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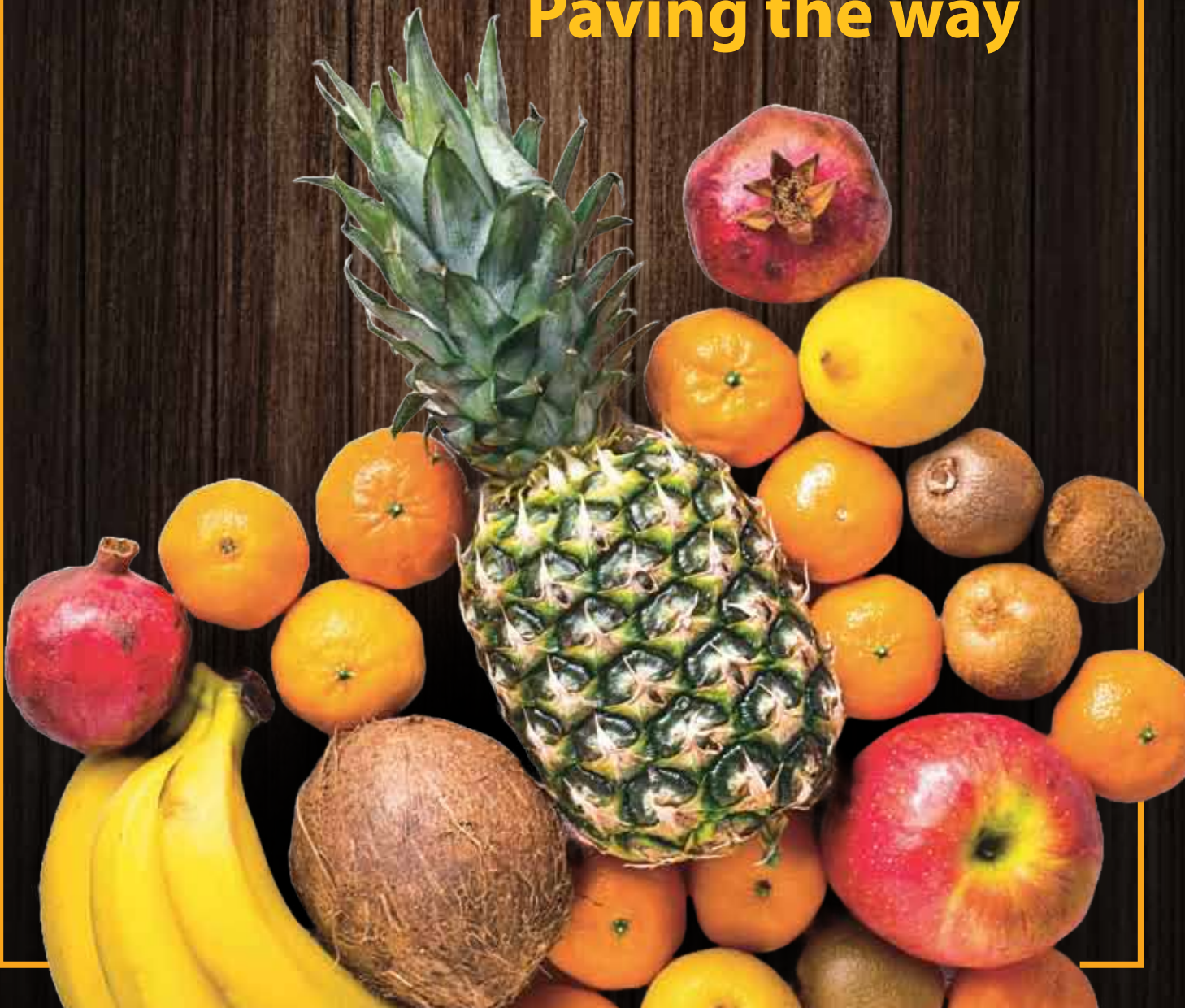
# AGRICULTURE The National Agriculture Magazine TODAY

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info@agriculturetoday.in

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## FROM PRODUCTION TO LOGISTICS

In August, 2024, the Union Cabinet approved the Clean Plant Programme (CPP), a mission aimed at increasing yield and productivity of horticulture crops in India.

This is a very important announcement, and in fact reiterates the significance this sector is assuming. India is the 2nd largest producer of fruits and vegetables. The Indian horticulture sector contributes about 33% to the agriculture Gross Value Added, making a very significant contribution to the Indian economy. India's horticulture production has long surpassed the food grain production, that too from much less area. Productivity of horticulture crops are also much higher compared to productivity of food grains and so is the value from them.

The rise of the middle income group, awareness of the nutritional value of fruits and vegetables, development of processing technology, and creation of new value added products have increased the demand for horticultural products in India. Farmers too have realised the potential of horticulture in earning extra incomes. The general mandate of crop diversification, and transferring the farming community from being focussed on cereal centric agriculture to mixed crop regime seems to be working.

But with this comes another set of challenges. The primary one being the availability of planting materials that are healthy and true to type. The planting materials of horticultural crops are hybrids/high yielding varieties/tissue culture plantlets, which are costlier. So a bad lot can affect the plant stand and yield, and will incur a substantial loss to the farmer. The clean plant programme can therefore be a path breaking initiative as the streamlined certification processes and infrastructure support will help nurseries in efficiently producing clean planting materials. The initiative ensures that consumers receive fruits that are not only virus-free but also enhanced in taste, appearance, and nutritional value. With higher-quality, disease-free fruits, India will enhance its position as a leading global exporter, thereby expanding market opportunities and increasing its share in the international fruit trade.

But access to healthier planting material is just a first step. The perishable commodities need a robust and strong logistics and cold chain network that guarantees the transport of fresh fruits and vegetables from farm to fork. Quality should be a paramount criteria and no seller - big or small - need to be exempt from that. From push cart vendors to retail stores, India should be able to guarantee farm fresh products.



Anjana





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# NEW ZEALAND AND INDIA FOR DEEPER AND STRONGER ENGAGEMENT IN AGRICULTURE



New Zealand and India have shared a warm relationship and maintained a strong association in both trade and cooperation. In his recent visit to India, New Zealand Minister of Agriculture, Mr. Todd McClay reiterated the New Zealand Government's commitment to further strengthen the relationship and improve the trade and cooperation in agri sector. In his discussion with Dr MJ Khan, President, Agriculture Today Group, he outlined the areas of cooperation between the two countries.



## How do you see the current trade relationship between New Zealand and India evolving in the agriculture sector, and what opportunities do you foresee for New Zealand's agricultural products in the Indian market?

India has always been an important partner for New Zealand. We share a warm relationship and have a long association in both trade and cooperation. The New Zealand Government is committed to achieving a step-up in our relationship with India. New Zealand and India are developing deeper and stronger engagement across food and fibre sector – of which New Zealand exports hit \$213 million last year. My visit will be an opportunity to discuss our ongoing trade and work through mutual access priorities. Increasing two-way trade in food and fibre products will benefit producers and give consumers in both India and New Zealand greater choice. We produce world-best food and fibre in New Zealand grown in our clean, sustainable, environment, and we are keen to offer Indian consumers the opportunity to experience the benefits of these products. New Zealand can also play a role in providing raw inputs to support the growth of domestic food processing in India.

## In India Kiwi is being produced in Himachal Pradesh and some states, but quality and productivity levels are concerns. Can India look forward for any center of excellence with New Zealand's assistance?

If the Indian government is keen on that, it is possible. But in the meantime, an agreement can be signed to start the work to increase the quality and production on the orchards. The main New Zealand company that's responsible for research, production and export of Kiwi, had visited India a number of times, and have seen immense opportunity to help Indian growers with the quality and quantity of the fruit. In fact, part of the reason for my visit to India was to meet



With Hon. Indian Minister for Agriculture Shri Shivraj Chouhan



At Atazpur Mandi wholesale market, from where New Zealand fruits such as apples, kiwifruit and avocados are sent off to retailers across India

“  
Increasing two-way trade in food and fibre products will benefit producers and give consumers in both India and New Zealand greater choice.

the agriculture minister and others to talk about these areas of cooperation. And as with most things, when it's government to government, if you can have a framework agreement to sign between you, then we find that cooperation, research and perhaps, a center of excellence can grow quickly as a result.

**Are there any new bilateral agreements or frameworks being discussed that could enhance**



### trade and cooperation in the agriculture sector?

New Zealand and India have already made good progress in our engagement to date. For example: MPI (Ministry for Primary Industries) has a Food Safety Cooperation Arrangement with the Food Safety and Standards Authority of India. In 2023, MPI funded three Indian officials to participate in a 24-week applied epidemiology virtual course that aims to boost epidemiological capacity of veterinarians in managing animal health and biosecurity. New Zealand has invited a further three Indian officials to attend the course, with another course due to kick off in August. New Zealand has invited two Indian officials to attend a 26-week food safety risk analysis training programme pilot planned for September this year. The MPI hosted India's Na-



At the Indo-Kiwi dairy venture Binsar Farms in Haryana



**The New Zealand Government is committed to enhancing engagement and cooperation to build a stronger food and fibre sector relationship and support commercial opportunities in both directions**

tional Dairy Development Board in New Zealand earlier this year to provide an understanding of our dairying system.

