 located on three different chromosomes 4, 5 and 7 were found common among grain Fe and Zn contents. Along with these the candidate genes for grain Fe and Zn also reported. 18 SNPs were associated with Fe content such as Like-Sm ribonucleoprotein (LSM) domain, late embryogenesis abundant protein, pentatricopeptide repeat involved in Fe homeostasis. Similarly SNPs associate with genes like Myb transcription factor, peptidase and HSP70 are unique for Zn.

By using this genomic regions for introgression through biotechnological tools lead wide impacts on biofortification with increased Fe and Zn content in pearmillet.

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# Overview of the molecular techniques used in public health laboratories


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Laboratory analyses that use DNA or RNA. Goals were to provide an overview of the molecular techniques used in public health laboratories. And explain how commonly used molecular techniques such as PCR, PFGE, and ribotyping are used in outbreak investigations.


## Introduction

Molecular biology techniques are most commonly used methods used in molecular biology, biochemistry, genetics and biophysics which generally involve manipulation and analysis of D.N.A, R.N.A, protein and lipids. Molecular biology is branch of biology that deal with the molecular basis of biological activity. This field overlaps with other areas of biology and chemistry, particularly genetics and biochemistry. It concern itself with understanding and the interaction between various system of cells like D.N.A, R.N.A and protein biosynthesis.

## What is DNA?

DNA stands for deoxyribonucleic acid. DNA is a twisty, ladder like molecule termed a 'double helix', DNA is the genetic material present in bacteria, plants, and animals and provides the code used to build the molecules that make up a living being. Some viruses also have DNA while others use RNA as their genetic material.

## DNA Structure

DNA is made up of 4 molecular units called bases. The bases are:

- Adenine (A)
- Thymine (T)
- Cytosine (C)
- Guanine (G)

Each base is linked with a partner—A with T and C with G. Together they are known as base-pairs. Bases are arranged in an exact order called a sequence, Example: AATTCGCG or CATAGCGTA. A particular sequence is like a recipe for the protein that will be created by that particular piece of DNA. DNA can also code for RNA but in RNA T (thymine) is replaced by U (uracil).

**DNA replication**

To replicate DNA or create proteins, the two sides of the DNA ladder separate from each other and new bases pair up with the existing sequence. In living cells RNA serves as the copy messenger to DNA.

- From the DNA template a cell makes a copy of RNA.
- RNA then circulates around the cell carrying the code to all parts of the cell's building machinery.

**Why is DNA useful in epidemiology?**

DNA sequences can be used to identify an organism causing a disease outbreak.

- Certain DNA sequences are unique to each organism.
- Samples can be tested for the presence of DNA from different organisms.

**DNA testing**

DNA sequences can vary between different strains of the same organism. Comparing variation in certain sequences can help distinguish one strain from another. For example, if Norovirus is identified in two cases of gastrointestinal illness, they may (or may not) be part of the same outbreak. DNA testing can help determine whether the same strain is present in both cases and therefore whether the cases are related.

**Polymerase Chain Reaction (PCR)**

Using molecular techniques such as PCR to examine DNA sequences can help to identify what strain of a pathogen is present in a specimen. PCR is a technique that makes multiple copies of a piece of DNA or RNA in a process called amplification. Amplification makes it easier to detect the tiny strands of an organism's DNA. PCR can start with very small amounts of DNA and can be used with viruses or bacteria.

**Steps in PCR**

1. PCR starts with a sample of DNA from a clinical specimen suspected to contain a pathogen.
2. A primer is added to the sample.
   - A primer is a very short sequence of DNA which will seek out and bind to a specific sequence of the target DNA
   - Primers can be designed to be very specific or more general

Example – a primer could be made to "match" echovirus 30 *or* to match any echovirus

3. After the primer other materials added to the mixture include:
   - A polymerase enzyme that will "read" a sequence of DNA and create copies
   - "Building blocks" of DNA bases to use as raw materials to make copies
4. The polymerase enzyme will make copies only of the DNA that matches the primer
5. **Results:**
   - Amplification occurs- DNA in specimen matched primer.
   - No amplification- particular DNA that primer was designed to match was not present.

**Sequencing DNA**

If you are still unsure what the infecting organism might be after PCR you probably ran a non-specific PCR reaction and amplified whatever genetic material was present. The next step would be to sequence the DNA with the genetic material obtained from amplification. You can determine the specific order of the bases in the DNA strand(s) that you amplified. This particular sequence can then be compared with known sequences of an organism or strain.

**DNA Sequences**

The DNA sequence amplified may be that of a known gene from a specific organism**.** Example: laboratory suspects *Salmonella* and runs the experiment to amplify the DNA of a *Salmonella* gene.

- Gene will be amplified if *Salmonella* is infecting organism**.**
- Gene will not amplify if *Salmonella* is not the infecting organism.

**PCR Gels**

After PCR amplification the laboratory technician will run the PCR product on a special gel that helps visual the DNA. With a known gene, you know how big the sequence is. When sample DNA is seen on a gel, it can be determined whether the gene is present and whether it has the correct length segment and is the expected organism.

**PCR gels & DNA Fingerprinting**

The pattern of DNA as it appears on a gel is called the DNA fingerprint. DNA fingerprinting is done when a specific organism is suspected in order to determine which strain of the organism is present. Example --Tuberculosis (TB) has very specific symptoms. DNA fingerprinting could help determine whether different TB cases are infected with the same strain due to an outbreak or common exposure.

**How do gels work?**

PCR product is placed in a lane at one end of the gel. A small electric field is applied which causes the DNA to migrate from one end of the gel to the other. The distance traveled by DNA depends on the sequence and the length of the piece(s) of DNA.

- DNA bases have natural electrical charges that determine speed and direction.
- Different sized pieces of DNA move faster/slower.

After a defined time period the electric field is turned off, freezing the DNA "race" so that the DNA pattern can be examined. Special techniques are used to look at the clusters of DNA which appear as solid bands in the gel.

- Different organisms have different DNA patterns.
- If samples taken from different patients have the same DNA pattern, these people were infected with the same organism.

**Pulsed Field Gel Electrophoresis (PFGE)**

DNA can also be detected by pulsed field gel electrophoresis **(PFGE)** which is used for the analysis of large DNA fragments. PFGE requires less processing and sample preparation of the DNA. To perform PFGE special enzymes can be used to cut the DNA into a few long pieces. Instead of applying an electric field so that DNA fragments race straight to the end, after the electrical field is applied the direction is changed several times. PFGE is like a race with only large, slow-moving runners. At the start they are so slow and large they appear only as a mass of runners. The finish line gets moved to different places and the "runners" re-orient each time. Switching directions separates the runners (the DNA pieces) into two different planes and separates out the DNA more distinctly. PFGE is used to identify bacteria but not viruses. DNA used for PFGE analyses can be extracted from a microorganism in culture, a clinical specimen or an environmental specimen. Like regular gels, PFGE can be used to identify an organism or to distinguish between strains of the same organism.

**Ribotyping**

Ribotyping is another molecular diagnostic technique. Name derives from the ribosome which is part of the cellular machinery that creates proteins. Ribotyping can be used to identify bacteria only, not viruses. As ribosomes are found only in cells whereas viruses have no cellular structure but are molecules with genetic material and protein only.

**Ribosomes & RNA**

A ribosome is composed of RNA that is folded up in a particular way. This is referred to as "rRNA" for ribosomal RNA. DNA codes for RNA and since a wide variety of living cells create proteins, the DNA genes that code for rRNA have a lot in common, even across different species. Some parts of the (DNA) genes that code for rRNA are highly variable from one species to the next or between strains of bacteria. These variable regions can therefore be used to identify a particular strain of bacteria.

**How are the variable regions of rRNA determined?**

DNA-cutter enzymes are used to divide the RNA only when a specific sequence occurs. If a strain of bacteria has that sequence in its rRNA, the rRNA strand will be cut at that location. The rRNA is then run on a gel so that the number and size of the pieces can be seen. rRNA that has been cut in the expected locations will appear different from rRNA that was not cut.

**Advantages of ribotyping as an identification method**

- Ribotyping is a fully automated procedure.
- Procedure involves less labor and is standardized

**Disadvantages of ribotyping**

- Expensive because of the equipment used, therefore usually only performed in reference laboratories.

Ribotyping is most commonly used for typing strains of *Staphylococcus aureus*, but it can also be used for typing other species of *Staphylococcus* and for *E. coli*.

## Summary

This has been an overview of molecular techniques, i.e., laboratory analyses that use DNA or RNA. Goals were to provide an overview of the molecular techniques used in public health laboratories. And explain how commonly used molecular techniques such as PCR, PFGE, and ribotyping are used in outbreak investigations.

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# UTILIZED THE ARTIFICIAL INTELLIGENCE FOR FUTURE FARMERS IN AGRICULTURE SECTOR


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Artificial intelligence is assisting various industries in increasing productivity and production. In every area, artificial intelligence technologies are assisting in overcoming conventional challenges. In agriculture, artificial intelligence is assisting farmers in increasing productivity while reducing negative environmental impacts. Artificial intelligence was enthusiastically adopted by the agriculture industry in order to improve overall performance. Artificial intelligence is changing the way our food is processed, resulting in a 20% reduction in agricultural emissions. Artificial intelligence technology is assisting in the monitoring and management of any unwelcome natural occurrence.

**Components of Artificial intelligence policy**

- Enabling Beneficial AI Research and Development.
- Global Governance, Race Conditions, and International Cooperation are all components of artificial intelligence policy.
- Economic consequences, labour shifts, inequity, and technological unemployment
- Transparency, Accountability, and Explainability.
- Human Rights, Ethics, and Fairness.

**Advantage of artificial intelligence**

- Farmers can better understand data insights such as temperature, precipitation, wind speed, and solar radiation by using artificial intelligence in agriculture.
- The focus of AI implementation is on detecting faulty crops and increasing the potential for safe crop production.
- Agro-based companies have benefited from the advancement of Artificial Intelligence technology, which has helped them operate more effectively.
- Artificial intelligence is being used in applications including automatic computer changes for weather forecasting and disease or pest detection.
- Artificial intelligence can help many tech companies invest in algorithms that are becoming useful in agriculture by improving crop management practices.
- AI strategies have the potential to address problems that farmers face, such as climate change, insect infestations, and weed infestations that reduce yields.

**Disadvantage of artificial intelligence**

- Making or purchasing robots is expensive.
- They need ongoing maintenance.
- Farmers can lose their jobs as a result.
- Robots have the ability to alter society.

- Energy costs and upkeep.
- Exorbitant research and development costs.
- Inaccessibility to marginal farmers.

**Applications of artificial intelligence**

**Weather forecasting**

AI is assisting farmers in staying current with weather forecasting data in a sophisticated way. Farmers can increase yields and income by using forecasted/predicted data without putting their crops at risk. By understanding and learning with AI, the farmer may take precautions by analysing the data produced. Implementing such a practice will assist you in making an informed decision on time.

**Monitoring Crop**

Deep learning applications are being designed to analyse flora trends in agriculture with the aid of Al. Soil defects, plant pests, and diseases can all be better understood with AI-enabled applications.

**Reduce the use of pesticides**

Data is gathered with the aid of AI to keep an eye on the weeds, allowing farmers to spray chemicals just where the weeds are. This resulted in a significant reduction in the amount of chemical used to spray an entire area. As a result, AI decreases the amount of herbicide used in the field when compared to the amount of chemicals usually sprayed.

**Farmers many difficulties face when using conventional farming methods**

- In agriculture, climatic factors such as rainfall, temperature, and humidity play an important role in the life cycle of the crop. Climate change is a result of increasing deforestation and emissions, making it impossible for farmers to make decisions on how to prepare the soil, plant seeds and harvest.
- Each crop necessitates a particular type of soil nutrition. In soil, three main nutrients are required: nitrogen (N), phosphorous (P), and potassium (K). Nutrient deficiency can cause crops to be of poor quality.
- Weed control plays an important role in the agricultural lifecycle, as can be seen. If not regulated, it may lead to an increase in production costs as well as the absorption of nutrients from the soil, resulting in nutrient deficiency.

## Conclusion

In agriculture, artificial intelligence not only aids farmers in automating their operations, but also transfers the focus to precise cultivation for increased crop yield and quality. Artificial Intelligence-based goods or services, such as agricultural training data, drones, and automated machine manufacturing, will advance technologically in the future, providing more useful applications to this field, assisting the world in dealing with food production issues for a rising population.

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# POST HARVEST TECHNOLOGY

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The Post-harvest technologies constitute an inter-disciplinary science and techniques applied to agricultural commodities after harvest for the purpose of preservation, conservation, quality control/enhancement, processing, packaging, storage, distribution, marketing, and utilization to meet the food and nutritional requirements of consumers in relation to their needs.

**Post-harvest technology**

Post-harvest technologies constitute an inter-disciplinary science and techniques applied to agricultural commodities after harvest for the purpose of preservation, conservation, quality control/enhancement, processing, packaging, storage, distribution, marketing, and utilization to meet the food and nutritional requirements of consumers in relation to their needs. Below is PHT work of GROUP 1 of Food Technology Department of College of Horticulture, VCSG UUHF, Pauri Garhwal. Following organic products are made by GROUP-1 such as organic squashes of Leamon, Malta and Rhododendron also Potato Chips are made. The main aim of PHT is to develop entrepreneurship skills in the student.

**Introduction**

Fruit juice is 100% pure juice made from the flesh of fresh fruit or from whole fruit, depends upon the. Type of the fruit used. It is not permitted to add sugars, sweeteners, preservatives, flavourings as well as coloring to fruit juice. Today with the benefit of ultra-high temperature (UHT) pasteurization, and various aseptic packaging techniques and systems, pressed juices can be preserved and stored for extended periods with very little deterioration in quality. Aseptic packaging can be defined as the filling of a commercially

sterile product into a sterile container under aseptic conditions and hermetically sealing the containers so that reinfection is prevented. This results in a product, which is shelf-stable at ambient conditions. Below is the organic squash of Malta and Rhododendron of group 1st in Food Tech Department.

**Market Outlook**

India's packaged juice market has shown a great growth trajectory. The fruit juice industry has made good progress in India. The packaged fruit juice is one of the fastest growing products.

At present, the Indian packaged juices market is valued at Rs 1100 crore and is projected. The rising number of health-conscious urban consumers is giving a boost to fruit juices. Juices are healthy only when prepared hygienically. So the hygiene conscious people are only buying packaged fruit juices for the companies that have trusted brand value in the market.

**Steps of making organic lemon squash**

**1-** Before you start preparing squash, boil the bottles on one side of the gas.
**2-** Put the sugar in the vessel and cover the vessel with water above sugar level.
**3-** Boil on low fire till sugar dissolve in water.
**4-** In Boiling water put the citric acid. It will clean the sugar syrup and enhance the taste of the squash.
**5-** If the syrup is sticky, add lemon juice in it, bring to boil on the low flame in the gas for some time.
**6-** Add Sodium Benzoate in the syrup solution 1gram per liter as a preservative and mix thoroughly in squash.
**7-** Add essence and color in the syrup to enhance its look and quality.
**8-** Measure the TSS of the juice with the help of Refractometer.
**9-** Fill the bottles, with syrup gently and cap the bottles tightly.
**10-** When want to serve the squash, pour 2-3 table spoon of the squash in the glass, pour chilled water and ice cubes and serve it.

**Process of making potato chips**

When the potatoes arrive at the plant, they are examined and tasted for quality. A half dozen or so buckets are randomly filled. Some are punched with holes in their cores so that they can be tracked through the cooking process. The potatoes are examined for green edges and blemishes. The pile of defective potatoes is weighed; if the weight exceeds a company's preset allowance, the entire truckload can be rejected.

**Destoning and peeling**

The potatoes are loaded into a vertical helical screw conveyer which allows stones to fall to the bottom and pushes the potatoes up to a conveyer belt to the automatic peeling machine. After they have been peeled, the potatoes are washed with cold water.

**Slicing**

The slices fall into a second cold-water wash that removes the starch released when the potatoes are cut. Some manufacturers, who market their chips as natural, do not wash the starch off the potatoes.

**Color treatment**

If the potatoes need to be chemically treated to enhance their color, it is done at this stage. The potato slices are immersed in a solution that has been adjusted for pH, hardness, and mineral content.

**Frying and salting**

The slices pass under air jets that remove excess water as they flow into 40-75 ft (12.2-23 m) troughs filled with oil. The oil temperature is kept at 350-375°F (176.6-190.5°C). Paddles gently push the slices along.

Potatoes arrive daily at manufacturing plants. After they are checked for quality, they are stored at a constant temperature until they are processed into potato chips.

**Cooling and sorting**

At the end of the trough, a wire mesh belt pulls out the hot chips. As the chips move along the mesh conveyer belt, excess oil is drained off and the chips begin to cool.

**Packaging**

The chips are conveyed to a packaging machine with a scale. As the pre-set weight of chips is measured, a metal detector checks the chips once more for any foreign matter such as metal pieces that could have come with the potatoes or been picked up in the frying process.