There are also ongoing discussions on many other areas where New Zealand and India can cooperate. These include animal health, horticulture, forestry and 'cooperatives'. To achieve this, we will need to broaden our trade and economic relationship and identifying new opportunities through sectoral cooperation and working at both state and national levels. My visit is an opportunity to discuss and understand where there could be new opportunities for New Zealand and India to work together to deliver on our shared goals.

### New Zealand is at the forefront of agri-tech innovation. What areas of agri-tech do you see as most promising for New Zealand India partnership?

New Zealand is regarded as having some of the most efficient producers of food and fibre in the world, and that's in large part because of continued innovation and adaption through smart technologies. New Zealand has built a world-class reputation of producing high quality and safe food and fibre products that we export around the world, and this experience and expertise puts us in a very good position to be a world leader in agritech solutions also.

Our agritech sector is made up of over 650 agritech companies developing novel solutions for the agriculture, horticulture, aquaculture, apiculture and fishing sectors to improve yield, efficiency, profitability, resilience, reliability, quality, and to add value. The New Zealand Government believes our smart agritech solutions can also provide benefits for India to help achieve its goals and tackle challenges. Our agritech enables more precise and efficient uses of resources like water, fertilisers, and pesticides, to help minimise environmental degradation and mitigate the negative impacts of farming on the environment while getting a better return on investment. Our farmers are also adopting AI-driven

predictive analytics to optimise irrigation schedules based on weather forecasts and soil moisture levels, to importantly reduce water wastage and improve water efficiency.

Our agritech solutions could have application in India to help boost farmer and grower productivity and profitability. Agritech comes in many forms. For example, New Zealand's most valuable Intellectual Property remains our ability to grow consistently high quality, export grade food.

### What are the key agro commodities in trade between the two countries, and how do you look at broadening or deepening the trade relationship?

India is an important partner for New Zealand. Two-way trade reached \$1.6 billion in the year to 31 December 2023, including New Zealand food and fibre exports of \$213 million. In the March 2024 quarter, New Zealand's top three agricultural exports to India were fruit and nuts, wool, and dairy products. In that same period, New Zealand's top three agricultural import from India were vegetable, fruit, and nut preparations, fish, and coffee, tea and spices.

New Zealand and India already share a warm relationship and have a long association in both trade and cooperation. Enhancing our trade is just one aspect of a deeper and broader relationship that we are looking to foster with India. We want to develop deeper and stronger engagement with India across all facets of the relationship: politics, business, academia, defence and security, civil society, youth, culture, and sports.

Like India, the food and fibre sector is the backbone of New Zealand's economy, playing a central role in our national identity, economic prosperity and the success of our respective rural communities. A key discussion point during my visit will be exploring areas where we can work together to deliver mutual benefits. My visit is also an opportunity to build rapport with newly appointed, and reappointed, Ministerial counter-



NDDB Chairman Dr Meenesh Shah and Amul Managing Director Jayen Mehta show Minister Hon. Todd McClay the milk collection process at Anand, Gujarat

parts, particularly with India's elections recently concluded, and help set the stage for further bilateral engagement. This could include broadening our trade and economic relationship and identifying new opportunities through sectoral cooperation and working at both state and national levels.

The New Zealand Government is committed to enhancing engagement and cooperation to build a stronger food and fibre sector relationship and support commercial opportunities in both directions. For example, Quality New Zealand



At the Mother Dairy plant in Patparganj, New Delhi

set up a plant in India for further processing using New Zealand raw product, which have provided jobs in India.

### What are your views on climate change and future food security? It this an area where the two countries can collaborate?

Our Climate Change Minister is very eager to come and visit India to talk more about this and there are some areas that we can cooperate. New Zealand has invested in some countries to get emissions down. In Southeast Asia, our government is investing in the development of rice varieties to produce more yield with lower emissions, helping them meet climate change obligations.

Around animals, there's a lot of work going on in New Zealand. The government, with the private sector, has invested a lot, in R&D for finding ways to allow cows, to produce milk but to reduce the amount of methane. We are a few years away from some of those solutions being commercially available. That means it will be easier for farmers to reduce emissions, helping the country meet its climate reduction obligations but without putting extra cost on the farmers and without compromising production.

I think there are many areas of opportunity in climate change for New Zealand and India to work together.



# HORTICULTURE

## ENHANCING FARMER INCOMES



Nagaland has made significant strides in horticulture, partly because of its unique agro climatic conditions and also because of initiatives by the government. “The enhancement of farmers’ livelihoods, as well as the well-being of the people, has been at the core of the Department’s efforts, driven by the scientific development of horticulture through the proper harnessing of natural resources to create a sustainable horticultural system,” says Ms. Salhoutuonuo Kruse, Minister for Women Resource Development & Horticulture, Nagaland. In an interview with Agriculture Today, the honourable minister discussed in detail the horticulture scenario of the state.

### How important is horticulture in Nagaland, especially to small scale farmers?

Nagaland has a rich biodiversity with diversified agro- climatic conditions which makes it highly suitable for cultivation of various horticultural crops. About 50% of the total area have economic cultivable land, and the mainstay of the people of Nagaland is land based, i.e. agro horticultural activities. However, not even 25% of the state’s total area has been brought under economic cultivation and thus, the potential of the land remains untapped. Today, horticulture has emerged as a primary occupation for the people. What began as a small backyard activity has today emerged as a significant economic activity of the State. The State’s Horticulture sector has seen a massive transformation in various ways, from subsistence to abundance, from traditional to technological and from undefined to precise, especially in the last decade, owing to the globalization of the economy and new advances made in agricultural technology, combined with the concerted efforts of the Department and the farmers. We are so proud to be standing where we are today; yet, we are well aware that it is not the end. There is still so much to do and strive for, bridges of hope to build, dreams and aspirations to fulfill.

### What are the initiatives taken by the government for horticulture development of the state?

Nagaland has made significant strides in enhancing horticultural productivity and production through the adoption of a balanced mix of hi-tech technology and Indigenous Technical Knowledge (ITK). The state focuses on the efficient and effective utilization of water resources to improve water management in horticultural crops. By placing a strong emphasis on Integrated Nutrient Management (INM) and Integrated Pest Management, Nagaland has been able to enhance productivity sustainably. Additionally, there is a concerted effort to



**Nagaland has made significant strides in enhancing horticultural productivity and production through the adoption of a balanced mix of hi-tech technology and Indigenous Technical Knowledge (ITK).**

create awareness about organic farming through a multi-pronged approach. Empowering women and reducing gender

disparity by increasing female participation in horticulture is another key focus area.

The Department of Horticulture introduced the concept of Vegetable Villages in Nagaland - a pioneering initiative in India. The state’s pineapple, known for its unique taste and flavor, has been nationalized under the brand name “Naga Pineapple,” bringing pride to the region. Similarly, Nagaland produces some of the juiciest and sweetest mandarins and sweet oranges, which are in high demand both within and outside the state. Recognizing the state’s potential to produce export-quality oranges, the Department declared citrus as one of the main focused crops, leading to large-scale area expansion under various schemes and establishing Nagaland as a well-known citrus-producing state.

To further boost productivity and



“It is noteworthy to also acknowledge the outstanding achievements of these FPCs, particularly Molsang Organic Pineapple Producer Company Limited, Phek Organic Large Cardamom Producer Company Limited, and Chansu Organic Kiwi Producer Company Limited which were awarded the Horticulture Value Chain Award 2022 by the Government of India, Ministry of Agriculture and Farmers Welfare in recognition of their exceptional contributions to the farming community. Additionally, Phek Organic Large Cardamom and Chansu Organic Kiwi Producer Companies were also honored for their achievements in ‘Organic Farming’ and ‘Organic Brand Development’ respectively at the Expo One 2023 Organic Northeast International Trade Fair. Their success is a testament to the dedication and hard work of the farmers behind these FPCs, whose commitment to organic farming has elevated our communities”.





ensure food security, Nagaland introduced Horticulture Model Villages (HMVs) in each district in 2023. These HMVs focus on cultivating one specific crop per village, serving as models for self-sufficiency and sustainability. This strategy supports the livelihoods of both rural and urban populations in the state, ensuring food and nutritional security through sound and sustainable farming practices. HMVs are envisioned not only as bastions of self-sufficiency but also as examples of environmental and economic well-being, providing blueprints for other villages across Nagaland to emulate.

#### Can you share with us a few instances of development of ITK?

The state promotes and develops indigenous technical knowledge, for example, the SAWO drier for processing spices like Large Cardamom and Naga Mircha, to enhance marketability. Efforts have been made to develop indigenous crops like Naga Mircha and Tree Toma-

“  
**One of the most commendable aspects of these FPCs is their commitment to organic farming, made possible through the Mission Organic Value Chain Development for North Eastern Region (MOVCD-NER) scheme.**

to through area expansion or on a pilot basis. Nagaland's commitment to preserving its unique horticultural heritage is evident in the GI registration of Naga Mircha in 2007 (No. 109), Naga Tree Tomato in 2012 (No. 374), and Naga Cucumber in 2018 (No. 640). Additionally,

cultivation of exotic crops such as Avocado, Persimmon, Kiwi and Dragon Fruit are being promoted by the Department to help meet the National demands.

#### How has the GI tag helped the farmers in Nagaland?

The GI tags awarded to the Naga Tree Tomato, Naga Mircha, and Naga Cucumber have had a profound impact on the horticultural landscape of Nagaland, bringing multiple benefits to the farmers who cultivate these unique crops. The GI tags for these three crops have empowered farmers in Nagaland by enhancing the value, protection, and marketability of their products, leading to improved livelihoods and a stronger local economy. By officially recognizing them as products that are unique to Nagaland, the tags have allowed farmers to sell them at premium prices. This is particularly important in niche markets where consumers are willing to pay more for authentic, region-specific produce. As a result, farmers have seen an

increase in their income, which has had a direct positive impact on their standard of living. The increased demand driven by the GI status has also stimulated the local economy, creating jobs not just in farming but also in related sectors like packaging, marketing, and logistics. The focus on maintaining the quality and uniqueness of these products has also encouraged the adoption of sustainable farming practices.

#### How has FPCs improved the income levels of horticulture farmers?

The majority of farmers in Nagaland are small or marginal, making it challenging for individual farmers to fulfill large consignment orders from interested buyers. To address this, the formation of Farmer Producer Companies (FPCs) has emerged as the most viable solution and they have become a driving force in the state's horticulture sector. As of now, Nagaland boasts 18 FPCs, comprising over 9,000 farmers who are dedicated to cultivating some of the state's most valued horticultural crops viz. Pineapple, Large Cardamom, Ginger, Kiwi, Passion Fruit, Naga Mircha, Turmeric, Dragon Fruit, Banana, Avocado, Chili, Apple, Persimmon and Oranges. These crops are cultivated across approximately 9,300 hectares, reflecting the extensive reach of FPCs throughout the state.

One of the most commendable aspects of these FPCs is their commitment to organic farming, made possible through the Mission Organic Value Chain Development for North Eastern Region (MOVCD-NER) scheme. By focusing exclusively on organic cultivation, these FPCs not only ensure the production of high-quality, health-conscious crops but also command premium prices in the market, thereby significantly boosting the income levels of the farmers involved. The success of these FPCs in raising income levels among horticulture farmers in Nagaland is evident, as they provide a structured, scalable approach to farming that empowers even the smallest of farmers to



participate in lucrative markets collectively as a FPC.

#### What are the challenges of horticulture farmers in the state?

The enhancement of farmers' livelihoods, as well as the well-being of the people, has been at the core of the Department's efforts, driven by the scientific development of horticulture through the proper harnessing of natural resources to create a sustainable horticultural system. However, the farmers face significant challenges which include the need to integrate food processing, cold-chain logistics, insurance, and value chain-related services, all of which are hindered by the state's limited resources. Some of the key issues also include a gap between supply and demand in terms of time, variety, form, and place and a lack of marketing infrastructure that supports transparent transactions. Additional challenges include insufficient climate-

controlled storage infrastructure, an underdeveloped supply chain, poor market linkages, a lack of processing facilities, inadequate packaging and branding, and the absence of essential infrastructure like roads and transport facilities.

#### What are the future initiatives planned by the horticulture department?

Recognizing horticulture as the sunrise sector of our state, the Department is spearheading a range of innovative interventions aimed at uplifting both our farmers and the state's economy. Some of the future initiatives include the promotion of horti-tourism, the organization of diverse crop festivals, a stronger emphasis on organic farming, the establishment of efficient cold chain systems, and more extensive training programs for women in floriculture, mushroom cultivation, and food processing.



# MODERN FOOD PROCESSING PLANTS BOOST FARM INCOMES



**F**arming has been the backbone of India's economy for millennia, and this rich agricultural heritage continues to offer tremendous opportunities for growth. The Indian food processing industry, while still developing, holds vast potential for expansion across the entire value chain from production and processing to storage, distribution, and marketing. As the world's second-largest producer of fruits and vegetables, India is well-positioned to tap into this market, especially with fruits like mango, guava, and pomegranate, where the country is already a global leader. By enhancing processing and cold storage facilities, India can further strengthen its position in the global market.

## Incentives, Investments, and Advantages of Food Processing

To accelerate the industry's growth, the Central Government recently announced a Production-Linked Incentive (PLI) scheme with an allocation of Rs 10,900 crores. This initiative aims to create globally competitive food processing prowess.

These facilities are

### About the AUTHOR

**Manish Bandlish,**  
Managing Director,  
Mother Dairy Fruit &  
Vegetable Pvt. Ltd.

**Despite its untapped potential, the Indian food processing industry's Gross Value Added (GVA) stands at 10%, compared to 30% in China and 60-80% in Western nations.**

crucial, as they benefit both farmers and consumers by turning raw produce into a consistent supply of processed products year-round, thereby reducing waste. They also help shield consumers from price fluctuations due to seasonal changes while offering added convenience. Furthermore, investments in food processing and storage facilities also generate employment and entrepreneurial opportunities in rural areas. According to recent reports, the domestic food processing segment is expected to reach \$535 billion by 2025-26, further highlighting its growth potential.

India's food processing industry benefits from abundant raw materials available at competitive prices, along with growing demand both nationally and internationally. However, the development of more advanced processing and cold storage facilities presents an opportunity to further enhance efficiency and reduce food wastage. By adopting modern food processing technologies, we can significantly improve the management and storage of food from farm to table, ensuring a consistent supply of safer and more nutritious products for consumers.

Despite its untapped potential, the Indian food processing industry's Gross Value Added (GVA) stands at 10%, compared to 30% in China and 60-80% in Western nations. Nevertheless, the sector remains a major employment generator in India and by converting raw agricultural products into value-added goods, it creates jobs throughout the value chain.

## Leveraging Technology to Boost Farm Efficiency

With its enduring potential, the food processing industry also relies heavily on the quality of farmers' produce, making farm interventions crucial for ensuring world class finished products and overall operational success.

While cold storage facilities and transport networks previously encountered significant challenges, these issues have been largely resolved. Energy availability is no longer a concern, and technological advancements are now delivering promising solutions. Farmers and others in the agricultural value chain can leverage AI-powered platforms to better assess market demand. By analysing weather data and satellite images, machine learning offers guidance on planting and harvesting times, while predictive analytics can detect crop defects and diseases early. Additionally, agriculture drones provide real-time insights into crop conditions, soil health, and water management.

By embracing these technological advancements, farmers can significantly improve yields and quality of produce, reduce costs, and operate more sustainably. This approach helps address rising global food demands and environmental challenges, while expanding the impact of food processing on a broader scale.

## Focus on Exports and R&D

Given India's strength in farm production, the future growth and success of the food processing industry are significantly dependent on both exports and R&D initiatives. Exports are pivotal as they extend market reach beyond na-

Our horticulture brand, Safal exemplifies the perfect equilibrium between value addition to agricultural produce and technological innovation. By leveraging advanced technology and robust R&D, Safal has not only established a strong presence in the domestic market but has also successfully expanded its reach to around 40 countries worldwide. The brand's export portfolio, featuring pulps and concentrates derived from fruits like mango, guava, and banana, showcases its ability to transform raw agricultural products into high-value processed goods. This approach demonstrates how efficient use of technology and research can create a thriving business model that benefits farmers, meeting consumer demands, and compete effectively in both domestic and international markets.

**The interplay between exports and R&D generates a positive cycle of growth and innovation, advancing the food processing industry and enabling it to address shifting consumer needs while tackling global food security challenges.**

tional borders, boost revenue through increased sales volumes, potentially higher margins, and contribute to economic growth of the country. This global expansion not only generates employment within the industry and related sec-



tors but also drives efficiency and quality improvements to maintain competitiveness in international markets.

At the same time, R&D fosters innovation by creating new products and enhancing existing ones, streamlining production processes to improve efficiency and reduce costs, and ensuring superior food safety and extended shelf life. It adds value to raw agricultural materials and promotes sustainability through the development of eco-friendly packaging and processing techniques. The interplay between exports and R&D generates a positive cycle of growth and innovation, advancing the food processing industry and enabling it to address shifting consumer needs while tackling global food security challenges.