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# Apple Ber : Treasure Trove of Health Benefits


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**Introduction**

The Apple ber (*Zizyphus mauritiana*) is a hardy minor underutilized ancient tropical fruit that belongs to the Rhamnaceae family. This fruit has the appearance of a green apple and tastes like ber, hence the name Apple ber. Apple plum or Jujube berry are other names for it. In Telangana region, it is also known as "Telangana Apple." There are about 40 species in the genus Ziziphus, which can be found all over the world in tropical and subtropical climates. *mauritiana* is cultivated commercially for its nutritive and edible fruits, among other species. It's also known as the "poor man's fruit of tropics".

Apple ber cultivation in India began in Maharashtra and was later expanded to other states such as Gujarat and Telangana. It is grown commercially in Telangana's districts of Hyderabad, Mahbubnagar, Medak, Warangal, and Khammam. In Telangana region, it is also known as "Telangana Apple." Each fruit weighs between 60 and 150 gm. It is appealing, soft, crispy, and juicy. Due to its unique characteristics such as thornless nature, high yielding, early crop, ease of cultivation in terms of harvesting, and wider adaptability to grow in any form of soil with less water consumption, farmers are showing interest in cultivating apple ber in recent years when compared to ber. It can withstand hot summers, heavy rains, strong winds, and cold winters. It begins to yield after nine months. Fruits are grown primarily from November to March, with a nominal first crop of 20-25 kg per tree, a second crop of about 50 kg per tree, and a third crop of 100 kg to 200 kg per tree from the third year onwards. The plant has a 20-year life span and can be propagated both by seed and by cuttings of half-ripe wood. The cuttings should be 10-12 cm long and have a heel if possible. The cuttings are easy to plant and are planted in July-August. Layering is also an option. Grafting by trained professionals can result in a higher yield of fruit.

**Medicinal importance of apple ber**

Traditional medicine has used the fruit as an emollient, expectorant, coolant, anodyne, and tonic. It is also been used as an aconite poisoning antidote. It is used to manage stomach pains during pregnancy and can be used as a poultice to treat wounds. The leaves can be used as a laxative and a decoction for throat

problems, and the same liquid can be used for skin problems as well. In addition, the roots have wound-healing properties. Medical researchers have discovered a "new" flavonoid in Ber called zivulgarin, and experiments are currently underway to see if it can help us. Oleamide, a compound contained in a Zizyphus jujube extract, has been shown to aid in the treatment of Alzheimer's disease and cognitive functions. Saponins have been discovered in the leaves, as well as vitamin C in the form of ascorbic acid, B-complex vitamins, thiamin, riboflavin, and pectin in the fruit. Pectin is used to help with diarrhoea and has immune-stimulant, antioxidant, and wound-healing properties. The fruit also aids in the reduction of cholesterol and blood pressure. Some of the triterpenoic acids derived from the fruit are also thought to have anti-cancer and anti-HIV properties. It is beneficial not only to those with dietary needs, but also to those who have digestive issues. Vitamins A and C, as well as all of the calcium contained in apple ber fruits, are responsible for the fruits' nutritional value. Ber fruits are also known to contain 18 of the 24 essential amino acids needed by the body.

**Health benefits of apple ber fruits**

1. **It possess anti-cancer properties:**

   Antioxidants abound in the apple ber berries. There can't be any free radicals where there are anti-oxidants, since free radicals are the elements that cause cancer. As a result, this fruit is thought to be cancer-preventive. Recent studies have shown that it is particularly effective in preventing leukaemia, the most deadly form of cancer.

2. **Assist in weight loss:**

   Although these fruits don't have any weight-loss properties, they make a perfect snack if you're trying to shed pounds. They are low in carbohydrates and fats, but high in fibre. As a result, they are nutrient-dense while not gaining weight when consumed as a snack. As a result, it's an excellent replacement for the unhealthy foods we regularly munch on.

3. **Builds immune system:**

   These fruits are rich in Vitamin C and Vitamin A, making them an excellent anti-oxidant that also helps to improve the body's immune system activities. As a result, we are better able to combat illnesses and keep seasonal colds and fevers at bay.

4. **For healthy teeth, bones and muscles:**

   Calcium, the essential mineral that makes up teeth, bones, and muscles, is abundant in apple ber fruit. Making these fruits a daily part of our diet helps to strengthen our bones, muscles, and teeth. This decreases the likelihood of easily broken bones. It may also help to strengthen teeth, lowering the risk of decay and cavities.

5. **Fights Alzheimer:**

   Apple ber fruit has been shown in recent studies to help combat Alzheimer's disease by preventing cell degeneration and improving brain cognitive function. If further studies support this and it can be used to treat Alzheimer's, it would be a huge advance in the field of Alzheimer's. However,

pregnant women should avoid consuming more Apple Ber fruit juice than is required or recommended, as it can cause diarrhoea and abortions if consumed in excess.

6. **Helps to soothe sore throats:**

Apple ber fruit extracts are used to relieve the ache and discomfort associated with a sore throat. The fruit juice soothes the throat when mixed with ginger or mint and taken as a potion.

7. **Helps in digestion:**

Apple ber fruit has a reputation for assisting digestion and absorption. It's particularly beneficial for people who have digestive issues, such as constipation or flatulence. Patients with diarrhoea should avoid taking it because it serves as a mild laxative.

8. **Sedative property of Apple Ber fruit soothes the nervous system:**

Apple ber fruit is well-known for its sedative qualities. Sedatives can aid in the relaxation of the nervous system, which can aid in the treatment of nervous problems such as anxiety and insomnia. It also aids in the treatment of more severe conditions such as psychosis and epilepsy.

9. **Keeps skin healthy, glowing and young:**

Vitamin C contains anti-oxidants, which help to slow down the ageing process. Apple Ber are high in Vitamin C, which helps to slow down the ageing of the skin and keep it healthy and lustrous for a long time. While wrinkles are an inevitable part of ageing, we can slow down the process by including this fruit in our diet.

10. **Miscellaneous uses:**

Villagers use the trees' wood to create agricultural tools because it is strong and sturdy, and the leaves are used as fodder for sheep and goats, so the tree's entire life cycle is used.

## Conclusion

Apple ber fruit and every part of the tree is a treasure trove of various nutrients and vitamins and can be used by the mankind to earn maximum profit.If used in a proper way it can have maximum profit because every part of the tree possess characteristics which are utilised by the researchers to cure many diseases.

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# Terrarium: An innovative approach for mini garden


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A terrarium is equipped with its own microclimate. For terrarium, a completely enclosed container or a container with a small opening or even a cover has been used. As a result, a terrarium resembles a greenhouse. In the same way as sunlight enters the atmosphere warms the Earth's surface, sunlight hits the glass and warms the air, soil, and plants. Like the Earth's atmosphere, the glass absorbs some of the heat.

**Introduction**

A terrarium is a transparent glass or plastic container filled with small plants that can be open or tightly closed. A transparent, open container for growing and displaying plants has also come to be known as a terrarium. Some small plants that do not adapt well to typical home environments can most benefit from terrariums. They provide a novel way to grow a large number of plants with little effort when properly planted and assembled.

**Types of Terrarium**

Terrariums are divided into two categories, each defined by the container used.

**1. Open-system terrarium-** Using a big glass bowl or another container with a wide opening. An open-system terrarium needs more frequent watering and has lower humidity levels than a closed-system terrarium.

**2. Closed-system terrarium-** Using a container that is closed (or nearly closed). It's best to use a lidded jar with a small mouth. The environment needed for moisture- and humidity-loving plants will be maintained in these containers.

**Choosing of containers for terrarium**

Clear glass or plastic can be used to make a terrarium jar. Almost any container, like fish bowl, a fish tank, a brandy snifter, an old glass jar or container, a glass mug, or a bottle. Transparent covers can be used on closed containers.

**Selection of plants for terrarium**

In a terrarium, you can grow a wide range of native and tropical plants. Native mosses and lichens may be used instead of combining all forms of plants in the same terrarium, which is not a good idea. Low-

to medium-light-loving plants are included. Make an effort to get a variety of leaf sizes, textures, and colours. Make sure they fit in your terrarium comfortably, ideally without touching the edges.

**Open-system terrarium plants (cacti and succulents) –** Aeonium, Aloe vera, Burro's tail, Cactus, Crown of thorns, Devil's backbone, Echeveria, etc.

**Plants suitable for both open- and closed-system terrariums -** African violets, Norfolk Island pine, Orchid, Anthurium, Ardisia, Palms, Artillery fern, Peperomia, Baby's tears, Philodendron and others.

**Open System Terrarium**

**Growing medium for terrarium**

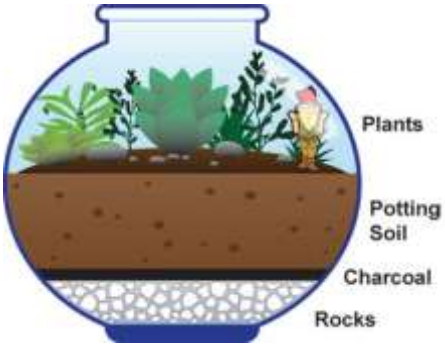
The growing medium in terrariums would have to be clean, well-drained, and organic matter content. For these purposes, a growing medium mix with one-part peat moss and one-part rich garden soil is used. A prepackaged peat-lite mix (a mix of peat moss, vermiculite, and perlite) is also an excellent option.

**Closed System Terrarium**

**Accessories for terrarium**

Rocks, gravel, and other natural materials such as bamboo or sticks, woods, seedpods, bark and mosses make attractive terrarium accessories. Frogs, fungi, and snails made of ceramic can help to create a natural environment. The inclusion of accessories is purely a matter of taste. However, don't overdo it with the accessories, particularly if they're in bright, unnatural colours.

**Assembling the terrarium**




- A few hours or a day before construction, water the plants in their original containers.
- Before using the terrarium container, make sure it's clean.
- Fill the bottom of the container with 1 inch of gravel.
- Add about a quarter inch of charcoal at a time.
- Add about 2 inches of growing medium to the container.
- Gently take plants out of their original pots and loosen up the medium at the all sides of root ball.
- Using your side, gently open up the root ball to divide the plants into smaller parts.
- Pruning is needed if foliage's contact the container's sides or lid.
- Place the tallest plants in the middle, with the rest of the plants arranged around them.
- Ensure that the terrarium is well-watered. Mist the inside walls of the glass jar with a mist spray. Water may be applied to the terrarium at carefully because it should not be drained from the terrarium.
- Tear big moss parts into small pieces and disperse them in patches around the soil surface. Some patches may be strewn with chopped bark. Finally, apply some finishing touches by using some decorative items.

**Care of terrarium**

☞ **Watering –** Water is usually not needed for 4 to 6 months in a closed terrarium. However, in open terrariums water require occasionally but not as necessary as other houseplants. Overwatering promotes

root infection by causing excess moisture in the gravel and charcoal. Since terrariums have no external drainage that's why light watering are needed.

- **Light –** Direct sunlight should not be allowed to enter an open or closed terrarium. Many plants would be harmed by direct sunlight because it causes heat accumulation. Artificial light for 16-18 hours per day is needed if the terrarium is in a low-light region.
- **Pruning –** Many plants in terrariums eventually outgrow their confines. Trimming them back quickly gets them into line and quite often encourages edge growth, which aids in plant filling out.
- **Fertilization -** After planting, wait at least a year before fertilising. If the plants appear yellowish and lack vigour after the first year and there are no other obvious problems, a light water soluble fertilisation may be needed.

**Other cares**

- Time to time remove thrive and died plants.
- If terrarium is closed, take off the top lid at least once a month to air it out.
- It should be kept in a light, but not direct sunlight, setting.
- Terrariums normally last for a year or more. They can then be redesigned.

## Conclusion

Terrarium has made significant contributions to landscape architecture. It's a glass container with a lid or without lid, that's a pleasant way to grow a collection of small plants. A terrarium, with careful care, can provide a humid environment that protects tender, tropical plants that are difficult to develop in the usually dry environment of homes. It can also help to start new plants under regulated conditions. The plants in their glass enclosures were decorative, and the concept was quickly adopted for home interior design.

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# TECHNIQUES FOR CROP REGULATION IN POMEGRANATE


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Pomegranate is one of the most promising fruit crops of India. It has exquisite nutritionally valuable and remunerative crops. In recent years pomegranate is getting popularity in the international trade due to its processed products and nutritional value. The main purpose of crop regulation is to force the tree to rest and produce prolific flowers and fruit during any one of 2 or 3 flushes. The aim of regulation is to produce uniform and good quality yield. A good crop is possible only when the crop is regulated in a single season, otherwise the flowers continue to bloom uninterrupted. The selection of bahar in one place is mainly determined by availability of water, occurrence of pests, diseases and marketing position. Crop regulation in Pomegranate is achieved by the several techniques like, flower bud thinning, shoot pruning, withholding irrigation and use of different chemicals.


## Introduction

Pomegranate (*Punica granatum* L.) is one of the most important fruit crops of India which is grown in the tropical and sub-tropical areas of the world. It belongs to the Punicaceae family and native of Iran but extensively grow in Mediterranean and central Asia. It is highly suitable for arid and semi-arid region. India is the largest producer of pomegranate in the world. The production of pomegranate is around 2.79 MT from the area of 0.25 million hectare. It is rich sources of nutrients and phytochemical compounds. Phytochemical compounds found in many parts of the pomegranate tree like peel, juice and seeds parts of pomegranate fruits. For multipurpose medicinal uses, so it is also known as “Dadima” in Ayurveda.

Pomegranates are mainly consumed as fresh and processed products like beverages, juice, jelly, jam etc. and as “Super fruit” in the global functional food industry. Pomegranate fruits peel is an inedible part obtained during processing of juice. Pomegranate peel is a rich source of flavonoids, tannins and other phenolic compounds.

Pomegranate has three main flowering and fruiting seasons or bahars, ambe bahar (spring season flowering), mrig bahar (June-July flowering) and hasta bahar (October- November flowering). Pomegranate flowers continuously throughout the year under tropical climate, subtropical central and western India, there are three distinct flowering seasons *viz*. rainy (Mrig Bahar), spring (Ambe Bahar) and autumn (Hasta Bahar) with the corresponding harvesting periods during the rainy, winter and spring seasons in pomegranate.

**Objectives of crop regulation in pomegranate**

The main purpose of crop regulation in pomegranate is to relax the tree during any one of the two or three flushes and to produce prolific blossom and fruits. Besides, some main objectives are as under:

1. To regulate the uniform and good quality of fruits
2. To obtain suitable crop at a desired season
3. To increase number of hermaphrodite flowers
4. To maximize the production as well as profit to the producer.
5. To reduces the fruit dropping and increases the yield
6. To reduce cost of cultivation

They always avoid taking ambe bahar crop and regulate this crop into mrig bahar and crop is harvested during winter but some farmers prefer hasta bahar with less availability of water.

**Principles of flower regulation**

The basic principle of crop regulation is to manipulate the natural flowering that increase fruit yield, quality and profitability in pomegranate during the desired season. Flower regulation is useful for best and long-term use of resources with high yield. Initiation of flowering and regulation of flowering are affected by the different factors viz. environmental and genetic factors. Pomegranate flowers produce irregularly from February to October in the arid and semi-arid regions. In India, all commercially grown varieties are very sensitive to insect-pests and diseases, especially Scorching, Bacterial Leaf Blight, Nematode, Termite and Mite etc. Therefore, availability of irrigation water, pest and disease infestation and market demand are the major issues for flower regulation. Indian pomegranate varieties are mostly produce flowers throughout the year.

**Methods of crop regulation in pomegranate**

Flowering is mostly affected by many factors viz. defoliants, withholding of irrigation, plant growth hormones, nutrients status and canopy management (training and pruning) etc. Light pruning and ethrels foliar spraying are defoliant practiced to shedoff leaves. Withholding of irrigation (lack of moisture) is done 1 to 2 month before taking desired bahar in pomegranate. The top soil around the tree should be dug to a depth of 30 cm, equal to the leaf canopy. The mixture of manure and fertilizers are applied into the soil which is then leveled and light irrigation is done after application. The better floral sex ratio, higher fruit setting and ultimately higher quality and yield of fruits may be taken in year at a desired season by these treatments. Bahar treatment must be started from third year onwards for taking better quality. Bahar treatment is done in the following ways:

1. **Flower regulation by cultural practices**

Canopy management by training and pruning (carbon nitrogen ratio) is the best method to achieve higher flowering percent and quality fruit production in pomegranate. Pomegranate may be trained as single stemmed tree or multi-stemmed tree. For the last few years, pomegranate plants have been trained by open centre system. Light pruning should be done after withholding of irrigation and 15 to 20 days before starting of new bahar. To avoid fungal attack on pruned parts of plants should use 10 per cent Bordeaux mixture

paste. Withholding of irrigation is done in April-May for regulating of crop in dry areas. These cultural practices give good quality fruits and yield 60 to 80 fruits should be retained on single plant.