## Local Sourcing and Allied Benefits

Processing plants located within specific regions support local sourcing, which retains many economic benefits within rural communities. These plants provide farmers with stable demand for their produce, helping them plan and manage production more effectively. Moreover, modern food processing technologies minimize agricultural waste by converting surplus products into valuable processed goods.

To elaborate, the Indian food processing industry stands at a crucial juncture. With the right investments in technology, infrastructure, and R&D, it has the potential to not only reduce wastage and increase efficiency but also significantly boost farm incomes, contributing to the overall prosperity of our farmers.



# THE FRESH FRUITS INDUSTRY IN INDIA NAVIGATING SCOPE, TRENDS, AND TECHNOLOGICAL DYNAMICS



India's horticulture sector, pivotal for both its economy and nutritional security, has seen remarkable growth over recent years. The Fresh Fruits market is expected to grow at a rate of 7.58% from 2024 to 2029, reaching a market volume of \$167.00 billion by 2029. In the fiscal year 2022-23, India exported fresh fruits

**Blockchain technology is being employed to ensure transparency and traceability in the supply chain.**

and vegetables worth a total of \$1.636 billion, with fresh fruits accounting for \$770.70 million and vegetables for \$865.24 million (APEDA).

India's fresh fruit industry is a vibrant sector with immense potential. The country's diverse agro-climatic zones support the cultivation of a wide range of fruits, from tropical bananas and man-

goes to temperate apples and grapes. India is one of the world's largest producers of fruits, contributing significantly to the global supply chain. The industry's scope encompasses not only the production and domestic consumption of fruits but also their export to international markets.

### Rising Growth Trajectory

The fresh fruits sector in India is marked by a strong growth trajectory. The increasing urbanization, rising disposable incomes, and growing health consciousness among consumers are driving demand for fresh, nutritious fruit. This growing demand is prompting advancements in production techniques, packaging, and distribution channels.

Consumers are increasingly prioritizing health and wellness, leading to a surge in demand for fresh, premium, and exotic fruits. This shift is pushing the industry to diversify offerings and enhance product quality. With rapid urbanization, the demand for convenience has increased. Consumers in urban areas seek readily available, high-quality fresh fruits, which has led to a rise in modern retail formats such as supermarkets and

online grocery stores.

There is a growing emphasis on sustainable practices and organic farming. Consumers are willing to pay a premium for fruits grown with minimal chemical inputs, prompting farmers to adopt environmentally friendly practices.

India is enhancing its focus on the global market, too. The government's initiatives and policies to improve fruit quality and compliance with international standards are opening new avenues for exporting Indian fruits, particularly to high-demand regions like Europe and the Middle East.

### Technology Integration

The integration of technology is revolutionizing the fresh fruits industry in India, addressing challenges related to production, irrespective of seasonal or geographical constraints. Quality control, and supply chain efficiency.

Technology-driven farming practices, such as precision agriculture, adoption of greenhouse and hydroponic farming, remote sensing and crop monitoring, etc. are allowing farmers to cultivate fruits in controlled environments, leading to increased yields and reduced wastage.

The development of robust cold chain infrastructure is critical for maintaining the quality of perishable fruits. Innovations in refrigeration technology, temperature-controlled storage, and logistics are minimizing post-harvest losses and extending the shelf life of fruits while maximizing reach to smaller towns and cities across India.

Advances in smart packaging technology are enhancing the freshness and safety of fruits. Techniques such as modified atmosphere packaging (MAP) and active packaging help preserve fruit quality during transportation and storage.

Blockchain technology is being employed to ensure transparency and traceability in the supply chain. This technology allows consumers to track the origin and journey of their fruit, ensuring quality and authenticity.



**The convergence of technology and global markets is yielding substantial benefits to the consumers, like greater access to fresh, high-quality fruits at competitive prices.**

### Marketing Turns a New Leaf

The rise of digital platforms and e-commerce has transformed the way fruits are marketed and sold. Online marketplaces and delivery apps are making fresh fruits more accessible to consumers, even in remote areas. This shift is also providing farmers with direct access to a larger customer base, bypassing traditional middlemen.

Global connectivity is enhancing the reach of Indian fresh fruits. The integration of digital technologies and international trade practices is facilitating this global expansion.

India's participation in international trade agreements and adherence to global standards are opening new markets for Indian fruits. Export channels are becoming more efficient, with better

logistics and quality control measures in place.

### Global Connect

Collaboration with international partners and organizations is fostering knowledge exchange and innovation. Indian fruit producers are benefiting from global best practices in cultivation, processing, and marketing.

Increased global connectivity is also raising awareness among international consumers about the quality and diversity of Indian fruits. This growing recognition is driving demand and positioning India as a key player in the global fruit market.

The convergence of technology and global markets is yielding substantial benefits to the consumers, like greater access to fresh, high-quality fruits at competitive prices. Technological advancements ensure better preservation and safety, while e-commerce platforms provide convenience.

Improved agricultural practices and better access to global markets are increasing profitability of growers. Technological interventions are helping the growers in efficient farming, reducing waste and optimizing yields.

Technological innovation and global connectivity are driving growth, expanding market reach, and boosting competitiveness. The industry is evolving to meet modern demands and standards, paving the way for a sustainable future.

### In Transformation Phase

The fresh fruits industry in India is navigating an exciting period of transformation. The integration of technology, evolving market trends, and global connectivity are collectively enhancing the sector's efficiency and reach. For consumers, farmers, and the industry as a whole, these advancements promise greater access to high-quality produce, improved agricultural practices, and expanded market opportunities. As India continues to leverage these dynamics, it is poised to solidify its position as a key player in the global fresh fruits market.



### About the AUTHOR

**Amit Kumar Verma**  
Vice President -  
Strategy & Farms  
IG International Pvt Ltd



# INDIA'S PERISHABLE BUSINESS MODELS

## A Contrarian View

In the early years of 2000-05 when modern and organized food retail started in the country, many of these formats started competing (more on fruit and vegetables category and less on the cereals and pulses) with the traditional roadside mom and pop stores, push carts etc on the price front rather than positioning themselves as parallel and premium category. Many of these modern stores used to run "mandi bazars" on weekends with deep discounts. While this is appreciable from a customer acquisition point of view, this has done some damage to the food retail revolution. Organized retail formats had the infrastructure and marketing budgets to educate the consumer and position their perishables as premium categories that are handled in cold chain right from the farm, sorted and graded in packhouses and shipped in cold chain logistics. They could have marketed "fresh and quality" as a driver to push for premium pricing. This is undoubtedly expensive, but that is exactly the category evolution we needed back then. Today, farmers would have been the happiest lot in the country. But that didn't happen. Counter argument is that Indians do not pay premium and they always look for bargains. Well, this is not a feature unique to India. Everybody in every country loves a bargain. It is just that Indian bargaining priorities are different. Modern retailers would have made the

**Just like public transport is the primary duty of Govt, milk and tomatoes also need coldchain transport directly operated or supported by Govt.**

road side hawkers and even farmers learn the importance of cold chain handling and importance of infrastructure for perishables to deliver the desired quality. Whole ecosystem would have changed for good creating win-win for all stakeholders across the value chain. All that needed was diverting the huge marketing budgets spent on deep discounting to educating both consumers, farmers and distribution channel.



### Long Live Packaging!

Some modern retail formats started packaging vegetables, and fruits by mixing various grades. A pack of apples or potatoes would contain often one or two pieces of bad quality. Idea was to mix and match good and bad stuff and clear the inventories and decrease the dump at the end of the day to reduce losses. But this backfired in the later days as many started opening the pack and removing the bad apple and getting it replaced with a good apple from another pack. One bad apple has resulted in damage of two packs. It is unfortunate that even today, consumers do not trust packed perishables and do the sorting and grading with their own hands every time they visit the super markets. You would do this anyway on a street pushcart. We should have aimed for a better experience for the consumers in these modern formats. My personal favorite of successful execution of packaging for perishables is that of Alphonso mango which is mostly sold in neat cartons. Few more examples of successful packaging (strawberries, mushrooms, kiwi etc) do exist in select markets for select perishables.

### About the AUTHOR

**Gopinath Koneti**  
Partner  
Food and Agriculture  
KPMG India Services LLP

### Is Organized Retail the Holy Grail for Indian Markets?

This is not to show that organized retail is the key front-end format for Indian consumers. On the contrary, it is anything but significant. Even in the current scenario, the total sale of perishables across all modern retail formats would still be below 2-3% on a pan India basis. But we lost an opportunity to educate the traditional supply chain stakeholders to move up the ladder in infra, freshness, quality etc., so that today, every street vendor would have been a modern retailer removing the infra barriers across the formats. For example If you want to sell icecream, whether you are a mega store or roadside pushcart, you need to have a freezer. Please do not think that the tomatoes you and me buying are farm fresh. They have endured a 24-48 hour journey in an ambient truck and countless hands touching them and finally arriving at a destination near you. These are half dead tomatoes. We, the end consumers buy them and promptly put them back in our household refrigerator thinking that miraculously they become fresh again. They do not. They are already devoid of freshness, some nutrition and half or more of their original shelf life. When I spoke to my friend Ravi who worked in fresh category for a retail chain, he says, perishables are often treated like untouchables. They do not get 10% of the respect we give to other supermarket categories.

### Fruits and Logistics

We have broadly two kinds of fruits, climacteric fruits, that can ripen after harvesting and separating from the plant provided there are optimal conditions and non-climacteric fruits, that do not ripen after harvest. Examples for former category are, banana, papaya, mango, custard apple, apple, kiwi etc. Melons, citrus fruits, strawberries, pomegranates, grapes etc., belong to non-climacteric group.

Climacteric fruits are sensitive to transport after they are fully ripened on the tree. But there is a sweet spot of



physiological maturity for each fruit for harvesting so that the fruit can ripen to optimal sweetness index or brix level. Since, the fruit is transported in open trucks where every fruit is dumped in heaps, semi ripened fruit cannot tolerate transport shocks unless we transport in crates and use coldchain. To avoid losses, our indigenous fruit handlers started harvesting and transporting unripen or raw fruits. They would use unscientific powders, carbide etc., to induce ripening. But these unscientific methods cannot induce ripening and hence customers end up buying unnatural fruits with less than desirable taste and quality. Govt should start rejecting the fruit lots in wholesale markets if the said fruit is found to be harvested at less than the required brix level. Easier said than done. Once again if consumers start refusing to buy these unnatural fruits, then we can see some change in the fruit supply chains. Unique Features of India - Its Consumers and sensitivities of Indian Food Systems

■ We are a large food production and consumption society that is benefitted with almost three growing seasons across the year for crops. All that we need is to ask for better quality and readiness to pay premium.

■ Cross subsidization: House hold expenditure on junk food can be partially moved towards premium that you pay for these quality perishables. You will be happy to see the difference in quality and freshness. Kids probably may eat more vegetables and drink more milk without any tantrums.

■ India is predominantly a tropical country barring few areas in North India with varying and higher temperatures

and humidity across the year. This has a huge bearing on the shelf life of several perishables. So, end to end coldchain is must for that natural and fresh taste. This is expensive. Endless price competition has made the brands and consumers settle for ordinary quality. Every brand must try to deliver the premium quality and then take the consumers slowly up the quality ladder.

■ There is now a new breed of supermarkets and dark stores that exclusively deal with Fruits and vegetables, meats, seafood etc. These are very early days to decide their longevity, but it is a welcome step towards premiumization.

■ Govt has already budgets allocated for perishables and infrastructure creation offered through various subsidies and grants. This budget needs to go up at least 10 times to create infra for a large country like India that has diversified 127 agro climatic zones. Govt can do a lot here. Just like public transport is the primary duty of Govt, milk and tomatoes also need coldchain transport directly operated or supported by Govt. This cannot be the job of private sector as it calls for massive expenditure. Building coldchain based infrastructure like pre-cooling customized to each commodity near production clusters can bring the desired change and let the private sector take up the processing and last mile delivery.

■ As we discussed, Indian perishables have different temperature and humidity standards to enhance their shelf life. Once the farm level cooling is done to enhance the shelf life, standardization of packing materials and customized coldchain needs to be created for fruits, vegetables, milk etc.



# HORTICULTURE

## A POTENTIAL SECTOR FOR DIVERSIFICATION



The Hon'ble Union Agriculture Minister Shri Shivraj Singh Chouhan on 05<sup>th</sup> August 2024 announced that an amount of Rs 18,000 crore expenditure would be incurred on setting up 100 export-oriented horticulture clusters in next five years. His announcement may be seen in the context that Government of India (GoI) has launched a program on Cluster Development of Horticulture to enhance global competitiveness of Indian horticulture. The Ministry has identified 12 horticulture clusters for the pilot launch of the Programme. These are a few examples

### About the AUTHOR



**Sunil Kaushik,**  
General Manager, NABARD

that amply reflects potential of the sector and Government's commitment.

### Indian Horticulture Scenario

India is the second largest producer of fruits and vegetables in the world, after China. The Indian horticulture contributes ~33% to agricultural Gross Value Added (GVA), while using about 13% of the gross cropped area. The horticultural production (Second Advance Estimates for 2023-24) is estimated to be 352.23 million ton, and has surpassed food grain production, from a much less area (28.63 million ha for horticulture against 127.6 million ha for food grains).

Productivity also is much higher vis a vis productivity of food grains (12.49 ton/ha against 2.23 ton/ha). Productivity of horticultural crops has increased by 38% during 2004-05 to 2021-22. The major subsectors of horticulture viz., fruits and vegetables are estimated to contribute a production of 112.63 million ton and 204.96 million ton, respectively.

### Challenges in Horticulture Sector

While the total production is high, the productivity is lower vis a vis the major countries. There is a necessity to address the issues of quality planting material, availability of productive varieties, and spruce up extension network for technology transfer.

Climate change is a big challenge for horticultural crops. With rising temperature, snow line is likely to recede to higher altitude areas in the hills making the lower areas unsuitable for temperate fruits. Unseasonal intense rainfall during flowering and fruiting period may



In urban India, the Monthly Per Capita Expenditure (MPCE) on cereals and pulses is Rs 325 and on fruits and vegetables Rs 491, and share of expenditure on fruits and vegetables in total food expenditure is 19.4% as compared to 9.3% on cereals. In rural India, the MPCE on cereals and pulses is Rs 261 and on fruits and vegetables Rs 343 and share of expenditure on fruits and vegetables in total food expenditure is 19.6% as compared to 10.6% on cereals. (NSS Report No. 591: Survey on Household Expenditure: 2022-23)

**Productivity of horticultural crops has increased by 38% during 2004-05 to 2021-22.**

lead to higher flower drop and poor fruit-setting. More frequent drought incidents may adversely affect the growth of fruits trees and may lead to poor harvest. Higher incidences of pests and diseases make produce unfit for marketing and consumption.

Lack of post-harvest infrastructure such as cold chain facilities and logistics is leading to reduced shelf life, market value of and huge post-harvest losses. Around 15-20% of the fruits and vegetables in India are wasted along the supply chain or at consumer level.

Role of credit is critical in promotion of horticulture sector that require long term investments. Owing to several reasons, credit off-take in horticulture sector is not commensurate to potential.

With an export of Rs 11,412 crore during 2021-22 for fresh fruits and vegetables, India is ranked 14<sup>th</sup> in vegetables exports and 23<sup>rd</sup> in fruits exports, and its share in the global horticultural market is a mere 1%. India has great poten-



tial for increasing exports of fresh fruits and vegetables.

**Government Initiatives**

Mission for Integrated Development of Horticulture (MIDH) is a Centrally Sponsored Scheme, launched from 1<sup>st</sup> April 2014, for holistic growth of horticulture sector covering fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa, and bamboo. GOI contributes 60% of total outlay in all the states, 90% in North-East and Himalayas and 100% in Union Territories. Horticulture Cluster Development Programme is another central sector programme aimed at growing and developing identified horticulture clusters to make them globally competitive.

Recognizing the need to take advantages of economies of scale, the GoI is implementing a central sector scheme to form 10000 FPOs with an outlay of Rs 6,300 crore. The scheme aims to promote the formation and strengthening of FPOs and development of entrepreneurship among the farmers. Horticultural sector with many subsectors offers great scope for FPOs to take advantage of this support.

The Union Cabinet, on 09 August 2024 approved Clean Plant Programme (CPP) with an outlay of Rs 1,766 crore to revolutionize India's horticulture sector. The CPP will address virus infestation in horticultural crops, affecting both productivity and quality. Key components of the programme are establishment of nine world-class Clean Plant Centres (CPCs) equipped with advanced diagnostic therapeutics and tissue culture labs; and implementation of a robust certification system under the Seeds Act 1966.

**Way forward**

- Cultivation of high yielding varieties. A rich number of varieties have already been developed by scientific institutes, which must be taken to cultivation. Also, adopting cropping systems such as high-density plantation, mixed cropping / multi layered



**Role of credit is critical in promotion of horticulture sector that require long term investments.**

cropping systems will boost productivity.