**2. Induce more flowering due to the stress of water scarcity**

The main principle of withholding of irrigation is to provide rest for the plant. Withholding of irrigation is done for one and half month in loamy soils and one month in light sandy soils. It practices to accumulate large amounts of food to enhance growth in the coming season and increasing of number of flowers. In this stage the leaves of pomegranate plant fall (50 to 70 %). Under water stress conditions, plants produce osmatin, arginine protein, proline and proteogenic amino acids like prolines etc. These amino acids help to stimulate flowering in the plants under water stress condition, so the plant produce more flowering and good sex ratio.

3. **Use of chemicals for flowering**

In pomegranate crop, spraying of ethrel (1-2 ml per litre) is sprayed extensively for crop regulation. Ehtrel hormone stimulates the enzymes i.e. polygalacteronase and cellulase for cell smelting. These chemicals are considered best for good flowering.

4. **Physiological disorder**

Major physiological disorders like fruit cracking, sun scorching, browning of arils etc. are in pomegranate in dry areas. The foliar spray of gibberellic acid (20ppm) and boron (0.2%) are control of fruit cracking in suitable bahar. Sun scorching in pomegranate fruits should be avoided with use of 30-35 per cent butter paper and shade net, respectively. Harvesting of pomegranate fruits should be done at appropriate time to avoid the browning of arils.

**5. Insect-pests and diseases management**

Crop regulation is good system for managing the insect pests. Use of defoliant induces leaf falls from 50 to 100 per cent, it helps to escape the crop from outbreak of insect-pests and diseases and also reduce usage of insecticides.

Crop regulation is an effective and advanced management practice for obtaining higher yield with good quality. Availability of irrigation, insect-pests infestation, market demand, climatic conditions and use of germplasm are play major role in crop regulation. It requires an intensive care and work for its operation. Crop regulation is more effective to control of physiological disorders i.e. sun scorching, fruit cracking etc.

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# HIGH DENSITY ORCHARDING IN APPLE

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High density orcharding is the practice of accommodating maximum number of plants of same species per unit area at a closer spacing than traditional planting system to get maximum crop yield and profit per unit of tree volume without impairing the soil fertility

- Pioneered for temperate fruits in Europe.
- First planted in Europe at the end of 1960.

**Objectives of High Density plantation:**

1. To overcome low productivity
2. To reduce gestation period for early returns

**Principles of High Density Plantation**

1. Maximum Sunlight harvesting per unit area
2. Land Use Efficiency
3. Maintain vegetative and reproductive balance
   High Early Yields = High Tree Density
   (Start at 3rd Year)
   Balance vegetative and fruiting

- Excessive vigor- Small yield, Larger fruit, Poor fruit color development
- Excessive Fruit Load- Large yields, Small apples, Weak trees
- Grow fruit, not trees

**Why HDP:**

**Future of apple cultivation**

- Standard Varieties (Seedling Rootstocks):178 trees/ha (7.5 x 7.5 m)
- Spur Varieties (Seedling Rootstocks) : 400 trees/ha(5 x 5 m)
- Average productivity of these orchards- 6-8 MT/ha (Traditional)
- Planting clonal rootstocks accommodating up to **5,333** plants/ha to achieve productivity (40-60 MT/ha) **(HDP/ UHDP)**

**Components of HDP**

1. Planting System
2. Canopy management
3. Dwarfing rootstock/ inter-stocks
4. Dwarf Scion Varieties
5. Efficient Training Systems and Pruning methods -dwarfing and spreading habits

- Plant growth retardants (Cycocel, Ancymidal, Paclobutrazol, B-9 (Phosphon D) and chloramquat
- HDP can be done on flat and fertile lands with assured irrigation using dwarf/semi-dwarf clonal rootstocks,

**Planting densities**

Low HDP: <250 trees/ ha, Moderate HDP: 250-500 trees/ ha, High HDP: 500-1250 trees/ ha,Ultra HDP: 1250-2500 trees/ ha and Meadow Orchard: >5000 trees/ ha

**Recommended Training Systems :(modern canopy management)**

- Vertical axis
- Tall spindle
- Slender spindle
- Head and spread

Branches are trained to horizontal positions/ below horizontal, using cloth pins on 8-10 cm shoots and tying of branches during summer.

**Desirable Plant Architecture for HDP**

- Prevent upright growth and develop horizontal laterals.
- Space small laterals along the central leader.
- Develop and maintain fruiting spurs along entire branch as it develops.
- Develop rigid, strong, self-supporting laterals.
- Maintain fruiting branches in one position.
- Develop fruiting spurs along the sides rather than top or bottom of lateral branches.

**Vertical axis**

- Trees are trained and maintained in a narrow pyramidal shape with a dominant central leader to maximize light penetration within the tree canopy
- Central leader is trained to grow vertically to a height of about 10 feet.

**Tall Spindle**

- Need to plant feathered trees
- do not prune at planting.
- Bend all laterals/feathers down. No heading cuts.
- New branches need to be pinned and banded down as they begin to grow in season

**Pruning methods**

**First dormant pruning**

- Select three primary scaffold branches with vertical spacing of 10-15 cm between them.
- Headed back these primaries by about $1/4^{th}$ to $1/3^{rd}$ of their length.
- Leader is also headed back by about $1/4^{th}$ to $1/2^{nd}$ of its length so that it is always higher than the primary scaffold limbs.

**Second dormant pruning**

- Select 5-7 secondary branches per tree usually 2 on each primary scaffold besides 1 or 2 primary scaffold on the central leader.
- Secondary limbs should be left full length and not headed back until it is necessary to maintain balance with the primaries or other secondaries.
- The central leader also be headed back again to stiffen it and to promote the development of lateral shoots.
- Remove all shoots competing with central leader .
- Remove all Upright growing shoots.

**Third dormant pruning**

- Selection of primaries on the central leader, secondaries on the lateral scaffold and tertiaries on the secondary limbs should be continued.
- Pruning of central and lateral leaders should be done as in the previous years to maintain growth.
- Training of tree-thinning out on wanted branches and cutting others to desirable side limbs.

**Mechanical branch bending**

Branches that are bent below the horizontal and even upside down are slowed dramatically and many buds become reproductive along with formation of more spurs.

- It's about the hormones. Bending is done to some angle from vertical. The more angle the more effect.
- 30-45 degree above horizontal because at horizontal there will be strong water sprouts from the high point.
- If shoot is straight vertical then hormones are programed to promote rapid growth trying to get above surrounding vegetation.

When more horizontal it's a signal that fruiting is now a better survival strategy than competing for light. ❑


# EMERGING TRENDS IN AGRICULTURE

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The agricultural industry affects many sectors of the economy both locally and internationally. From farmers and real estate to supermarkets and restaurants, it is important to understand what is happening in this sector and how it will affect food production and distribution. These agricultural trends seen this year are likely to pave the way for many years and more. Issues such as new vaccines, soil health, food processing, the use of global water resources, the new technological capacity, hemp production to further monitor crops will continue to play a role in India and in agricultural measures around the world.

To address this pressing problem, agriculture needs new approaches that not only increase productivity, but also ensure the protection of the environment and the preservation of limited natural resources. Looking ahead, there are actually quite a few trends that are transforming agriculture on a global scale.

**Augmenting Hybridization**

The use of hybrid seeds allows a better adaptation to unfavorable soils and climatic conditions such as saline soils and rainfed ecosystems. Short-lived hybrids produce more in less time and therefore consume less water. Integrated quality hybrid seeds can provide additional tolerance to disease, reduce the use of chemicals on plants, and reduce the level of chemical residues in soil and water.

**Smart agriculture**

With 11 agro-climatic zones, India has diverse agricultural practices, and this technology can really help farmers to increase agricultural production. Precision farming techniques can help eliminate uncertainty or at least further reduce risk by providing accurate weather data through connected devices such as GPS sensors. The information collected can be analyzed to compile a suitable agricultural analysis in which farmers can make specific decisions for their agro-climatic zones.

**Sensor-based drip irrigation**

Agriculture accounts for 70% of total water use and mostly focus on improving water quality and also addressing water scarcity. Prediction models for the optimal application of phytosanitary compounds by drip

irrigation allows us to use sensors and technology to deliver water and crop protection treatments with specific precision based on specific geographic needs, in time, in specific quantity, pest and disease pressures and plant life cycle requirements contributing a lot to the economic savings of farmers.

**Drones / Robots in agriculture**

In addition to mapping the growing area, these tools could also manipulate the responses, it seems exciting right? The application is based on the needs of agrochemicals by identifying weeds, pests and diseases and their types. Drones are completely changing the entire agricultural process around the world. According to industry estimates, the use of drones can provide a 15-20% increase in agricultural productivity.

**Soil Health Management**

Soil health is fast becoming the next frontier in agriculture. While we know the benefits of reduced tillage to preserve soil and prevent erosion and moisture loss, we are still in our infancy when it comes to the complexity of the soil biome.

The activities in soil health management can be achieved by establishing a joint venture between the research and development departments of India which help them in identifying and developing indigenous microbes that can help plants and soils to fix nitrogen by using air or other alternative sources as a way to reduce the need to use conventional nitrogen fertilizers in agricultural production.

Nitrogen fertilizers are not only costly for farmers, but also for the environment, causing increasingly worrying water pollution through runoff and accounting for 3% of global carbon emissions.

**Digitization**

At the moment, the idea of autonomous vehicles does not seem fanciful as it becomes more widespread, but the technology is likely to be adopted more quickly in agriculture. Planting can be done 24/7 with autonomous tractors, drones and robots guided by a farmer's phone or tablet during critical times of the season.

The integration of artificial intelligence, satellite imagery and advanced predictive software will help farmers make key decisions in real time, saving time, money and possibly even harvest in the face of devastating pests or extreme weather conditions.

All of these trends will help increase farmers' incomes and also help reduce distribution losses that have plagued Agri Space for decades.

**Diversification of agriculture**

Agriculture responds not only to the demand for food grains, but also to other development needs. In recent years, the agricultural sector has diversified to produce commercial and horticultural crops such as fruits, vegetables, spices, cashews, areca nuts, and coconuts, and floral products such as flowers and orchids, dairy products and livestock products. The demand for these products is also increasing. The liberalization of the economy has created ample room for development of the agricultural sector in terms of increased production and trade.

**Free trade**

Liberalization removed all restrictions on the movement of agricultural products within the country and outside the country. This has facilitated the expansion of trade in agricultural products, horticulture, floriculture and dairy products, especially food grains.

**Food processing**

Economic liberalization has highlighted the development and expansion of the food processing industry in India. Perishable fruits and vegetables face a huge loss of Rs 3 billion every year. To avoid this loss, the National Horticultural Board takes the necessary measures to provide the infrastructure, packaging, storage and transportation of horticultural products.

Processed fruit and vegetable production provides a large number of jobs and improves agricultural productivity by increasing agricultural export prospects. The government also provides the necessary incentives by exempting the industry from excise duties.

In order to invite foreign capital into the industry, the government authorized a 51% foreign capital partnership and also offered immediate approval for the transfer of foreign technology to the country's food industry.

**Development of agriculture in underdeveloped regions**

In the post-Green Revolution period, the application of agricultural strategy, research and new technologies was severely limited in the production of food grains, that is, only wheat and rice. But under the wave of liberalization, with the growing demand for agricultural exports, many new agricultural areas have become favorable and profitable.

In backward agricultural regions, which do not have an irrigation system, arid land cultivation has begun. Other activities such as horticulture, floriculture, livestock, fishing, etc. were encouraged. The application of improved modern technologies in these areas has led to the development of many backward areas that were previously vulnerable to widespread poverty.

**Development of new biological techniques**

During the period of the Green Revolution, the increasing use of chemical fertilizers and pesticides was encouraged on a large scale to meet the growing demand for food needed to feed the growing population. Population growth, the ever-increasing demand for food and the unlimited exploitation of natural resources have created a serious threat to the environment and the agricultural sector.

In order to save and protect the environment and the agricultural sector from further damage, emphasis has been placed on the increasing use of biotechnology for agricultural processes and more emphasis has been placed on developing new biological technologies.

**The growing trend of unemployment in the agricultural sector and its solution**

The green revolution and the increasing mechanization of agriculture reduced employment opportunities, causing serious problem in rural areas. Although many private employment programs have

been put in place to act as a safety net, the growing potential of the agricultural sector resulting from the liberalization wave needs to be properly harnessed.

The increasing trend of agricultural exports and the increasing demand for horticultural and animal products in the export market have created many opportunities and job opportunities for a large number of people. This labor-intensive sector can provide a permanent solution to the country's rural unemployment problem.


**Water management**

Water is the basis for many agricultural crops in the India and around the world. Access to water remains one of the many problems facing farmers this year. Agriculture consumes eighty percent of the total water used in India. Farmers are looking for ways to help them reduce the water consumption of their crops. In many cases, they choose to collect more water from their fields. We can also reuse the water we use. For example, we can use the leftover water by the animals and water for washing the animals to help in irrigating the crop when the animals have finished drinking.

**Animal vaccines**

Vaccines are an amazing human achievement. In the new year, vaccines continue to be applied in many areas of agriculture. Efforts are underway to help provide more access to animal vaccines. Indian government officials are concerned about the spread of some vaccine-preventable diseases in livestock such as foot and mouth diseases in cattle's.

**Hemp production**

Farmers can produce and sell all forms of cannabis. This substance can be used to create many articles, as well as for those who want to smoke it at home. Experts researching the industry expect much higher growth in this area next year, as it is legal to grow and use hemp. Farmers can now choose to incorporate this crop into their general crop type and keep a specific area of the farm for introduction to the market. Experts warn that any farmer planning to do so must make sure he understands the methods to grow and exactly what it means for anyone who chooses to grow this crop on their own.

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# HEALTH BENEFITS & NUTRIENTS OBTAINABILITY IN UNRIPE MANGO

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**Common Name:** Indian mango

**Family:** Anacardiaceae

**Mango** (*Mangifera indica*) is a stone fruit made from plentiful species of tropical trees belonging to the genus *Mangifera*, mango is one of the edible sweet, most delicious, seasonal fruit. Mangoes are the important in Indian cuisine and are popular throughout the world. The fruit has established its medicinal properties for decades. Still it is not a fruit which is commonly consumed as this is a seasonal fruit. The subject of Food Science & Nutrition is a captivating one. Based on this aspect the present study reviewed to create outline the health benefits, nutrients and source of the fruit.

Known as the "king of fruit," the mango is an antioxidant-rich health booster. Low in calories and high in vitamins and minerals, mangoes make for a nutritious treat. Mangoes offer many nutrients that boost health. Depending on the cultivar, mango fruit varies in size, shape, sweetness, skin colour, and flesh colour which may be pale yellow, gold, or orange. It has been an important herb in the Ayurvedic and indigenous medical systems for over 4000 years. Mango is one of the most important commercial fruit crop worldwide in terms of production, marketing and consumption and is found in wild as well as cultivated form in India, China, Mexico, Pakistan, Indonesia, Nigeria, Thailand, South Central America, Philippines, Brazil, Australia and Egypt (Kumar et al., 2001). Today, these colourful, sweet fruits are a mainstay of Indian cuisine and are popular throughout the world. These fruits offer some impressive health benefits. While mangos were historically only available at the end of the dry season, today they can be found in grocery stores all year long.

**Nutrition**

Mangos are rich in folate, which is used for healthy cell division and DNA duplication. Folate is one of the B-vitamins and is needed to make red and white blood cells in the bone marrow, convert carbohydrates into energy, and produce DNA. The recommendation by the physician that for pregnant women's to consume at least 400 mcg of folate daily, because it is critical for avoiding birth defects.

| Nutrient | Percentage of daily requirement in adults |
|---|---|
| **Vitamin C** | 66.78% for males, and 80.13% for females |
| **Vitamin A** | 9.9% for males, and 12.73% for females |
| **Folate** | 17.75% |
| **Vitamin B-6** | 15.08% |
| **Vitamin K** | 5.77% for males, and 7.7% for females |
| **Potassium** | 5.89% |

**Benefits of mango leaves**

Mango leaves help treat kidney stones and gall bladder stones. Mangoes contain an antioxidant called zeaxanthin which plays a protective role in eye health. Mangoes are a good source of vitamins and minerals.

Mangoes also contribute copper, calcium, and iron to the diet, as well as the antioxidants zeaxanthin and beta-carotene.

**Health benefits**

The vitamins, minerals, and antioxidants in mangos can deliver essential health benefits. For example, vitamin K helps your blood clot effectively and helps prevent anaemia. It also plays an important role in helping strengthen your bones. Mangos are also rich in vitamin C, which is important for forming blood vessels and healthy collagen, as well as helping you heal. In addition, mangos can provide other health benefits like:

1. **Lower Risk of Cancer**: Mangos are rich in beta-carotene, a pigment responsible for the yellow-orange colour of the fruit. Beta-carotene is an antioxidant, just one of many found in mangos. The antioxidants in mangos have been shown to fight free radicals, which can cause damage to your cells and potentially lead to cancer.
2. **Heart Health:** Mangos are also helpful for supporting your cardiovascular system. They are a great source of magnesium and potassium, both of which are connected to lower blood pressure and a regular pulse. Furthermore, mangos are the source of a compound known as mangiferin, which early studies suggest may be able to reduce inflammation of the heart.
3. **Digestive Health**: Mangos can help stabilize your digestive system. They offer both amylase compounds and dietary fiber, which can help you avoid constipation. Amylase compounds can help dissolve other foods in your stomach, breaking down difficult starches. Meanwhile, the fibre in mangos can be more effective for relieving constipation than equivalent fibre supplements.