- Alignment of Research towards building climate resilience. Development of drought / heat resistant varieties, protected cultivation through low-cost poly houses and net houses, adoption of agronomic practices that reduce impact of climate change, micro irrigation, integrated pest and disease management, natural farming practices, etc. be promoted on a mission mode.
- Optimization of production through advances in technology such as precision agriculture techniques. This involves using data and sensors to monitor crops, soil conditions, and weather patterns, enabling farmers to take informed decisions and increase efficiency, reduce costs, and improve sustainability.
- Promotion of low-cost decentralized processing technologies and near farm primary processing infrastructure.
- Engagement with FPOs, FPO federations, SHGs and SHG Federations and new age agri startups in the value chain of horticulture crops. Providing common post-harvest infrastructure such as cold storage, integrated pack houses, ripening chambers, etc. to these farmer groups will enable economies of scale and orient production to high end processing and exports.
- Improvement of marketing facilities in small towns and connect to distant markets, promotion of digital

marketing channels such as e-NAM, ONDC, etc. on a campaign mode and incentivizing farmers / FPOs / SHGs on branding and labelling.

- Access to credit on easier terms, interest subvention for long term investments and credit linked capital subsidies.
- Technology transfer by gearing up Government's extension machinery and adoption of digital means to reach farmers. Research institutions should strive to transfer technologies on modern farming techniques, good agricultural practices, and market-oriented production. Collaboration of research institutions and agricultural extension agencies is critical.
- Rooftop gardens and vertical farming systems will gain momentum in future. Aeroponic and hydroponic systems have made it easier to grow a variety of vegetables in limited space.

To achieve demand-driven horticultural production, improved productivity, effective credit and risk management, and more efficient marketing network, there is a need for multi-stakeholder partnerships involving horticulturists, government, consumers, agro-based industry, and academia/research. As India aims to become the world's food basket, the journey needs to be supported by joint efforts to achieve income and livelihood advancements of horticultural farmers.

*\*Disclaimer: This is the personal viewpoint of the author and does not represent the opinion of NABARD in any way.*



# CLEAN PLANT PROGRAMME

## A MAJOR LEAP FORWARD IN HORTICULTURE SECTOR

In a transformative move for India's horticulture sector, the Union Government has approved the Clean Plant Programme (CPP). Supported by a substantial investment of Rs. 1,765.67 crore and spearheaded by the Ministry of Agriculture and Farmers Welfare, the CPP aims to enhance the quality and productivity of fruit crops across the country. This initiative is expected to set new benchmarks for excellence and sustainability in agriculture.

**The Clean Plant Programme (CPP)**

CPP is designed to address critical issues in horticulture by providing access to high-quality, virus-free planting material. The programme is poised to deliver

numerous benefits across various stakeholders, from farmers to consumers, and bolster India's position in the global fruit market. By providing virus-free, superior planting material, the CPP aims to boost crop yields and enhanced income opportunities for the farmer. The streamlined certification processes and infrastructure support will help nurseries in efficiently producing clean planting material. Improved facilities will also foster growth and sustainability in the nursery sector. The initiative ensures that consumers receive fruits that are not only virus-free but also enhanced in taste, appearance, and nutritional value. With higher-quality, disease-free fruits, India will enhance its position as a leading global exporter,

thereby expanding market opportunities and increasing its share in the international fruit trade.

**Core Components of the CPP**  
**Clean Plant Centers (CPCs)**

Nine advanced CPCs will be established across India, each focusing on specific fruit types. These centers will be equipped with modern diagnostic and therapeutic facilities, including tissue culture labs. The centers will be located at Grapes: NRC, Pune; Temperate Fruits (Apple, Almond, Walnuts, etc.): CITH, Srinagar & Mukteshwar; Citrus Fruits: CCRI, Nagpur & CIAH, Bikaner; Mango/Guava/Avocado: IHR, Bengaluru; Mango/Guava/Litchi: CISH, Lucknow; Pome-



granate: NRC, Sholapur and Tropical/ Sub-Tropical Fruits in Eastern India Certification and Legal Framework

#### Regulatory Measures

A robust certification system will be implemented under the Seeds Act of 1966, ensuring accountability and traceability in the production and sale of planting material.

#### Enhanced Infrastructure

Large-scale nurseries will receive support for developing infrastructure to facilitate the efficient multiplication of clean planting material.

#### Integration with Mission for Integrated Development of Horticulture

The CPP complements the ongoing Mission for Integrated Development of Horticulture (MIDH), a Centrally Sponsored Scheme initiated in 2014-15 aimed at the holistic growth of the horticulture sector. MIDH covers a wide range of crops including fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, bamboo, and cocoa.

#### Under MIDH, several key measures are being undertaken

- Plantation Infrastructure Development: Establishing nurseries and tissue culture units to produce quality seed and planting material.
- Area Expansion: Creating new orchards and gardens for various crops, with or without integration (e.g., drip irrigation).
- Rejuvenation: Revitalizing old, unproductive orchards.
- Protected Cultivation: Setting up poly-houses, greenhouses, shade net houses, and walk-in tunnels, along with micro irrigation facilities.
- Promotion of Organic Farming: Encouraging organic practices, certification, and establishing vermi-compost units.
- Creation of Water Resources: Developing community tanks, on-farm ponds, and water harvesting systems.



**CPP is designed to address critical issues in horticulture by providing access to high-quality, virus-free planting material**

- Pollination Support through Bee-keeping: Producing bee colonies, honey bee hives, and related equipment.
- Horticulture Mechanization: Providing power tillers, tractors, and plant protection equipment.
- Human Resource Development: Conducting awareness programs, farmer training, exposure visits, and study tours.
- Post-Harvest Management (PHM) Infrastructure: Setting up cold storage, pack houses, ripening chambers, reefer vehicles, processing units, and food processing facilities in North Eastern States.
- Marketing Infrastructure: Developing static and mobile vending carts, retail outlets, rural markets, wholesale markets, and direct market platforms.

#### Inclusion and Sustainability

The CPP places a strong emphasis on

inclusivity and sustainability. It aims to provide affordable access to clean plant material for all farmers, regardless of their landholding size or socioeconomic status. The programme will also actively engage women farmers, ensuring their participation in planning, resource access, training, and decision-making processes. Additionally, the CPP will address the diverse agro-climatic conditions across India by developing region-specific clean plant varieties and technologies.

#### Alignment with Broader Initiatives

The Clean Plant Programme aligns with broader initiatives such as Mission LiFE (Lifestyle for Environment) and the One Health approach. By promoting sustainable practices and reducing dependence on imported planting materials, the CPP represents a crucial step towards establishing India as a global leader in fruit production and export.

#### Implementation and Oversight

The programme will be implemented by the National Horticulture Board in collaboration with the Indian Council of Agricultural Research (ICAR). Through this partnership, the CPP is set to drive transformative change in India's horticultural sector, marking a significant leap forward in the country's agricultural landscape.

With its comprehensive approach and substantial investment, the Clean Plant Programme is poised to revolutionize India's horticulture sector, ensuring that farmers, consumers, and the global market benefit from high-quality, virus-free fruits.

#### Horticulture schemes and initiatives

India's horticulture sector, vital for both the economy and nutrition, has seen significant enhancements through various government schemes and initiatives. These programs are designed to address diverse challenges and unlock the sector's potential, focusing on improving crop quality, expanding production, and

ensuring market access.

#### National Horticulture Mission (NHM)

Launched in 2005, the NHM is a centrally sponsored scheme aimed at promoting holistic growth of the horticulture sector. It focuses on enhancing horticulture production, improving nutritional security, and providing income support to farmers. The mission covers a wide range of horticulture crops and provides support for various activities including area expansion, rejuvenation of old orchards, protected cultivation, and post-harvest management.

#### Enhanced Support for Horticulture Under PMFBY

Under the PMFBY guidelines, the premium contribution for farmers is capped at 2% for Kharif crops, 1.5% for Rabi crops, and 5% for commercial and horticultural crops. This substantial support underscores the government's commitment to protecting horticultural crops, reflecting their importance and the need for targeted insurance solutions to safeguard this vital sector.

**The CPP complements the ongoing Mission for Integrated Development of Horticulture (MIDH), a Centrally Sponsored Scheme initiated in 2014-15 aimed at the holistic growth of the horticulture sector.**

#### Horticulture Cluster Development Programme (HCDP)

The HCDP is designed to leverage geographical specialization and promote integrated and market-led development of horticulture clusters. By focusing on identified crops in specific regions, it aims to optimize productivity through better utilization of resources. The program targets to increase in exports of the focus crops and seeks to improve the competitiveness of Indian horticulture products in the global market.

#### Post-harvest Infrastructure Development Scheme

This scheme addresses the critical issue of post-harvest losses in the horticulture sector. It provides support for establishing modern post-harvest facilities such as pack houses, ripening chambers, cold storage units, and processing facilities. By improving post-harvest management, the scheme aims to reduce wastage, extend the shelf life of produce, and ensure better returns for farmers.