## Conclusion

The most popular and the choicest fruit of India occupies and prominent place among the best fruits of the world that is mango. Mango is a popular fruit with many forms of consumption like raw mango, ripen mango fruit and with variety of seasonal nutritional recipes. Traditionally pickling was famous in Andhra Pradesh. Unlike many fruits, mangoes are rich in vitamin E. In addition, mangoes contain Vitamins A (betacarotene), B6, C, and K, Potassium, Calcium, Phosphorus, Magnesium, Copper, Iron, Zinc, Fiber. In this study discussed about the health benefits and nutrients available in the mango which will improve the health status of human health.

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# AN INTRODUCTION OF SOIL SOLARIZATION

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Soil solarization is a nonchemical or natural method for controlling soilborne pests (weeds, nematodes, insect, diseases etc) using high temperatures produced by capturing radiant energy from the sun. In other word, it is an environmentally friendly method of using the sun's power to control pests such as bacteria, insects, and weeds in the soil. The method involves heating the soil by covering it with clear plastic for 30 to 45 days during a hot month of the year. The sun heats the soil to temperatures that kill bacteria, fungi, insects, nematodes, mites, weeds, and weed seeds.

Solarization leaves no chemical residues and is a simple method appropriate for the home gardener and small to a large scale farmers. Solarization is primarily used as a broad-spectrum pest control technique, but it may also improve soil health by increasing the availability of nitrogen and other nutrients to growing plants and by beneficially altering the soil microbiome.

**Most effective**

Soil solarization works best on heavy soils-those containing clay, loam, or mixtures of them. They can hold more water than can light soils, long enough to produce steam every day. Steam is needed to kill nematodes, weed seeds, and insect eggs in the soil.

**Less effective**

Solarization may be less effective on sandy soil, which drains faster and produces less steam. To maximize the benefit of solarization in sandy soils, lay drip irrigation lines under the clear plastic cover and add water regularly.

**Plastic**

Polythene plastic 0.025 mm thick is efficient and economical. White or transparent plastic is most effective for solarization. Black plastic, often used for mulching, does not heat the soil as well as clear plastic.

**Soil solarization for Garden**

**Soil solarization for Bed**

**Method of soil solarization**

i. **Preparation of soil-** Solarization is most effective when the plastic is laid as close as possible to a smooth soil surface. Preparation of soil begins by clear the area of plants and debris, remove any large rocks, weeds.

ii. **Laying the Plastic-** Plastic sheets may be laid by hand or machine. Plastic is laid either in complete coverage, where the entire field or area to be planted is treated or strip coverage, where only beds or selected potions of the field are treated. In complete coverage, plastic sheeting is laid down to form a continuous surface over the entire field or area to be planted. In strip coverage, plastic is applied in strips over performed beds.

iii. **Irrigation of field-** For best results, wet the field to at least 12 inches deep because wet soil conducts heat better than dry soil and makes soil organisms more vulnerable to heat. Soil must be irrigated either before or after the plastic sheets are laid.

iv. **Time period of treatment-** The plastic should be left in place for at least 30-45 days in the hottest part of the summer to allow the soil to heat to the greatest depth possible.

v. **Removal of plastic-** After solarization period is complete, the plastic sheet may be removed before sowing of crop or plan.

**Impact of soil solarization**

**1. Increased soil surface temperature**

Sun, the heating effect of soil solarization is greatest at the surface of the soil and decreases with depth. The maximum temperature of soil solarized in the field is usually from 108$^{o}$ to 131$^{o}$ F (42$^{o}$ to 55$^{o}$ C) at depth of 2 inches and from 90$^{o}$ to 99$^{o}$ F (32$^{o}$ to 37$^{o}$ C) at 18 inches. Control of soil pests is usually best in the upper 4 to 12 inches.

**2. Impact on various soil pests**

- Solarization controls many important soil borne fungal and bacterial plant pathogens, including those that cause Verticillium wilt, Fusarium wilt, Phytophthora root rot, Southern blight, damping-off, crown gall disease, tomato canker, potato scab, and many others.

- Control of nematodes by solarization will be greatest in the upper 12 inches of the soil. Nematodes living deeper in the soil may survive solarization.
- Soil solarization controls many of the annual and perennial weeds. Solarization, generally does not control perennial weeds as well as annual weeds because perennials often have deeply buried underground vegetative structures such as roots, corms, tubers, and rhizomes that may resprout. Rhizomes of Bermuda grass and Johnson grass may be controlled by solarization if they are close to the soil surface.

**3. Impact on beneficial soil organisms**

- Earthworms has not received much attention, but it is thought that they retreat to lower depths and escape the effects of soil heating.
- Beneficial fungi, especially Trichoderma, Talaromyces and Aspergillus spp. Survive or even increase in solarized soil. Mycorrhizal fungi are more resistant to heat.
- Populations of the beneficial bacteria Bacillus and Pseudomonas spp. are reduced during solarization but recolonize the soil rapidly afterword.

**Factors that limit effectiveness of solarization**

- Weather and timing- soil solarization is most effective close to the surface under climate, weather conditions of high air temperature and long days for soil heating. It may require 4 to 6 week for treatment during the summer months.
- Soil moisture and soil colour- Soil must be too dry, weed seed and pathogens may not imbibe enough water to mate them vulnerable to the increase heat. Dark colour soil absorb more solar radiation than lighter coloured soils. Organic material such as manure may give the same limited effect.
- Direction of strip bed- Soil solarization is most effective when the beds are oriented north to south rather than from east to west and no slope or when the slope has a south or southwest exposer.

**Advantages**

- Soil solarization also speeds up the breakdown of organic material in the soil, often resulting in the added benefit of releasing soluble nutrients such as nitrogen (from nitrate and ammonium), calcium, magnesium, potassium, and fulvic acid, making them more available to plants.
- Plants often grow faster, with higher and better-quality yields, when grown following soil solarization.
- This may be attributed to improved disease and weed control, increased availability of nutrients, and greater proportions of beneficial microorganisms.
- It is non-pesticidal and simple with no health or safety problems associated with use.

**Disadvantages**

- Soil solarization cannot be considered as a high-tech solution.
- Animals and high speed winds may harm the plastic sheet.
- If plastic applied in strip coverage, no pest control in furrows between strips.
- It may not fit in with some cropping cycles.
- 4-6 weeks cannot grow any crop during the summer.

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# Integrated Nutrient Management (INM) and Its Need

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Under the heading of INM practices, many subheadings can be introduced, including the use of farmyard manures, natural and mineral fertilizers, soil amendments, crop residues, and farm waste recycling, agroforestry, green manures, and compost. Integrated nutrient management is also described as the technique of using minimum effective dose of sufficient and balanced quantities of organic and inorganic fertilizers in combination with specific microorganisms to make nutrients more available and most effective for maintaining high yields without exposing soil native nutrients and polluting the environment. Furthermore, many benefits can also be gained from using integrated nutrient management. INM can act as the driving forces, able to support the plans of converting marginal lands into productive ones, therefore fulfilling the strategy agenda of increasing cultivated land. integrated nutrient management is a tool which can offer good options and economic choices to supply plants with sufficient amounts of most macro- and micronutrients and also can reduce the dose of chemical fertilizers, create favorable soil physiochemical conditions and healthy environment, eliminate the constraints, safeguard the soil nutrient balance in the long run to an optimum level for sustaining the desired crop productivity, and find safety methods to get rid of agriculture wastes.

During the World War II the tragic Bengal famine struck the country in the year 1942-43. It claimed about five million lives. This forced the then Government to launch the 'Grow More Food Campaign' with fertilizer use as the key component. This is the clear indication that fertilizer use has come into existence due to its urgent need.

During mid-sixties India was facing severe food crisis and India had to import food grains in huge quantities to feed its teeming millions. The country bounced back with one of the most spectacular success stories of the twentieth century in the entire world in the form of "Green Revolution ". The green revolution was mainly facilitated by the HYV, introduction of agro chemicals. The immediate enhancement in productivity lined the farmers into using more and more agro chemicals like fertilizers and pesticides. It is important to note that the high yielding hybrids and non-indigenous varieties that were introduced during the green revolution required many chemical supplement for sustained growth and high productivity.

At the time of green revolution agricultural scientists were trying to introduce fertilizers to the farmers field and they demonstrated the higher yield and high crop growth, But they did not informed the ill effects of chemical fertilizers. Farmers stopped the use of organic manures and started using fertilizers to their fields. These gap between scientists and farmers also a reason for this shift from organic farming to inorganic farming.

**Need of integrated nutrient management**

The INM is a prescription for developing a durable IPNS. The INM is soil fertility sustaining practice because it enhances the availability of both applied and native soil nutrient during the crop season. It synchronizes the nutrient demand set by the plant both in time and space with supply of nutrient from soil and applied nutrient pool.

As we are using more and more chemical inputs agricultural lands and water gets polluted and thy reduced the soil fertility. Productivity has stagnated and is showing signs of declining in some cases; the incidence of pests and diseases has gone up. This caused concern in some quarters as to whether this will wipe out the gains of green revolution.

In India too similar to other developing countries the primary objective of agricultural planning is increase the 'production of food grains to satisfy the food needs of the growing population. The achievement of steady growth in the output of protective foods as well as industrially important farm products is also one of the major objectives. To achieve the targeted output, the consumption of plant nutrients also has to increase. For promoting better soil health and stability in production, the most desirable approach is to satisfy the future increase in nutrients needs through IPNS recombined use of all the sources of plant nutrients viz., mineral fertilizers, organic manures and bio fertilizers etc.

In a country like India where food production has to grow steadily to feed more than one billion, switch over to organic farming, without use of mineral fertilizer is perhaps not feasible. The objective of higher crop productivity has to be achieved through the successful application of the concept of IPNS. Farmers should use organic manures in large quantities, wherever available, along with fertilizers, without of course causing any decline in food production.

In nature there is no quarrel between organic and inorganic sources of plant nutrients. Because plants take nutrients in inorganic forms only. Plants do not differentiate the nutrient whether it comes from organic or inorganic sources. This discrimination is manmade. Organic farming, in strict sense of total abandonment of fertilizer, is ruled out in Indian context. Because the fertilizer consumption per ha in India is too low compared to the developed nations of the world to go a long way in fertilizer consumption. Since no single source of plant nutrients is in a position to meet the increasing nutrient demand. Total inorganic farming cannot sustain a profitable agriculture. Total chemical farming is hazardous, so what is to be contemplated and practiced is an integrated approach in soil fertility and plant protection management. Such integrated management programs will ensure not only the productivity of the soil but also the quality of the agricultural produces.

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# Vermicomposting: An Organic Approach for farming

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## Introduction

Increasing population has resulted in higher consumption of goods and services that increases the organic wastes originating from households, industry and agriculture. Much of the organic wastes are very hazardous as they contain a variety of pathogenic microorganisms. These organic wastes when applied directly to agricultural fields cause soil environment-related problems including phytotoxicity. However, if handled properly, these organic wastes can be used as valuable product for agriculture i.e. vermicomposting. Vermicomposting is regarded as a clean, sustainable, and zero-waste approach to manage organic wastes with the use of different species of worms, which generally live in soil, eat biomass and excrete it in digested form called worm casts. Worm casts are known as black gold. Compost produced using this method is known as vermicompost. This compost is generally richer in nutrients, growth promoting substances, beneficial soil microorganisms that make the soil healthy. Vermiculture means scientific method of breeding and raising earthworms in controlled conditions. It may be used for farming, landscaping, composting tea, treatment of sewage sludge, treatment of dung etc. to manage the waste on different scale. Vermicomposting is a best and suitable alternative to chemical fertilizers, being an excellent growth promoter and protector for plants. Thus, vermiculture is not only managing the solid waste but also produces excellent nutrient enriched compost and it is beneficial for sustainable organic agriculture and maintaining balanced ecosystem.

## Importance of vermicomposting

Vermicompost is very important to the fertility of the soil by its physicochemical and biological properties. It contains high amounts of nitrogen, potassium, phosphorus, calcium, and magnesium than the regular compost. Vermicompost improves the aeration, porosity, structure, drainage, and moisture holding capacity of the soil. It can hold nearly nine times their weight in water. It increases the ability of soil to hold nutrients in a plant available form and reducing toxicity of heavy metals. It also reduces the proportion of water soluble chemical, which causes possible environmental contamination. Vermicompost has favorable properties to influence the growth and yield of several crops like paddy, sugarcane, brinjal, tomato, and okra.

Thus, vermicompost acts a soil conditioner and a slow-release fertilizer that ultimately improves plant growth and suppresses diseases caused by soil borne plant pathogens, increases crop yield. It is economically viable and environmentally safe nutrient supplement for organic food production and easily adoptable.

**Materials of vermicomposting preparation**

Any type of decomposable waste

1. *Eisenia foetida* (Red earthworm)
2. Mixture of leguminous and non-leguminous crop residues/Farm residue
3. Weed biomass
4. Leaf litter
5. Waste from agro-industries
6. Animal dung (specially cow dung)
7. Biodegradable portion of urban and rural wastes (kitchen wastes/vegetable waste)

**Method of vermicomposting**

**Most commonly used methods for vermicomposting are discussed below:**

1. **Bin composting**: The most common method of vermicomposting for small scale composting is bin composting method. The bin can be constructed with the help of several materials such as wood/plastic/recycled containers like bathtubs and barrels. A vermicompost bin may be in different sizes and shapes, but its average dimensions are 45 × 30 × 45 cm. Around ten holes with 1–1.5 cm in diameter holes in bottom, sides and cap of bin is useful for aeration and drainage.
2. **Pit composting:** Pit composting is useful for large scale composting; dimensions of pits are 2.5 m × 1 m × 0.3 m under thatched sheds without side walls are advisable. The bottom and sides of the pit should be made hard with a wooden mallet.
3. **Pile composting:** Pile method is mostly used for vermicomposting in larger scale. The piles can be made in porch place like greenhouse or in a floor with some facilities for drainage in warm climate. The pile size may vary in length and width, however, its height is average height of bin used for bin composting.

**Process of vermicomposting:**

**Phase 1:** Processing of vermicompost involves collection of wastes, shredding, mechanical separation of the organic and non-organic waste such as animal dung, leafs, metal, glass and ceramics and storage of organic wastes. Composting unit should be cool, moist and shady.

**Phase 2:** Pre digestion period of organic waste is 15-20 days by heaping the animal dung along with chopped dried leafy material in the proportion of 3:1. It partially digests the material and makes the material fit for earthworm consumption.

**Phase 3:** Bed preparation for earthworms: A concrete base is required to put the waste for preparation of vermicompost. Loose soil is not recommendable because it will allow the worms to go into the soil while watering, all the dissolvable nutrients go into the soil along with water.

A layer of 15 to 20 cm of material should be kept as bedding material at the bottom of bed. Red earthworm should be released on the upper layer of bed. Watering is required immediately after the release of worms. Daily watering is necessary and beds should be covered by gunny bags or polythene. Bed should be turned once in a month for aeration and proper decomposition. Composition required 45-50 days. The finished product is 3/4th of the raw materials used.

**Phase 4: Collection of earthworm after harvesting:** Sieving the composted material to separate fully composted material. The partially composted material will be again put into vermicompost bed.

**Phase 5: Storage of vermicompost:** Storing the vermicompost in proper place to maintain moisture and allow the beneficial microorganisms to grow.

**Application of vermicompost**

Amount of vermicompost depends upon the type of crops grown in the field. For the field crops 5-6t/hec, for fruit crops 3-5 kg per plant and for pot crops 100-200g per pot is necessary for proper growth of the crops.

**Preventive measures**

- Animal dung should be 15-20 days old to avoid excess heat.
- Wastes should be free from non-organic waste such as plastics, chemicals, pesticides and metals etc.
- Aeration should be maintained for proper growth and multiplication of earthworms.
- Optimum moisture level (30-40 %) in the bed should be maintained
- Temperature of bed should be 18-25$^{o}$C for proper decomposition.

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# SIGNIFICANCE OF NUTRIENT MANAGEMENT IN ORGANIC FARMING


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## Introduction

In order to realize the potential of production systems on a sustained basis, efficient management of resources is crucial (essential). A successful farming system relies on the management of organic matter to enhance physico-chemical and biological properties of the soil. The effects of soil organic matter are dynamic as it is a source of gradual release of essential plant nutrients; improves soil structure, its drainage, aeration and water holding capacity (WHC); improves soil buffer capacity; influence the solubility of minerals and serves as a source of energy for the development of micro-organisms.