#### Soil Health Card Scheme

While not exclusive to horticulture, this scheme significantly benefits horticultural farmers. It involves testing soil samples and providing farmers with soil health cards containing crop-wise recommendations for nutrients and fertilizers. This enables farmers to make informed decisions about soil management, potentially leading to improved crop yields and reduced input costs.

#### Horticulture Mission for North East and Himalayan States (HMNEH)

This mission focuses on the comprehensive development of horticulture in the North Eastern states and Himalayan regions. It takes into account the unique agro-climatic conditions of these areas and promotes crops that are particularly suited to these regions, aiming to improve farmers' livelihoods and promote sustainable horticulture practices.

Clean Plant Programme (CPP) stands as a transformative initiative poised to significantly elevate India's horticulture sector. By improving the quality and sustainability of fruit production and enhancing the country's export capabilities, the CPP is set to reinforce India's position as a global leader in the fruit trade. Furthermore, its inclusive approach, which ensures equitable access to resources and actively involves women farmers, highlights the programme's dedication to fostering broad-based growth and development within the sector.

**CABINET DECISION**  
9<sup>TH</sup> AUGUST, 2024

Cabinet approves the **Clean Plant Programme (CPP)** under **Mission for Integrated Development of Horticulture**

- Investment of **Rs.1,765.67 Cr**
- CPP will provide access to virus-free, high-quality planting material to farmers regardless of their landholding size or socioeconomic status
- Streamlined certification processes & infrastructure support to nurseries
- Nine world class state-of-the-art Clean Plant Centers will be established across India
- It will address diverse agro-climatic conditions across India by developing region-specific clean plant varieties & technologies



# SOLAR WATER PUMPS FOR SMALL-SCALE HORTICULTURAL FARMERS

**O**n the background note of the ambitious aspiration by India to meet net-zero emissions by 2070, the agricultural sector is also now visibly turning toward renewable energy solutions. Amidst fears that climate change may further throw a spanner on the efficiency of renewable energy projects, solar water pumps are fast becoming a game-changing technology for small land holder farmers and farms in remote locations. These pumps, though offering a more sustainable and cheap irrigation solution under the PM-KUSUM scheme and rapidly growing global markets, have additional potential to increase the income and energy security of farmers. Their full potential yet remains unexploited, calling for further innovation and strategic implementation to enable maximum benefits for India's agrarian economy.

Indian market for solar water pumps is growing rapidly with significant thrust from the government and is poised to become world's largest market for Solar Agri pumps. This shows how quickly this new trend is picking up steam in rural areas, particularly with regard to farming using solar power as well as other innovative technologies like biogas digesters. By incorporating such equipment into their small-scale farming activities, they can however benefit from economic, environmental and pragmatic advantages that come with it.

## ECONOMIC BENEFITS

### Reduced Operational Costs

Solar water pumps have significantly reduced operational costs and this is one of the main reasons they are preferred. Diesel or electricity powered pumps are usually used in conventional irrigation



**Indian market for solar water pumps is growing rapidly with significant thrust from the government and is poised to become world's largest market for Solar Agri pumps.**



methods. In comparison, solar water pumps operate on solar energy, which is available for free throughout the year; this consequently saves a lot on fuel and electricity bills. Farmers operating small scale farms can redirect such savings towards purchasing quality seeds, fertilizers and improving their farming tools among other critical areas

### Minimal Maintenance Costs

When compared to those working with diesel counterparts, users of solar water pumps incur lower maintenance costs. Diesel pumps frequently break down and require repair services and after-

### About the AUTHOR

**Mr. Gopal Kabra,**  
Founder & CEO of  
GK Energy

sale support. The solar-powered pumps, however, are less prone to damage due to fewer moving parts involved in their design than the mechanical ones. This has led to farmers spending less on maintenance as well as fewer interruptions that are caused by broken-down machines, while giving more attention to their crops instead of fixing their equipment every other time

### Environmental Benefits

#### • Solar Energy as a Renewable Power Source

It utilizes solar power, which is pure and renewable. Solar energy does not emit the greenhouse gases in contrast to fossil fuels. It leads to reducing the carbon footprints involved in agriculture. This is crucial for global efforts directed towards tackling climate change. By adopting solar water pumps, smallholder farmers can support sustainable farming that conserves natural resources

#### • Water Resource Management

The most common systems used in this case are drip irrigation or sprinkler irrigation, which are also compatible with solar powered water pumps. For instance, trickle technology allows direct delivery of water into plant roots thereby minimizing losses through evaporation and surface run-offs respectively; very essential especially where water is scarce. In short, these devices help to maintain supplies for future generations by saving on one of the most precious elements – clean water.

## PRACTICAL BENEFITS

### Reliability and Independence

In many rural areas, access to a reliable electricity supply is a significant challenge. Solar water pumps provide an independent solution, as they do not rely on the grid. This is particularly advantageous for small-scale farmers in remote areas. Free-standing in sunlight, solar pumps can be installed anywhere so that farmers always have enough water to drink. These are responsible for crop yield increases and higher farm production in general.

**Small-scale farmers can reap numerous advantages from solar water pumps, including financial savings, environmental preservation, practical benefits, and socioeconomic empowerment.**

### Ease of Installation and Use

Modern solar water pumps are designed to be user-friendly, with straightforward installation processes. They often come as complete kits, including solar panels, the pump, and necessary accessories. This simplicity means that farmers can set up and start using the pumps with minimal technical knowledge or assistance. Additionally, solar pumps can operate automatically, adjusting to sunlight availability, which further simplifies their use

## SOCIO-ECONOMIC IMPACT

### Strengthening Farms on a Small Scale

Small-scale farmers may have significant socioeconomic effects from the use of solar water pumps. Through the reduction of costly fuels and unstable power sources, these pumps help improve the financial stability of farmers. Better living standards may result from the sav-

ings and higher productivity, enabling farmers to make investments in the general well-being, health, and education of their families. This empowerment may aid in rural areas' overall economic development.

### Encouragement of Eco-Friendly Behaviours

Sustainable farming methods are becoming more popular as more farmers use solar water pumps. This change may inspire other farmers to investigate and apply environmentally beneficial practices, starting a chain reaction that encourages environmental care throughout the agriculture industry. Additionally, the public recognition of effective solar pump deployments can garner backing from governmental and non-governmental entities, resulting in an increase in sustainable farming-related projects.

Small-scale farmers can reap numerous advantages from solar water pumps, including financial savings, environmental preservation, practical benefits, and socioeconomic empowerment. These solar-powered pumps offer a dependable, economical, and environmentally friendly irrigation solution. The use of solar water pumps stands out as a crucial step in securing the future of small-scale farming as the globe shifts to more sustainable agricultural practices. Adopting this technology benefits individual farmers as well as the more general objectives of environmental preservation and sustainable growth.





# SMART URBAN HORTICULTURE FARMING

**S**mart urban horticulture farming deals with growing high value horticultural crops in peri and peri urban areas with the help of modern technologies. High value horticultural crops like vegetables, flowers, herbs and seedlings can be grown round the year, or in off season, under smart urban farming. It is being practised in open field, protected structures, roof top, balcony, kitchen garden and also inside closed room. It can be adopted with or without artificial light. Smart urban farming involves application of modern technologies, mainly for efficient control, and management of costly inputs like energy, water, seed, fertilizer and other chemicals. Value chain based efficient marketing system is the important component of Smart Urban Farming. These two important components of Smart Urban Farming are attracting youth and common citizens to adopt it on mass scale, mainly in the big cities. Simultaneously, this type of farming helps in growing safe food with one's own involvement in relatively small space, sometimes within home itself. It also helps in pollution control, and facilitates supply of abundant oxygen, and control of many harmful gases by growing specialized plants. This has been the main reason for massive adoption of Smart Urban Farming technology in the post covid era. Smart



*IoT and Sensor Operated Greenhouse Smart Urban Farming at ICAR-IARI Pusa*

**Protected cultivation has very high entrepreneurial value and profit maximization leading to local employment, social empowerment and respectability of the growers.**

Urban Farming gives the opportunity to grow safe and high value horticultural crops for our own family and for the society. Many start ups related to different aspects of Smart Urban Farming are now flourishing in big cities.