The use of biological inputs such as N-fixing bacteria, mycorrhiza or soil fauna as a means of enhancing the endemic biological activities are the means of biological soil management. Direct management is also achieved by the use of organic matter inputs, for the purpose of providing feeding materials to biological populations. Management techniques such as tillage and fertilization also influence the activity of the biota by improving the physical and chemical environment of the soil.

According to a conservative estimate, around 600 to 700 mt of agricultural waste is available in the country but it is not managed properly. We must convert waste into wealth by converting this biomass into energy, nutrient to starved soil and fuel to farmers. India produces about 1800 mt of animal dung per annum. Even if ⅔ of the dung is used for biogas generation, it is expected to yield about 440 mt/ annum of manure, which is equivalent to 2.90 mt N, 2.75 mt $P_2O_5$ and 1.89 mt $K_2O$.

## Concept and definition of biological INM

The concept of biological INM is the continuous improvement of soil productivity on long-term basis through appropriate use of organic manures, green manures, BGA, bio-fertilizers and other biological derived materials and their scientific management for optimum growth, yield and quality of crops and intensive cropping systems in specific agro-ecological situations.

According to Sanchaz (1994), we should rely on biological processes by adapting germplasm to adverse soil conditions, enhancing soil biological activity and optimizing nutrient, cycling to minimize external inputs and maximize the efficiency of their use. It can also be defined as "a system for approaching of soil nutrient management which maintain soil health, soil fertility, sustaining agricultural productivity and

improving farmer's profitability through effective, judicious and intensive use of biological based nutrient management resources". The resources are biofertilizers, organic manures green manuring crop rotation, N-fixing organisms, mycorrhizae, PSM etc.

**Role of different sources for biological INM**

**1. Organic manures**

Manure was used originally for denoting materials like cattle manure and other bulky natural substances that were applied to land, with the object of increasing the productionof crops. Urine is normally low in phosphorus and high in potash, whereas about equal parts of nitrogen may be excreted in faeces and urine of the cattle. Hence the manure in which the proportion of the urine was allowed to drain away would be relatively low in N and K. Poultry manure is very important for organic farming due to there will be no loss of urine, since both liquid & solid portions are excreted together. Fresh poultry manure creates local alkalinity, it may hamper the standing crop. Therefore,it is recommended to preserve the excreta at least for six months with suitable amendments and appropriate microbes.

**Table-1: Average nutrient content of different organic manures**

| Organic manures | Per cent composition | | |
|---|---|---|---|
| | **N%** | **$P_2O_5$%** | **$K_2O$%** |
| **A) Bulky organic manures** | | | |
| FYM | 0.5 | 0.2 | 0.5 |
| Compost | 0.5 | 0.15 | 0.5 |
| Biogas Slurry | 1.0-1.8 | 0.4-0.9 | 0.6-1.0 |
| Night Soil | 5.0 | 4.0 | 2.0 |
| Activated Sludge | 3.6 | 2.0 | 1.0 |
| Sheep and goat Manure | 3.0 | 1.0 | 2.0 |
| Poultry Manure | 2.87 | 2.93 | 2.35 |
| **B) Concentrated organic manures (Oil Cakes)** | | | |
| **i) Edible oil cakes (feed for livestock)** | | | |
| Safflower (decorticated) | 7.9 | 2.20 | 1.9 |
| Groundnut | 7.3 | 1.5 | 1.3 |
| **Cotton seed (decorticated)** | 6.5 | 2.9 | 2.2 |
| **ii) Non-edible oil cakes (not fed to livestock)** | | | |
| Safflower (un-decorticated) | 4.9 | 1.4 | 1.2 |
| Cotton seed (un-decorticated) | 3.9 | 1.8 | 1.6 |
| Caster | 4.3 | 1.8 | 1.3 |
| Neem | 5.2 | 1.0 | 1.4 |
| **iii)Animal Origin** | | | |
| Bone Meal | 1.0-2.0 | 10.0-13.0 | -- |
| Horn Meal | 14.0 | - | - |
| Blood Meal | 13.0-20.0 | - | - |
| Meat Meal | 7.0 | 1.0-5.0 | 3.0-10.0 |
| Fish Meal | 7.0-8.0 | 2.0-3.0 | 0.2-0.5 |
| Guano (Bird/Fish) | 8.0-15.0 | 2.0-3.0 | |

**Advantages of manuring**

- Manures supply plant nutrients including micro nutrients.
- They improve soil physical properties, soil tilth, aeration and WHC of the soil.
- Increase nutrient availability.
- Provide food for soil micro-organisms.
- Provide buffering action in soil reaction.

**1.2 Vermicomposting**

- When added to clay soil, loosens the soil and provides the passage for the entry of air.
- The mucus associated with it being hygroscopic, absorbs water and prevents waterlogging and improves water holding capacity.
- In the vermicompost, some of the secretions of worms and the associated microbes act asgrowth promoter along with other nutrients.
- It improves physical, chemical and biological properties of soil in the long run onrepeated application
- The organic carbon in vermicompost releases the nutrients slowly and steadily into thesystem and enables the plant to absorb these nutrients.
- The multifarious effects of vermicompost influence the growth and yield of crops.
- Earthworm can minimize the pollution hazards caused by organic waste by enhancingwaste degradation.

**3.3 Green manuring**

- It adds organic matter to the soil. This stimulates the activity of soil micro-organisms.
- Green manuring concentrates plant nutrient in the surface layer of the soil.
- It improve the structure of soil by deep rooting system.
- It facilitates the penetration of rain water, thus decreasing run off & soil erosion.
- It holds plant nutrients that would otherwise be lost by leaching (Eg. N).
- It increases the availability of certain plant nutrients like P, Ca, K, Mg & Fe.
- It checks weed growth by quick initial growth.
- It aid in reclamation of sodic soils by release of organic acids.

**3.4 Recycling of organic residues**

A variety of organic residues include crop residues in the form of straw, husk, forest litter; animal wastes like dung urine, bones etc., guano, city or household residues, oil cakes, bye products of food and sugar industries, pond silt, marine wastes, sea weeds and human habitation wastes. There are two major components of crop residues available, i. e. *harvest refuse* (straw, stubbles, haulm of different crops) and *process wastes* (nut shell, oilcakes and cobs of maize, bajra and sorghum). ***Crop residues*** are defined as "the non-economic plant parts that are left in the field after harvest and remains that are generated from packing sheds or that are discarded during crop processing". The *benefits* of proper organic residue recycling are that they supply essential plant nutrients, improve soil properties, protect the soil from erosion hazards, reducing residue accumulation at the sites they produced, providing employment as well as income to many, enhancing environmental qualities and illustrate that man is not a waste generator but also its wise utiliser/ manager.

**3.5 Benefits of bio- fertilizers in organic farming**

- Bio-fertilizers are eco-friendly and do not have any ill effect on soil health andenvironment.
- They reduce the pressure on non-renewable nutrient sources/fertilizer.
- Their formulations are cheap and have easy application methods.
- They also stimulate plant growth due to excretion of various growth hormones.

- They reduce the incidence of certain disease, pathogen and increase disease resistance.
- The economic benefits to cost ratio of bio-fertilizers is always higher.
- They improve the productivity of waste land and low land by enriching the soil.

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# Biochar: A source of C sink and soil health

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Biochar is relatively new term not a new substance. It's is originated from greek word "bio" Meaning life and "char" short for charcoal. It's is a type of charcoal made by thermal decomposition of biomass, but without use of oxygen. It's use as soil conditioner for both Corban sequestration and soil health. Ideal temperature of biochar creation is at 400-500°C while temperature above 700°C favours the yield of liquid and gas fuel components.

**Advantage of Biochar**

- Increase cation exchange capacity.
- Increase water holding capacity.
- Supports soil microbial life and biodiversity.
- Stimulated symbiosis nitrogen fixation in legumes.
- Help retain nitrogen and sulfurs in soil, which also reduces emissions
- Reduced leaching of nutrients.
- Reduced soil acidity.
- Inhibit the growth of molds or mildews.

**Disadvantage**

- The increase in cation exchange capacity depends on the composition of the soil. it is minimal in soils with high clay or organic matter content especially at realistic rates of biochar additions.
- The reduction in nitrous oxide emissions is not universal and emissions even increase sometimes.
- The fine ash associated with biochar is the perfect source for dust, posing a risk for respiratory diseases.

**Biochar as a source of C sink**

When biochar is burnt or naturally disorganized, huge amount of $CO_2$ and $CH_4$ is released into earth's atmosphere. Biochar also similarly released the same elements into atmosphere. But the C content is static by comparison.

As such biochar provide for a suitable storage of carbon in the ground potentially and sequestered in soils for hundred and even thousands of the years.

**Restoring the Carbon balance in the atmosphere**

It removes net carbon from the atmosphere. When a green plant grows, it takes $CO_2$ out of the air to build biomass. All of the carbon in the plant came from $CO_2$ taken out of the air, and returns to the air when the plant dies and decomposes. When the biomass is pyrolyzed heated in the absence of oxygen over 40% of the total carbon from the waste biomass is retained in biochar and sequestered in the soil for thousands of years, effectively removing that carbon from the atmosphere. The carbon in 1 ton of biochar is equivalent to about 3 tons of $CO_2$ removed from the atmosphere.

**Effects of biochar on soil health**

**Influence of biochar on soil physical properties**

Biochar has high concentration of organic carbon high porosity and surface area are improvement in soil physical properties including soil structure, aggregate and water holding capacity would be requisite following incorporation into soil. The effective maintenance of biochar in offended soil can help preserve soil fertility and reduce erosion sensibility by promoting soil aggregation durability and improving hydraulic conductivity and water retention and holding capacity.

**Influence of biochar on soil chemical properties**

Observed significant changes in soil quality, including pH increase organic carbon and exchangeable cation were noticed at higher rate of biochar application.

**Influence of biochar on microbial properties**

Biochar provides a suitable habitat for a large and multitudinous group of soil microorganism. Symbiosis between effective microbes and plant root through the medium of charcoal that promotes the growth of plant.

**Influence on nutrients use efficiency**

Long term benefits of biochar application on nutrient availability mainly due to greater stabilization of organic matter, coincident slower nutrients release from organic matter and better assumption of all cation due to a greater cation exchange capacity.

## Conclusion

Biochar has the ability to change the biodiversity of an agro-ecosystem without negatively impacting crop yield. It has potential to improve physical, chemical and biological properties of soil, enhance crop yield significantly and mitigation the climate change. We need to investigate and utilize it to reduce our emissions and sustain soil but we can not rely on it for solving our emerging problem.

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# DOUBLING FARMERS' INCOME

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In the present covid-19 scenario, agriculture is at lowest stake. Various development programmes schemes reforms and policies have come into force responding to significant returns to the farmer. It is apparent that income earned by a farmer from agriculture is essential to address agrarian condition and promote welfare of farmers. In this context, the goal set by doubling farmers income by 2022-23 is foremost to encourage farmers' welfare, reduce agricultural distress and bring equivalence between income of farmers and those working in non-agricultural professions.

**Introduction**

The goal of doubling farmers' income by 2022 was put forward in Bareilly, UP by Prime Minister Narendra Modi at February 28, 2016 during his address to the nation. Later it was announced by Hon'ble finance minister Late Arun Jaitley during his budget speech.

After the Green Revolution India's food production increased 3.7 time while the population grew by 2.55 times. The food production has increased from 51 million tonnes from 1950-51 to 297.5 million tonnes (record) in 2019-20.

The net result it has been a 58% increase in per person food production which has made India self-sufficient at gross level and also on net food export by the country. The strategy of doubling farmers' income includes increase in crop productivity, increase in livestock production, improvement in efficiency of input used, high value crop production, enhancing market value realization etc. The centre also recently announced

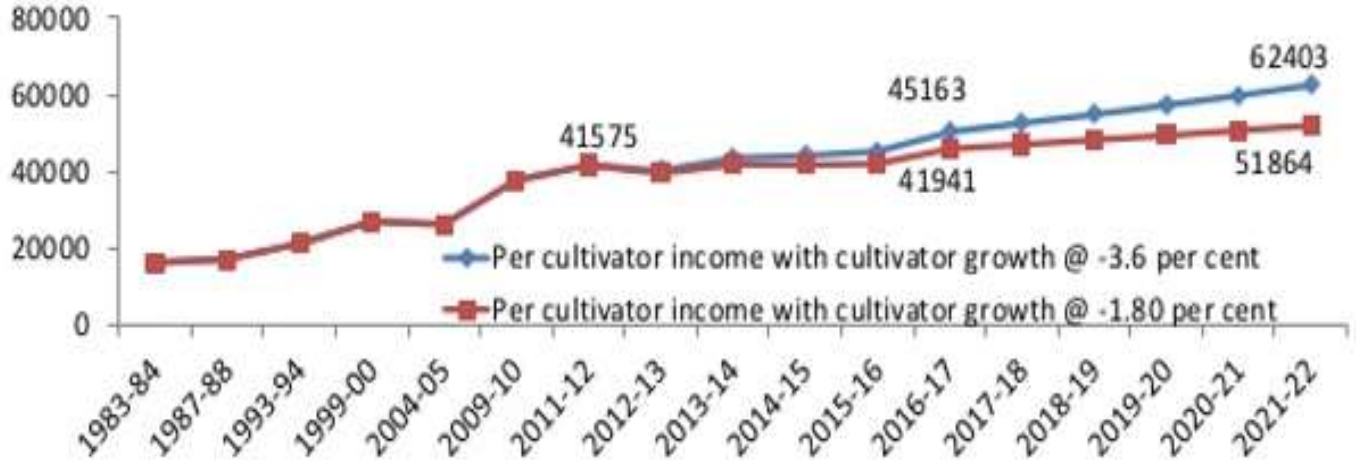


**Fig. 1: Effect on income with growth in no. of cultivators**

the agriculture export policy 2018 which would play a critical role in in agriculture item exports. This way would also generate job opportunities and skills.

**Doubling farmers' income committee**

An inter-ministerial committee formed as on April 2016 to recommend a set of guideline to achieve the goal of doubling farmer income (DFI) by 2022. The committee submitted report in September 2018. They suggested seven source for growth of farmers' income 1. crop productivity enhancement 2. livestock productivity enhancement 3. decreasing the cost of production 4. increase in cropping intensity 5. diversification of high value crop 6. increasing amount of reel price received to the farmer 7. shift to non farm activities.

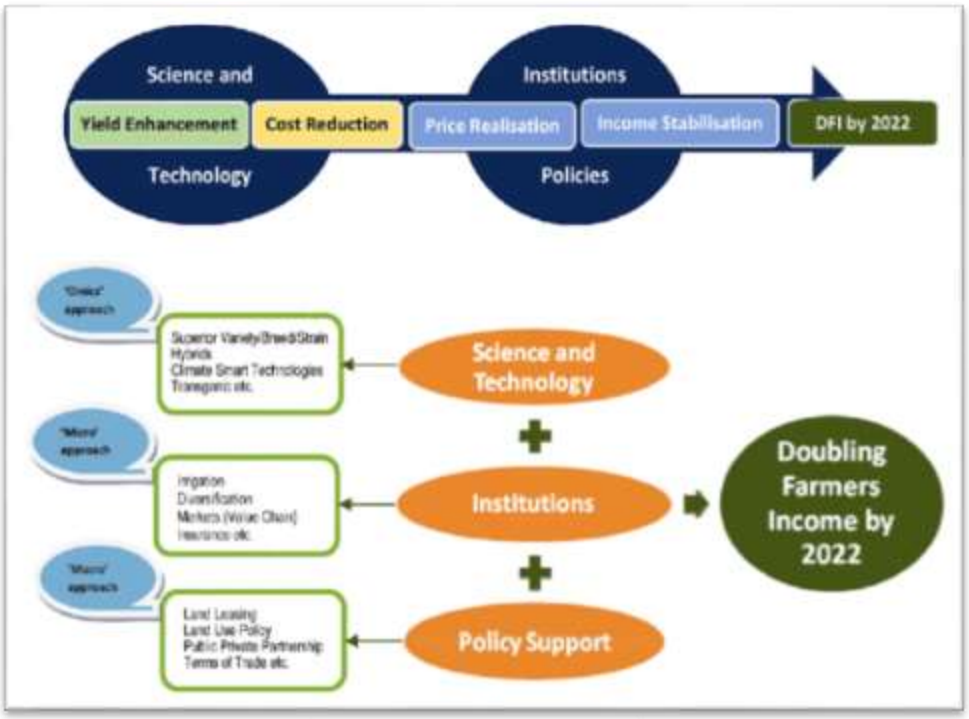


**Fig. 2: Pathway to double farmers; income**

**Related steps taken by government**

**Institutional reforms**

- PM-KISAN (Pradhan Mantri Krishi Samman Nidhi): This scheme provides financial assistance of Rs 6000/-per year in 3 quarter installments of Rs 2000/- to provide support to farmers in terms of agriculture and allied activities.
- PM-KMY (Pradhan Mantri Kisan Mandhan Yojana): A central scheme in which small and marginal farmer are eligible for minimum pension of Rs 3000/-after 60 yrs. age.
- PMKSY (Pradhan Mantri Krishi Sinchai Yojana), Soil health card and PKVY (paramparagat krishi vikash yojana): All these aim to raise the output and reduce cost of cultivation and promote organic framing approach.

- Pradhan Mantri Fasal Bima Yojana (PMFBY): Launched in kharif season of 2016 to provide insurance against crop and income loss at any stage of farming, including post-harvest risks.
- Government had declared the increase in MSPs of various kharif and rabi crop for season 2019-20 and hiked from Rs 50 to Rs 300/quintal for the Rabi season of 2021-22.
- PM-AASHA (Pradhan Mantri Annadata Aay Sanrakshan Abhiyan): It insures remunerative Prices Farmers As per their production to insure farmer income. It includes Price Support Scheme, Price Deficiency Payment Scheme etc.
- Operation Green: To check price fluctuations of perishable items like tomato, Onion and potato (TOP).
- PM Kisan Sampada Yojana: To promote food processing through Holistic approach.
- Government has released the annual cash flow budget of Rs 15 lac crore for the year 2020-21 in the agriculture sector.
- Government has also suggested severe market reforms as; The Farmers Produce Trade & Commerce (Promotion & Facilitation) Ordinance, 2020 Farmers Agreement of Price Assurance and Farm Services Bill 2020 & Amendments to Essential Commodities Act, 1955.

**Technological reforms**

- Initiating E-NAM: The National Agriculture Market (e-NAM) is an Indian online trading portal for agri products. It connects the existing agricultural produce market committees (APMC) mandis which facilitates producers, traders and consumers on one platform for better price realization.
- "Per Drop More Crop" initiative: The drip and sprinkler irrigation are being encouraged for optimization of water use efficiency and reducing the cost of watering.
- Technology Mission on cotton: It aims to increase the earning of cotton growers by reducing the cost of cultivation as well as by increasing the yield per hectare through use of modern technology among growers.
- Technology mission on oilseeds pulse and maize (TMOPM): Few schemes under TMOPM umbrella scheme are; oilseed production programme (OPP), National pulses development project (NPDP) etc.
- Mission for integrated development of horticulture (MIDA): It is a scheme aimed at the holistic growth of the horticulture sector including fruits, veg, mushroom, flowers, aromatic plants, bamboo etc.
- Sugar technology mission: Focused at reducing the cost of sugar production and improving sugar quality through initials of improvement in productivity, energy conservation and improvement in gross returns.
- National Mission on sustainable agriculture: It aims at promoting sustainable agriculture adopting a chain of measures focusing on ten key features enclosing indian agriculture namely; farm practices, Nutrient management, Agriculture insurance, credit support, information technology and livelihood diversification etc.
- National bamboo mission: Launched in the year 2018 to enhance bamboo plantations on non agri lands under agroforestry reform.
- In addition, schemes related to tree plantation (Har Medh Par Ped), bee keeping dairy and fisheries are also implemented for additional returns.

## Conclusion

The low level of farmer income and year after year alteration in gross returns are a major source of agrarian distress. This disturbance is spreading and getting severe over time affecting almost half of the population of the country that depends upon farming for a living. Stationary, low level of farmer income can also cause serious drawbacks for the future of agriculture in the country. To secure future of agriculture and uplift the living standard of half of India's population proper attention is necessitated to be given for the welfare of farmers and to raise agricultural income. Obtaining this goal will reduce the continuous imbalance between farm and non-farm income will relieve agrarian distress promote collaborative growth and saturate dynamism in the primary sector. The youth will also tempt toward the respectable income in farm section and also it will ease the pressure on non-farm jobs which is not growing as per the expectations.

Doubling farmer income by 2022 is quite challenging, but it is required and is attainable. The three-pointed strategy is focused upon: 1. Development activities 2. Technology revolution 3. Policy reforms need to be implemented to double farmers' returns.

- The rate of increase in source need to accelerated by 33% to meet the goal of desired growth in output.
- The country requires to increase use of good quality seed fertiliser and power supply to agriculture by 12.8, 4.4 and 7.6 percent every yr.
- The irrigated area has to be expanded by 1.7 Million hectare and area under intensive cropping should be increased by 1.85 million hectare every year.
- In the case of livestock improvement in herd quality, better feed, increase in artificial insemination, reduction in calving interval and lowering age at first calving are the potential source of growth.

Research Institutes need to come with technological reforms for shifting production frontiers and increasing use of efficient inputs. The growing scope of agronomic practices like precision farming to enhance production and income of farmers significantly. Similarly, modern machinery tools such as laser land leveller precision seeder and planter and practices like SRI (System of Rice Intensification), Direct seeded rice, Zero tillage, raised bed plantation and Ridge Plantation had also improvised farming technically in an efficient way. However, these modern farming methods, have very low marketability. They require a strong advertisement and reachability to farmer. R&D institution’s need to include significant level of innovations and which are sustainable and income enhancing.

Near about one third of the increase in farmers' income is easily achievable through better price realization, well struured post-harvest management, competitive value chains and adoption of other farm activities. This needs absolute reforms in market, land leasing and raising of trees on private fallow land. The agriculture needs to be liberalized to attract secure private investments in production as well as market.

Similarly, FPOs and FPCs can play a major role in promoting small farm entrepreneurs. Securing MSP alone for farm produce through government intermediation will result in reasonable increase in farmers' income in many states.

Most of the development initiatives and policy reform for agriculture are executed by the states. States usually invest much more than the outlay by the Centre on many development activities, like irrigation. Also progress of major reforms related to market and land lease performed by State. Therefore, it is essential to employ states and UTs on their own and achieve the goal of doubling farmers' income. If collateral and well-coordinated efforts are made by the Centre and all the States and UTs together the country can attain the goal of doubling farmers' income by the year 2022.

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# EFFECT OF CLIMATE CHANGE ON SOIL FERTILITY

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The most recent report of the Intergovernmental Panel on Climate Change (IPCC) indicates that the average global temperature will probably rise between 1.1 and 6.4 °C by 2090–2099 as compared to 1980–1999 temperatures, with the most likely rise being between 1.8 and 4.0 °C. The levels of $CO_2$, a major greenhouse gas, in the atmosphere are expected to be higher than today (TPCC) and IPCC reports that the 21'"century is likely to be warmer. Climate change can have a very big impact on soils and the functions that soil performs. In agriculture, climate change will affect crop production as changes in soil, air temperature and rainfall affect the ability of crops to reach maturity and their potential harvest. These are the consequence of global warming due to emission of greenhouse gases like $CO_2$, $CH_4$ and $N_2O$ to the atmosphere. The climate heats up; reductions in the amount of water available may be made up initially by irrigation. However, scarcity of water may prevent water being used for irrigation. Increasing damage to the land, or land degradation, will occur in the form of soil erosion, desertification, salinization, or loss of peat soils, further impacting on the capability of soils to support the needs of agriculture.

Agriculture is considered one of the major contributing sectors to the economy not only of rural areas but also of the whole country. The livelihoods of majority of rural communities mainly rely on agriculture to meet their subsistence needs. The farmers of our country is always producing huge quantities of various crops, yet our agricultural production is not still secured for alarmingly increasing population. Besides soil health and other input factors, agricultural production system depends on climatic factors of a locality. The unpredicted climate changes directly affect environment and more particularly soil and crop productivity, for which farmers have to suffer and rural economy is adversely affected.

Soil is one of the most valuable natural resources. The change in climate particularly the rise in global temperature and change in rainfall pattern adversely affect the ecosystem leading to increasing magnitude of natural resources degradation in terms of soil fertility, soil structure, soil and water erosion, wind erosion, deforestation,

siltation, water stagnation and depletion of soil organic carbon and nutrients, which are creating serious hindrance to agricultural productivity.

Soil organic matter is any material produced originally by living organisms (plant or animal) that is returned to the soil and goes through the decomposition process. At any given time, it consists of a range of materials from the intact original tissues of plants and animals to the substantially decomposed mixture of materials known as humus. Most soil organic matter originates from plant tissue. Plant residues contain 60-90 percent moisture. The remaining dry matter consists of carbon (C), oxygen, hydrogen (H) and small amounts of sulphur (S), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Although present in small amounts, these nutrients are very important from the viewpoint of soil fertility management. To produce more crop yield from less land area for a large population, there is a dire need to feed the soil for sustaining soil fertility through maintaining organic carbon content in soil. Soil organic matter plays an important role in determining the physical, chemical and biological properties of soil. Plant nutrients availability can be increased through the process of decomposition of organic matter. Properties of soil such as cation exchange capacity, water holding capacity, aeration etc, can be increased by improving the soil environment through application of organic matter. The activities of some beneficial soil microorganisms like cellulose degraders, N- fixers and P-solubilisers are governed by the factors like soil temperature, soil moisture and soil organic matter. As a result of changing weather situation, the activity of soil microorganisms is changed and the increasing temperature causes faster rate of breakdown of organic matter resulting in more release of carbon dioxide gas at a time in the atmosphere. It has been reported that the practice of zero or minimum tillage may slowdown the rate of decomposition of organic matter and helps to get rid of higher carbon dioxide emission from the air.

Biofertilizers have enormous potential to fulfill the nitrogen and phosphorus requirement of the crops in soil without much emission of C02 and can be used to mitigate the bad effect of inorganic chemical fertilizers. The bacteria (Rhizobium) in the root nodules of legume crops have the ability to fix atmospheric nitrogen in soil without any detrimental effect on soil environment. It is very much important to include one legume crop i.e. the cropping system. Phosphate solubilizers are most efficient in increasing availability of native phosphorus in soil. Use of rock phosphate in acidic low P soils can be effective to increase crop production. Owing to continuous deforestation, soil organic matter has been reducing alarmingly. Soil organic carbon can be sustained at a high level by incorporating left out crop residues into the soil, plough down of green manuring crops, application of organic manures like PYM, compost, vermicompost, biofertilizers etc. Mulching with crop residues over the ground surface is used to control soil temperature, reduce moisture loss through evaporation and enhance water infiltration. Mulching also tremendously helps in preventing soil erosion. Use of improved technology, seeds and practice of crop diversification are also influencing soil.

According to FAO, sustainable agriculture is the successful management of natural resources for agricultural production to meet the changing human needs, while maintaining or enhancing quality of environment and conserving natural resources. It indicates some important aspects like meeting changing need of today and tomorrow, economic viability at enhanced productivity, successful management of resources - external, internal, renewable or nonrenewable, maintenance, preferably enhancement of Quality of environment and conservation of natural resources particularly soil and water which form the pivot of agriculture. Therefore, organic agriculture movement can be considered to be the roost efficient sustainable approach in crop production for food security where recycling of organic crop residues and less amount of external inputs are involved to produce high output. Organic agriculture is the only way in enhancing soil health by reducing the severe impact of weather changes and to some extent C02 gas emission. Plantations can lower down the atmospheric temperature by the process of transpiration. It is the peak time not only for coming new generation but also for every human being to be aware of the climate change. Each and every growers should recycle their farm wastes into the soil through in situ incorporation and I or making compost or vermicompost , instead of burning, to increase the soil organic carbon or soil organic matter for long term restoration of soil environment, fertility and productivity for food security of the nation.

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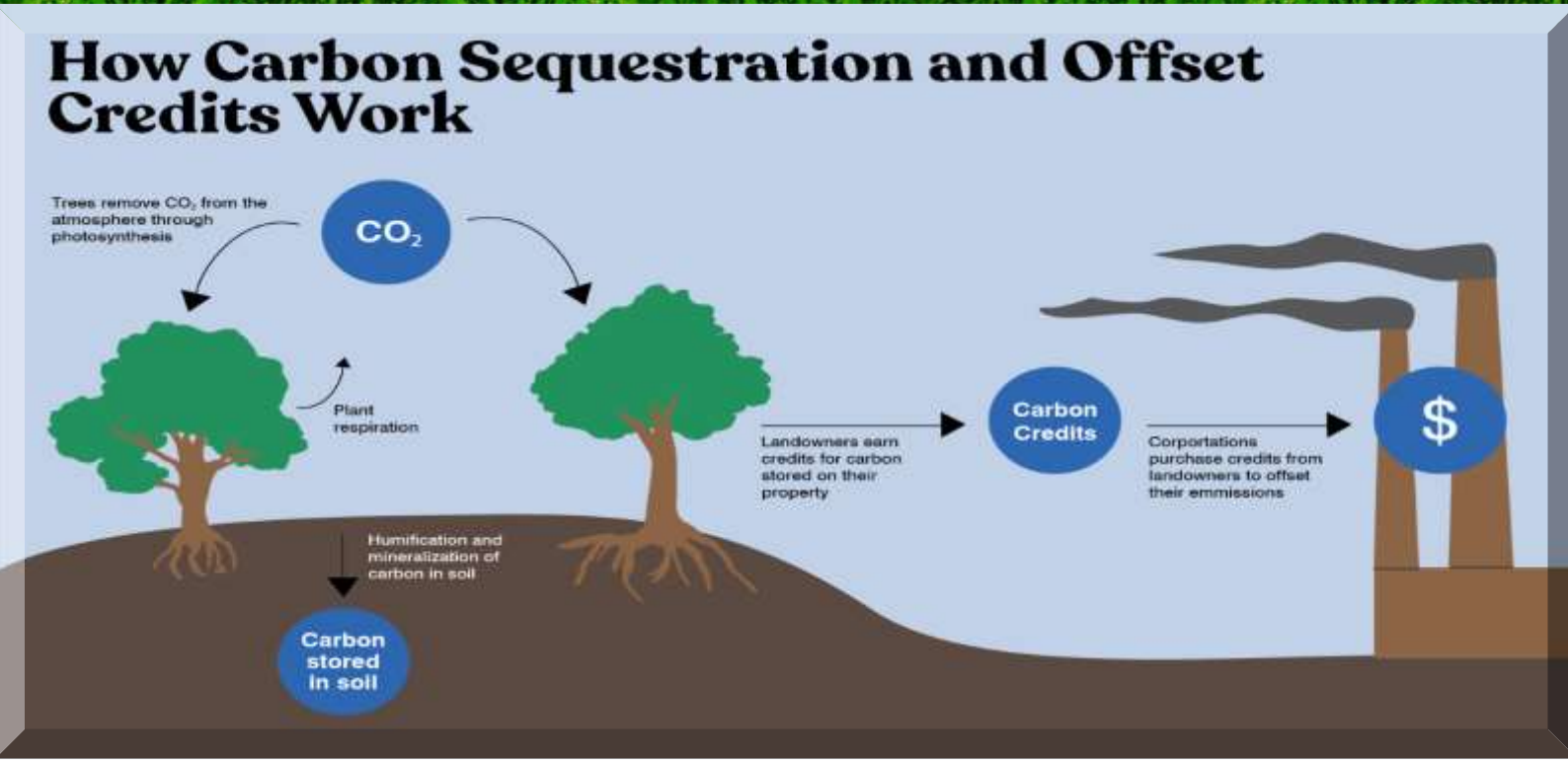


# CARBON SEQUESTRATION TO MITIGATE CLIMATE CHANGE

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**Climate change is an unavoidable phenomenon in the world owning to the use of fossil fuels for energy production. It has a wide range of implications, including reduced crop yields due to water scarcity and soil health issues, decreased livestock productivity, increasing sea levels, biodiversity loss, and glacier melting. To minimize its impact, various methods are used, including carbon sequestration in various sinks, which is the most efficient and reliable process.**

## Introduction

Human activities, particularly the use of fossil fuels like coal, oil, and gas, have resulted in a significant increase in the concentration of carbon dioxide ($CO_2$) in the atmosphere. Over the last 250 years, the rise in atmospheric $CO_2$ from around 280 to more than 380 parts per million (ppm) has resulted in observable global warming. Potential adverse impacts of climate change include sea-level rises; increased frequency and wildfire severity, flooding, droughts and tropical storms; changes in the amount, timing, and distribution of rain, snow, and runoff; and disturbance of coastal marine and other ecosystems. Rising $CO_2$ levels in the atmosphere are also increasing $CO_2$ absorption by seawater, causing the ocean to become more acidic, potentially disrupting marine plankton and coral reefs. Without drastic action today, adapting to these impacts in the future will be more challenging and costly. There are three key strategies for reducing $CO_2$ concentrations in the atmosphere: (i) reducing global energy use, (ii) developing low-carbon or zero-carbon fuels, and (iii) capturing $CO_2$ from the atmosphere and storing it in the ocean, terrestrial environment, or geological formations, that is carbon sequestration.

Carbon sequestration is the process of removing atmospheric $CO_2$ through physical, chemical, or biological processes and storing it in long-lived carbon pools such as the ocean, soil, vegetation (particularly forests), and geologic formations so that it is not re-emitted into the atmosphere in the near future. $CO_2$ enrichment in the atmosphere can be mitigated by reducing anthropogenic emissions and implementing sound agricultural and forestry management practices that increase carbon storage or sequestration in plants and soil. There are certain scientific links that are well established:

- The concentration of GHGs in the earth's atmosphere is directly related to the average global temperature;
- The concentration has been steadily rising, and mean global temperatures with it, since the Industrial Revolution;
- Carbon dioxide ($CO_2$), the most abundant GHG, accounts for about two-thirds of GHGs and is largely the product of fossil fuel combustion.

## Climate change in India: observed

### Temperature Rise Over India

India's average temperature has risen by around 0.7°C during 1901–2018. This rise in temperature is largely on account of GHG-induced warming, partially offset by forcing due to anthropogenic aerosols and changes in LULC.

### Indian Ocean Warming

Sea surface temperature (SST) of the tropical Indian Ocean has risen by 1°C on average during 1951–2015, markedly higher than the global average SST warming of 0.7°C, over the same period.

### Changes in Rainfall

The summer monsoon precipitation (June to September) over India has declined by around 6% from 1951 to 2015, with notable decreases over the Indo-Gangetic Plains and the Western Ghats.

### Sea Level Rise

Sea-level rise in the North Indian Ocean (NIO) occurred at a rate of 1.06–1.75 mm per year during 1874–2004 and has accelerated to 3.3 mm per year in the last two and a half decades (1993–2017), which is comparable to the current rate of global mean sea-level rise.

## Climate change mitigation

Climate Change Mitigation refers to efforts to reduce or prevent greenhouse gas emissions. Climate change mitigation actions aim to reduce greenhouse gas emissions while increasing the amount of greenhouse gas removed from the atmosphere by greenhouse 'sinks.' Oceans, plants and soils are sinks of carbon dioxide, since it absorbs more carbon than it emits.

Globally, scientific and technological research is under way into how to reduce the amount of greenhouse gases that we emit. This includes research into:

- Cleaner energy supplies such as electricity from renewable sources and automotive biofuels
- Using energy more efficiently to avoid burning fossil fuels
- Developing more efficient transport
- Improved cropland and livestock management
- Better waste management
- Reducing land clearing and deforestation.

## Carbon sequestration

Carbon sequestration is the process of capture and long-term storage of atmospheric carbon dioxide to mitigate global warming and to avoid dangerous impacts of climate change. In other words, it also refers

to the process of removing carbon from the atmosphere and depositing it in a reservoir. This carbon storages or reservoirs are also known as carbon pools.

## Important terminology

**Definitions:**

- **Carbon pool:** A carbon reservoir. A system that can either accumulate or release carbon.
- **Carbon stock:** The absolute amount of carbon held in a pool at a given time. Mass is the unit of measurement.
- **Carbon flux:** Transfer of carbon from one carbon pool to another in units of measurement of mass per unit area and time (e.g., t C ha $^{-1}$ yr$^{-1}$).
- **Carbon sink:** Any process or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere. A pool (reservoir) can be a sink for atmospheric carbon if more carbon flows into it than flows out during a given time interval.
- **Sequestration (uptake):** The process of increasing the carbon content of a carbon pool other than the atmosphere.

## Ways that carbon can be stored (sequestered)

1. Deep in ocean **"ocean sequestration":** The oceans stored about 30% of $CO_2$ and 93 % of all greenhouse gases.
2. In plants and soil **"terrestrial sequestration"** ("carbon sinks"): $CO_2$ from the atmosphere is absorbed by plants through photosynthesis and stored as carbon in soils and biomass (tree trunks, branches, foliage, and roots).
3. Underground **"geological sequestration":** Capturing carbon dioxide, transporting carbon dioxide, and placing the carbon dioxide in a geologic formation for permanent or semi-permanent storage

## Oceanic carbon sequestration

The world's oceans are the primary long-term sink for $CO_2$ emissions caused by humans, currently accounting for a global net uptake of about 2 giga-tonnes of carbon per year. In the ocean, carbon sequestration, a fancy word for the process by which carbon dioxide is removed from the atmosphere, is achieved through various chemical and biological processes. Photosynthesis is used by plankton at the ocean's surface to convert carbon dioxide into sugars in the same way that trees and land plants do on land. Sea creatures consume phytoplankton (photosynthesizing plankton) and thus the carbon-containing sugars, eventually dying and sinking to the bottom of the unfathomably deep ocean, where the carbon is locked away as sediment over millions of years.

## Terrestrial Sequestration

Terrestrial or biologic sequestration refers to the use of plants to capture $CO_2$ from the atmosphere and then store it as carbon in the plants' stems and roots, as well as in the soil. Plants take in $CO_2$ and give off oxygen $O_2$ to the atmosphere as a waste gas during photosynthesis. The plants retain and use the carbon to live and grow. When a plant dies, a portion of its carbon is preserved (stored) in the soil. Terrestrial sequestration refers to a set of land management practices that maximize the amount of carbon stored in soil and plant material over time. Terrestrial sequestration includes wetlands management, rangeland management, and reforestation. It is critical to remember that terrestrial sequestration does not store $CO_2$ as a gas, but rather the carbon component of $CO_2$ (the C in the $CO_2$). As soil carbon is disturbed and comes into contact with oxygen in the air, the exposed soil carbon may combine with $O_2$ to form $CO_2$ gas and re-enter the atmosphere, reducing the amount of carbon stored. Carbon sequestration in the soil improves soil fertility and water holding capacity.

## Geologic Sequestration

Geologic sequestration is the process of storing $CO_2$ in deep geologic zones for long periods of time. Geologic sequestration is the method of storage that is generally considered for carbon capture and storage

(CCS) projects. $CO_2$ is stored deep in rock formations that can hold vast quantities of $CO_2$ for long periods of time. Only a handful of specialized facilities like natural gas processing plants, coal gasification plants, and ethanol plants currently have processes that separate $CO_2$ and make it available for geologic sequestration. Specific conditions are required within the deep subsurface geological environment to effectively store the injected $CO_2$. These include a porous and permeable reservoir, an impermeable seal or confining unit overlying the reservoir, and adequate depth to contain the $CO_2$ as a dense fluid, in what is termed a "supercritical state." $CO_2$ must be maintained in a manner that prevents it from migrating out of the storage reservoir and into other subsurface resources such as groundwater and other mineral reserves that could be used in the future. The placement and storage of large volumes of $CO_2$ in a storage reservoir must be effective for an extended period of time; slow leakage back into the atmosphere would negate the practice's value.

## Conclusion

The primary objective of climate change mitigation is to enact policies that limit the severity of climate change. Carbon sequestration is a broad and critical topic. It is critical in the effort to avoid the effects of climate change. There is, however, no single solution to this problem. We cannot pump carbon underground forever. In order to reverse the effects of climate change, carbon capture and storage must be coupled with forward thinking methods of generating clean energy so that there is no more carbon being released into the atmosphere. Furthermore, cleaner farming methods, reforestation, and afforestation are effective ways of restoring natural sequestration methods that existed before humans tampered with the environment. Creating additional carbon sinks by promoting large-scale afforestation and reforestation are financially viable methods of reducing emissions. Carbon sequestration through conservation practices is a strategy for achieving global food security while mitigating climate change.

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# MITIGATION STRATEGIES FOR GREENHOUSE GAS EMISSION FROM AGRICULTURAL ECOSYSTEM

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**Introduction**

Global warming has been emerged as an alarming issue over the last few decades. We have heard scientists and environmentalists debating on this very sensitive issue. A rise in the average global temperature is certainly not a good sign of a healthy ecosystem and it will affect all form of life on earth. Certain gases present in our atmosphere are working as major driving force behind increase in global average temperature. These gases are mainly carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and water vapors. They allow the solar radiations to come to the earth but they do not allow the outgoing infrared radiations to move out from the earth's surface and thus raise the temperature, by the process of trapping. Because of their insulating effect, these gases nicknamed as "Greenhouse Gases". Though greenhouse gases are integral part of our atmosphere because they maintain the favorable temperature of the earth and in their absence it would not be possible for us to survive. But their increased concentration in the atmosphere has posed a serious threat, because the temperature is going above its average values.

The Inter-Governmental Panel on Climate Change (IPCC) has projected a temperature increase between 1.1 and 6.4°C by the end of the 21$^{st}$ Century. This Global warming due to increased concentration of green house gases has also resulted in other regional and global changes in climate-related parameters such as rainfall distribution, soil moisture pattern, and variation in sea level. While we count on the top contributors of greenhouse gas emitters in our environment, Agricultural ecosystem gets considerable attention as various agricultural activities contributes about 10-14% of total global anthropogenic green house gas emission. The agricultural activities which are mainly responsible for emission of green house gases are: enteric fermentation (methane), application of synthetic fertilizers (nitrous oxide), tillage (carbon dioxide) and our livestock. Several studies conducted in this regard have revealed that India is one of the major emitter of greenhouse gases over the world. According to an estimate, in India annual GHG emissions from agriculture and livestock stood at 481 MT of $CO_2$ equivalent, of which 42% came from crop production and 58% was emitted from

livestock. Therefore, serious actions are required to bring down this emission of green house gases, so that issues such as global warming and climate change can be tackled in smart way.

**Agricultural source of GHGs emission**

The major greenhouse gases present in the earth's atmosphere are Carbon dioxide (76% contribution), Methane (16% contribution) and Nitrous oxide (6% contribution). All three gases are released from agricultural ecosystem in one or the other way.

**1. Methane emission**

Methane is produced in the soil during microbial decomposition of organic matter under anaerobic conditions. These favorable conditions for production of methane are present in the paddy fields. Paddy fields accounts for about 20 % of anthropogenic methane. Continuous submergence, higher organic C content and use of organic manure in puddled soil favors the methane emission. Another threatening issue i.e. burning of crop residues also contributes to the global methane budget. Livestock also contributes a major amount of methane in the atmosphere. Enteric fermentation in ruminants is the major cause of methane emission. The amount of methane emitted by livestock is approximately 2.2 billion tones of $CO_2$ equivalents, which is about 80 % of the agricultural methane emission.

**2. Nitrous oxide emission**

Nitrogenous fertilizer is a source of $N_2O$ in fertilized soils, whereas the indigenous N contributes to the release of this GHG in unfertilized soil. Soil water content and the availability of carbon enhance the production of $N_2O$ provided a suitable nitrate source is available. Generally, an increase in N2O emission is observed following irrigation and precipitation. The burning of crop residues also contributes to the global $N_2O$ budget. Apart from this, the contribution of livestock is also very high. Globally around 75 % of $N_2O$ emissions are reported from livestock sector.

**3. Carbon dioxide emission**

The main source of carbon dioxide from agriculture is through soil management practices such as tillage, which triggers the emission of carbon dioxide through the biological decomposition of soil organic matter. Tillage breaks soil aggregates and thus increases the oxygen supply in the soil ecosystem and exposes the surface area of organic matter and promotes its decomposition. Apart from this, the fuel used for various agricultural operations and the burning of crop residues are other sources of carbon dioxide emission in the atmosphere. Another off-site or indirect source of carbon dioxide is the manufacturing fertilizers and pesticides.

**Mitigation Strategies**

Knowing that increased emission of green house gases could potentially harm our ecosystem, we should always look upon strategies to manage it properly and focus on ways by which this value can be lowered down. One such way is proper field management. Good management practices at field level can reduce the emission of greenhouse gases from crop fields. So, let's discuss how we can produce crops without hampering environmental sustainability.

**Field level management to reduce GHG emission**

**1. Methane**

- Water management is the most confounding factors affecting methane emission. The emission pattern of $CH_4$ from a rice field illustrates that the peaks of the flux are governed by the moisture content of the soil. Continuously saturated rice fields are able to produce higher values of methane emission as compared to intermittently wetted and dried soil conditions. Continuous saturation of soil creates anaerobic conditions which are always conducive for the formation of methane as methanogens are strict anaerobes. When such saturated soils are allowed to get dry (making them aerobic), the formation of methane can be reduced to considerable levels. So, the best method to reduce methane emission from a paddy field is to go for alternate wetting and drying.

- Outcome from a study conducted by Pathak *et al* (2014) on Methane emission from different rice ecosystems in India in 2010 is as following:

| Ecosystem | Water regime | Rice area (Mha) | Methane (Mt) |
|---|---|---|---|
| Irrigated | Continuous flooding | 6.78 | 1.10 |
| | Single aeration | 8.98 | 0.59 |
| | Multiple aerations | 9.39 | 0.19 |
| Rainfed | Flood-prone | 3.05 | 0.58 |
| | Drought-prone | 8.22 | 0.54 |
| Deep water | | 1.29 | 0.25 |
| Upland | | 5.16 | 0.00 |
| Total | | 42.86 | 3.25 |

- Another technique that can employed to reduce methane emission is upland rice cultivation or aerobic rice system where rice is grown under non-puddled, non-flooded and non-saturated soil conditions. This technique could be potentially very suitable for reducing methane emissions from the rice field.
- Use of Nitrification Inhibitors such as neem-coated urea, coated Ca-carbide, neem oil and Dicyandiamide (DCD), which slow down the process of nitrification in soil, could reduce the emission of methane from the soil by 10–15%.
- Application of manure such as farmyard manure (FYM) increases methane emission by adding organic carbon and N required for microbial activities. So its use should be avoided in paddy fields, whereas application of biogas slurry is found to be effective in reducing emission by 2.3 times as compared to FYM, suggesting that biogas slurry should be a preferred source over FYM in terms of mitigating methane emission.

**2. Nitrous oxide**

- Use of lesser doses of nitrogenous fertilizer or apply in splits to increase the efficiency of use by plants, allowing less nitrogen to be lost to atmosphere or leach.
- Site specific Nitrogen management i.e. apply only when required by observing visual symptom by LCC or SPAD chlorophyll meter is another viable option.
- Inclusion of legume crop or pastures in rotation which are capable of fixing atmospheric nitrogen into the soil. They not only fix nitrogen for themselves but also make it available to the succeeding crop.
- Prevent waterlogging to avoid anaerobic condition where there are chances of denitrification loss.
- Nitrification inhibitors can work effectively for reducing nitrous oxide release from crop field as well.

**3. Carbon-di-oxide :**

- Conservation tillage, a practice which ensures the minimum number of machinery passage on the soil, lesser disruption of soil aggregates and a minimum of 30% crop residue retention over the soil surface is the best tool for lowering $CO_2$ emission from crop field. In this process atmospheric carbon is captured and stored as soil carbon which is popularly known as carbon sequestration. So, in place of releasing carbon dioxide in the atmosphere, conservation tillage will sequester the carbon into the soil.
- Crop straw (stubble/residue) retention in fields is a well-known agricultural management practice which provides several positive effects including better soil structure, improved water retention, and less risk of erosion. Straw retention can also potentially improve the nutrient status of agricultural soils, which in turn enhances SOC due to increased crop rhizodeposition. Though in the recent days, crop residue burning in India particularly N-W India has been a common practice, which is responsible for air pollution and

greenhouse gas emission. Opting for mechanized agriculture like happy seeder, Straw Management System (SMS) or decomposing the crop residue by newly developed PUSA decomposer can be an effective solution of this problem.

- Improvement of crop rotations by changing from a monoculture to more diverse cropping systems, integrating forages/ley and cover crops in rotations and increasing cropping intensity in drylands is a promising strategy to increase SOC stocks in agricultural soils.

## Conclusion

As a responsible country of the world, India is trying its level best to cope up with the problem of green house gas emission. According to a report published by Times of India, our country has secured 10$^{th}$ position among the countries who have adopted substantial measures to mitigate the climate change with a score of 63.98. The main focus should be on the diverse soil and climatic conditions, different management practices and socioeconomic status of the farmers influencing GHG emission. An appropriate nationwide applicable exercise is needed for this purpose. This will not only improve estimates of emission and related impact assessments but also provide a baseline from which future emission trajectories may be developed to identify and evaluate mitigation strategies.

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# Natural Metabolites: An Eco-friendly Approach in Plant Diseases Management

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Agriculture is the primary source of livelihood for about 58% of India's population. With the advent of new techniques in agriculture crop production and cultivation has become more and more efficient but still the demand is very high because of large population. In the recent past globalisation has revolutionized food production and consumption throughout the world. One of the greatest challenges in food consumption and transportation has been seen in current COVID-19 pandemic, as global food supply chains are disrupted. The goal of sustainable and organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals, and people. Plants are constantly challenged by various pathogenic microorganisms (fungi, bacteria, phytoplasma, viruses, viroids and nematodes) that decrease the quantity and quality of food, thereby pose serious threat to food security. Plant pests and pathogens cause significant reductions in crop production, with estimated global losses of 20%–40% per year. In the present scenario, current pest management relies heavily on the application of pesticides. In spite of many advantages, pesticides have harmful side effects towards non-target organisms, the resurgence of the pest population and the development of resistance. Furthermore, it is estimated that 90% of applied pesticides are lost during or after application. As a result, there is an increased motivation to develop cost-efficient, high-performing pesticides that are less harmful to the environment. The availability of innovative applications and molecular techniques opens up new possibilities in the approach to plant protection for sustainable and organic agriculture. New strategies not only directly protect plants against pathogens but can also induce enhanced immunity that permanently protects against pathogenic strains.

Natural bioactive compounds and biocontrol agents are becoming more popular now days because of their environment friendly nature. Bioactive compounds are isolated from plant sources, algal sources, microbial sources and marine sources. They act as elicitors for plant defence and thereby activating resistance in plants. Majority of them are salicylic acid (SA), benzoic acid, chitosan, benzothiadiazole, alkaloids, flavonoids, terpenes, proteins, peptides, blasticidin, mildiomycin, polyoxins, phenolic compounds, etc., which act against various phytopathogens.

Microorganisms and plants have proven to be good source of natural products such as anti-insecticidal, antimicrobial agents, and antineoplastic agents. Bioactive natural products derived from these sources are also reported to have various biological activities related to human health including biofilm inhibitory, antiinflammatory, immunosuppressive, anticancer, antifungal, and antibiotic activities. Different plant extracts from leaves, seeds, stems, and even roots are reported worldwide as medicines but also asbiopesticides. Diverse genera belonging to different plant families such as Apocynaceae, Flacourtiaceae, Fabaceae, Lamiaceae, and Asteraceae, are reported as potent sources of biopesticides and bioactivenatural products. Resigns and essential oils of different plants are used as anti-microbial compounds. These essential oils are major component for making formulation of biopesticides which include *Allium sativum* (garlic, family *Amaryllidaceae*), *Syzygium aromaticum* (clove, family Myrtaceae), *Cinnamon cassia* and *Cinnamomum zeylanicum* (cinnamon of family Lauraceae), *Mentha piperita,* and *Thymus vulgaris* (peppermint and thyme of family Lamiaceae). Oil of tea plants is enriched in terpenes andterpinenic which were having antimicrobial activities and also used as biopesticidesagainst viruses and plant fungal infections by infecting membrane integrity. Members of family polygonaceae i.e., *Reynoutria sachalinensis* is known to produce salicylic acid and also reported to show resistanceto phytopathogens and play an important role in acquiring systemic resistance. Similarly, phenolic compounds contribute to host plant resistance against pathogens, insects and herbivores. Plants are rich source of flavonoids and more than 5000 flavonoids have been reported. They play an important role in imparting resistance in plants. Several flavones such as flavonols, flavones, proanthocyanidins, flavan-3-ols, flavonones, flavans, and isoflavonoids etc. function against many insect pests and pathogens.

Biological control is one of the most interesting alternatives to chemical control. It involves the use of antagonistic microorganisms to suppress pathogens and pests. The growth of pathogens and pests is restricted by beneficial microbes that involve several mechanisms such as production of antimicrobial compounds, production of hydrolytic enzymes; competition and/or immobilization of micronutrients such as Fe by siderophore production; competition for space; inactivation of germination factors; degradation of pathogenic factors; or parasitism of the pathogen and insecticides, or nematicides. Bio prospecting for microbial bioactive compounds (MBCs) produced by biocontrol agents is very important to drive plant health. A number of commercial products have been registered both at national and inter-national levels based on different fungal and bacterial antagonists. These commercial products include, Biocon, Biogaurd, Ecofit, F-Stop, Soil gaurd etc with *Trichoderma* sp. as active ingredient, and Mycostop utilizing various *Bacillus* species as active ingredient. Genus *Streptomycetes* of the family Actinobacteria has been reported for the majority of naturally producing antibiotic agents. Species of the genus *Streptomyces* are also reported to produce proteins and peptides (blasticidin, mildiomycin, and polyoxins) which are used as a defence against pathogen.Phenazines produced by different bacteria such as *Pseudomonas*, *Streptomyces*, *Burkholderia*, *Brevibacterium* and *Xanthomonas*, are known for antimicrobial activity. Similarly various other natural bioactive compounds are obtained from many marine sources and algae.

In the present crop production scenario, the biocontrol is of utmost importance, but its potential is yet to be exploited fully mainly because the research in this area is still confined to the laboratory and very little attention has been paid to produce the commercial formulations of bio agents. Moreover, whatever has been commercially produced has not been used efficiently by the farmers owing to the lack of information regarding its use. So to popularise the concept of biological control extension at University level in this direction needs to be improved. The application of the research to real-world producers will be of great benefit to understand any changes in behaviour of these natural extracts under environmental conditions, while further identifying the modes of action will increase the extension of applications of these extracts into fields.

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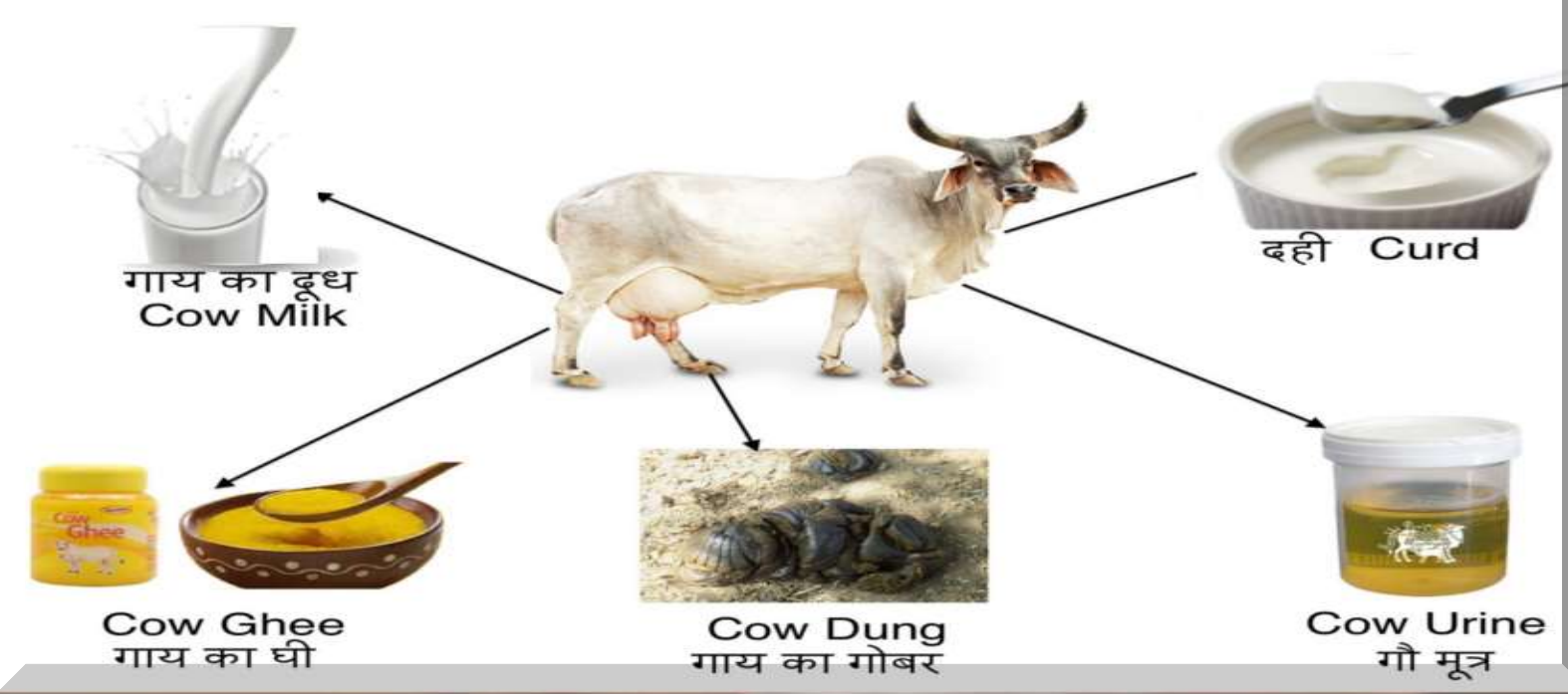


# Role of Panchagavya in Agriculture

**Anuj Shakya, Sachin Kumar** [Ph.D. Scholar (Entomology), CSAUAT, Kanpur]
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In the journey of agricultural development, the chemical agriculture apparently won over traditional no chemical farming, because of certain benefits like high yield and chances to improve the food security. Now, the scenario is again changing. The benefits that we obtained due to continuous long-term use of chemical farming are turning very costly, if we talk in terms of soil quality, environmental quality and human health. The continuous use of chemicals in agriculture is not only deteriorating the health of soil but also polluting the environment in various ways. The residues of chemical fertilizers and pesticides are entering in our food chain and their level is increasing continuously and certainly reaching beyond the safe limits. Therefore, it is the right time to popularize the indigenous knowledge or indigenous practices once again in order to regain the environmental balance that we are losing. Use of panchagavya that is obtained from cow helps in preserving the reproductive and regenerative capacity of the soil. Panchagavya not only act as a biofertilizer, but it also acts as a pest repellent. Apart from this, panchagavya is also beneficial for milch animals such as goat and sheep and also in poultry and fish production, as it acts as an organic growth stimulator.

**Panchagavya**

It is an organic product that is prepared by mixing five products viz. Cow dung, cow urine, milk, curd and ghee obtained from cow. Apart from these five products, four more products viz. Jaggery, banana, tender coconut and water are added in order to make it a miraculous product for use in agriculture in order to make the agricultural systems self-sustainable.

**How to Prepare Panchagavya**

1. In order to prepare panchagavya for agricultural use the following nine products *viz*. Cow dung, cow urine, milk, curd, jaggery, ghee, banana, tender coconut and water are mixed with each other. First of all, cow dung @ 7 kg and ghee @ 1 kg are mixed and it should be kept for three days.

2. Care should be taken to turn it thoroughly in morning and evening hours. After the time span of three days mix 10 L of cow urine and 10 L of water in it and leave it for 15 days. Regular mixing should be done in both morning and evening hours.
3. After 15 days, rest of the ingredients i.e. cow milk @ 3 L, curd made from cow milk @ 2 L, tender coconut water @ 3 L, jaggery @ 3 kg and 12 well ripened bananas. After 30 days panchagavya becomes ready for use.
4. All the materials should be kept in an earthen pot, concrete pot or a plastic tank, but care should be taken to keep it under shade and it should be covered with a mesh to prevent the infestation of any insect.

**Beneficial effects of using panchagavya**

- It serves as a growth promoter as it contains plant growth regulators and amino acids and it also helps the plants to gain immunity.
- It helps in enhancing the yield and quality of the agricultural produce. It also enhances the sugar content of fruits as well as their aroma.
- Plants sprayed with panchagavya produced bigger leaves and they develop denser canopies.
- Use of panchagavya, induces the tolerance to water stress, thus it helps the plants in sustaining the conditions of water stress.
- Early maturity of the products can be achieved.
- Panchagavya promotes profuse growth of roots and also promotes root penetration in deeper layers of the soil.
- Panchagavya contains several macro nutrients such as NPK, and micronutrients that are beneficial for the growth and development of plants.
- The presence of microorganisms like Pseudomonas, Azotobacter and Phosphobacteria makes it a potent product.
- When panchagavya is used in agriculture, the use of chemicals is restricted. Therefore, there is a major reduction in the cost of cultivation.
- It is also beneficial for the health of farm animals.

**Recommended dose of panchagavya**

- In general for all the crops 3 % spray of panchagavya is found effective.
- The panchagavya solution can also be mixed with irrigation water @ 50 L/ha and can be supplied to various crops.
- For seed treatment or for treating the roots of seedling, 3 % solution of panchagavya can be used. Seed soaking is generally recommended for 20 minutes, but in case of sugarcane setts and turmeric and ginger rhizome it should be done for 30 minutes.
- Before storing, the seeds can be treated with 3 % panchagavya solution and then they are dried and can be stored.

## Conclusion

In the current agricultural scenario where, synthetic chemicals are not only hazardous for environment, but also have residual effect in the soil. Under these situations when we are looking for sustainable agricultural practices, Panchagavya seems to be a potent agricultural input that has immense potential to increase the agricultural productivity.

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# How to Multiplicate the Dragon Fruit (*Hylocereus undatus*)

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## Introduction

Dragon fruit (Kamalam) is a horticultural fruit crop for future. It is a perennial climbing cactus belongs to the family *Cactaceae.* Dragon fruit is one of the newly introduced exotic fruit crop in India. The origin is tropical and subtropical forest regions of Maxico and South America. It is commonly called as Pitaya, Strawberry pear, Night blooming cereus, Queen of night. It has received worldwide recognition as an ornamental plant and as a fruit crop.

Generally dragon fruit plants can be propagating through sexually and asexually method. There are two methods of propagation (i) seed propagation (ii) vegetative propagation.

## Seed propagation

Seed propagation involves the collection of seed from mother plants of dragon fruit, washing them properly with water and germinating them on compost or potting soil mixture even as potted indoor plants. Dragon fruit seeds usually start germination within one week and they are ready for field planting within 9-10 months. This method is very simple but time taking to reach bearing age is usually (2-3 years) longer than for plants propagated using cuttings.

**Vegetative propagation**

The easiest and cheapest propagating method of dragon fruit vegetatively is done by cutting. Cuttings should be selected from old mother plants, the cuttings size 15-20 cm long are used for planting. Pile up these cuttings 1-2 days prior to potting. To prevent the diseases, the cuttings should be treated with fungicide. Treated cuttings should be cured in dry cool places before planting. These cuttings are potted with planting mixture. Planting media is to be prepared using dry cow dung, top soil, and sand in the ratio of 1:1:2. Keep these pots or poly bag with shade place to rooting. The cuttings can be directly planted in the field, but the most common practices are to pot them in a suitable potting media. Use of rooting hormone IBA @ 4000 mg/ l (*Pandey et. al.*, 2020) before planting induces quick formation of roots. It can improve rooting success and encourage the time taken for root development (10-15days instead of 40-50 days). The cutting can be obtained throughout the years, however, it is preferable to collect the cuttings after fruiting season of mother plants. Cuttings showing colours other than normal plant colour should be avoided. Cutting should be collected early in the morning. At the time of taking cuttings, a slanting cut is made at stem base. Mature cuttings are better as they resistant to insect and snail damages. Mature cuttings faster regeneration rate of new shoots- probably associated with the amount of stored food. If the cuttings are transported long distances they should be wrapped with moist cloth to prevent loss of moisture. The cuttings should be watered properly but not excessively, when it well established, they can be transplanted in to the field. The dragon fruit cuttings start flowering after one to two years of planting from established plant cuttings.

Dragon fruit is also propagated vegetatively by grafting. Grafting however, it is not very common as cuttings are easy and well-situated method of propagation. However, grafting is useful when using selected rootstocks and scions.

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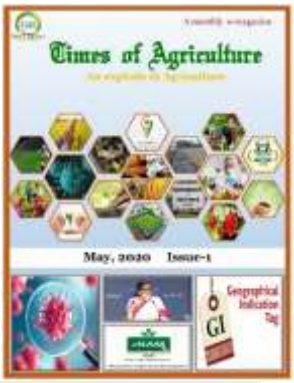


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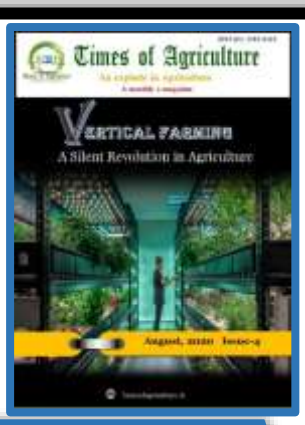


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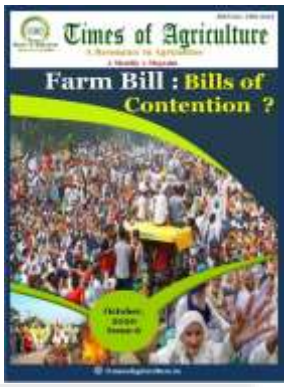


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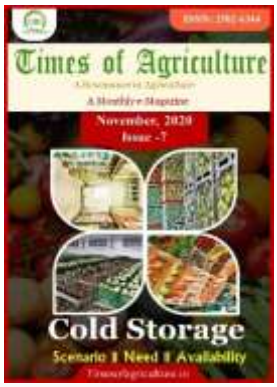


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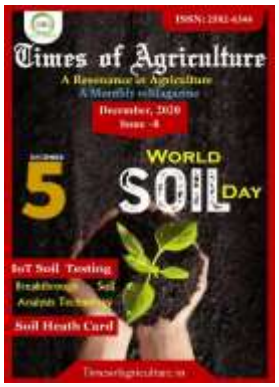


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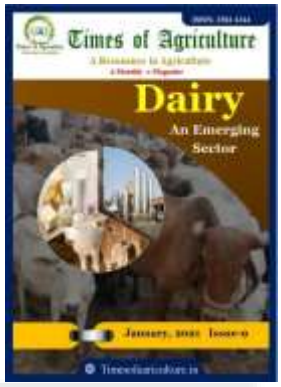


9-January


10-February


11-March


12-April