#### **Smart Urban Horticulture Farming under Protected Cultivation Technology**

Protected cultivation based smart urban farming offers several advantages to produce horticultural crops and their



#### **About the AUTHOR**

**M. Hasan, A M Tripathi, Vinod Kumar, Mahesh Rangoli and Adarsh Kumar**  
Principal Scientist, Centre for Protected Cultivation Technology, ICAR IARI Pusa Delhi



*Smart Urban Vertical farming Model being displayed at Kisan Mela ICAR IARI Pusa Delhi*

#### **Modern technologies are important components of Smart Urban horticulture Farming**

- Protected Cultivation Technology
- Drip Irrigation and Fertigation
- Soilless Cultivation Technology
- Hydroponics, Aeroponics and Aquaponics
- ML, AI, Automation, Sensors, Controller and IoT
- Vertical Farming

#### **Major advantages of Smart Urban Horticulture Farming**

- Round the year possibility of growing high value horticultural crops
- Off season availability of growing high value horticultural crops
- Efficient control and management of inputs
- Safe and chemical free production of high value horticultural crops
- Leads to healthy and environmental friendly atmosphere
- Personal involvement in growing high value horticultural crops

planting materials of high quality and yields, through efficient land and resource utilization. Fruits, vegetables and flower crops normally accrue 4 to 8 times higher profits than other crops. This margin of profit can increase manifold if some of these high value crops are grown under protected conditions, like greenhouses, net houses, tunnels, shade net etc.

Following important protected structures are commonly used for smart urban farming.

- Naturally Ventilated Greenhouse
- Climate Controlled Greenhouse

**The future of smart, efficient and precision agriculture is mainly based on automation linked with IoT and AI.**

- Insect Proof Net House
- Shade Net House
- Tunnel type Greenhouse
- Rain Shelter

All these protected structures can be

used for adopting smart urban farming based on either soil or soilless system in both single and multi layers. The growing system can be modified and easily constructed as per the special requirement of the module adopted for crop production.

Such an agricultural production system could provide a more profitable source of income and employment in urban and peri-urban areas. The amount of post harvest losses in vegetables and cut flowers is very high (20-30%), which can be significantly reduced and productivity can be increased 5-10





through protected cultivation technologies by taking the crops round the year. Protected cultivation has very high entrepreneurial value and profit maximization leading to local employment, social empowerment and respectability of the growers. Environmentally safe methodologies involving GAP and IPM tactics reduce the hazards lacing the high value products.

#### Technology and Urban Farming

Machine learning (ML), Internet of Things (IoT) and Artificial intelligence (AI) based automation have been the recent most successful approaches for controlling greenhouses and urban farming models for maximizing the quality crop production of high value vegetables, flowers and seedlings, and efficiently controlling the entire related business models. These recent techniques incorporate and integrate the human expertise, sensors, online and in-situ data, software and hardware from different sources for the efficient management of all the related inputs, and maximize the output in terms of both quality and quantity. The future of smart, efficient and precision agriculture is mainly based on automation linked with IoT and AI.

ICAR-IARI Pusa Delhi is one of the

lead institutes carrying research, education and training on different aspects of Smart Urban farming Technology including Soilless Vertical Hydroponics based Farming at Center for Protected Cultivation Technology. Indigenous infrastructures for Soilless, Hydroponics, Aeroponic, Multi layered vertical farming have been developed, installed and evaluated with significant achievements in Automation with sensors including IoT development. Technical Bulletins titled "Hydroponics Technology for Horticultural Crops" (TB-ICN:188/2018), Smart Urban Farming Technology (TB-ICN:270/2022- English) and (TB-ICN:H-195/2022-Hindi) have been published by ICAR-IARI for Technology dissemination related to Smart Urban farming.

#### Government of India initiatives for Smart Urban Farming

Smart urban farming has great prospects for Indian agriculture. It is one of the potential technologies for doubling farmers income. In the changing scenario of food habits and growing fad for green vegetables, herbs and fruits, hydroponics technology is going to play a major role for sustainable and round the year production in urban and peri-urban

areas. As this technology is capital intensive and requires technical knowhow, GOI has launched many schemes to promote this technology through different agencies.

Some of the major agencies to promote Smart urban farming are Ministry of Agriculture & Farmers Welfare, GOI; National Horticultural Board (NHB); National Horticultural Mission (NHM) and Horticulture Mission for North East & Himalayan States

Credit linked projects relating to establishment of Commercial production units in protected conditions for Hydroponics cultivation are supported financially by National Horticultural Board NHB. The details of the schemes are available at [www.nhb.gov.in](http://www.nhb.gov.in). National Horticultural Mission (NHM) and Horticulture Mission for North East & Himalayan States also indirectly support Hydroponics related projects through the protected cultivation initiatives. Farmers and entrepreneurs can avail these schemes as per the eligibility and suitability. Ministry of Agriculture and Farmers Welfare, GOI is providing funding (Up to 2 crore loan) to farmers under Agriculture Infrastructure Fund for Smart Urban Farming models like Vertical Farming, Soilless, Hydroponics and Aeroponics.

# CULTIVATING GREEN GOLD

## AVOCADO

**H**undred years ago avocado was introduced by American missionary in India, which was rejected by the native population.

The recent rise in popularity of avocado farming, driven by the increasing awareness and global demand for this nutritious fruit, underscores the need for a sustainable approach to ensure the long-term viability of cultivation.

Commonly referred to as the "butter fruit", they are nutritious. Avocado trees are slow in growth and usually takes three to five years for a tree planted from a sapling to start bearing fruit. And even more in achieving its full potential for commercial farming. Trees typically reach their peak productivity between the ages of 10 and 20 years. So, successful avocado farming requires both time and patience to see the best results. Avocado farming is prominently practiced in regions such as Mexico and Central America.

Notably, the Indian Institute of Horticultural Research (IIHR) pioneered avocado plantation initiatives. In India, avocado cultivation is concentrated in specific regions, with significant activity in Karnataka, Tamil Nadu, Kerala, and Maharashtra. However, the cultivation footprint is expanding, and in the northern state of Himachal Pradesh, fruit



growers in areas like Solan, Mandi, and Bilaspur have successfully planted avocado orchards. These orchards have reached the fruit-bearing stage, indicating the adaptability of avocado trees to diverse climatic conditions. The geographical diversification of avocado cultivation within India showcases the

The geographical diversification of avocado cultivation within India showcases the potential for this fruit to thrive in various climates across the country.

#### About the AUTHORS



Shiv Kumar Shivandu, Ishani Sharma, Deeksha and Nischala  
Dr Yashwant Singh Parmar University of Horticulture and Forestry,  
Nauni Solan – Crop Treatise



potential for this fruit to thrive in various climates across the country.

### Climatic conditions

Modern advancements in crop improvement have led to the development of avocado varieties capable of tolerating temperatures lower than 0°C. Despite this progress, the cultivation of avocados faces challenges due to the sensitivity of the plants to temperature fluctuations. While these improved varieties can withstand temperatures below freezing, sharp and extreme temperature fluctuations can still limit avocado cultivation. Maintaining the right soil temperature is crucial for successful avocado growth, with the optimal range being 20°C to 30°C. Root growth is significantly hindered when temperatures drop below 10°C or rise above 30°C.

Additionally, young avocado plants are susceptible to temperature stress when exposed to extreme heat, exceeding 40°C. Avocado plants have specific temperature requirements for flowering. Frost can be a limiting factor so, protection from frost during the winter months is essential.

### Water and Humidity

Avocado trees, in particular, thrive in climates with an average rainfall ranging between 1000 mm to 1300 mm. Successful cultivation typically requires a relative humidity level of 60-80%. However, it's noteworthy that avocados can still produce fruits in lower humidity conditions, even below 40%. Despite the adaptability of avocado trees, sustained low humidity increases the risk of water stress, rendering plants more susceptible to pests and leading to blossom and fruit drop. Moreover, higher relative humidity can elevate the incidence of fungal attacks in avocado trees.

Adhering to good agricultural practices is crucial for optimal avocado cultivation. This includes proper spacing and timely pruning, facilitating better airflow within the orchard. Adequate spacing prevents overcrowding, reducing the risk of waterlogging. Proper airflow, in

turn, helps in mitigating the risk of water stress, pest infestation, and fungal diseases. Additionally, strategic pruning enhances cultural practices, making it easier to manage the orchard and address potential issues promptly.

### Soil and Nutrients Management

Avocado cultivation, known for its adaptability, can thrive in diverse soil types, yet certain conditions are pivotal for optimal growth. While avocados can endure a range of soil pH levels (preferably between 5-7, with tolerance up to 6-7), they excel in well-drained alkaline soils. Notably, the avoidance of waterlogged conditions and saline soils is crucial for the successful development of avocado trees.

Organic matter plays a key role in promoting avocado health. Soils rich in organic content not only help maintain moisture levels but also enrich the soil with vital minerals such as nitrogen, phosphorous, and potassium. For areas

with nutrient-deficient soils, the addition of aged manure or compost proves invaluable, acting as a natural fertilizer to support avocado growth.

### Plantation and After Care

To ensure optimal conditions for planting avocado trees, it's essential to prepare the soil adequately. Loosen the soil by incorporating dehydrated cow manure, garden compost, or peat moss (up to 1/3 concentration) into the topsoil pile. Make sure to use baled sphagnum or granular peat moss. Enhance the soil further by adding Coco-Fiber Potting Medium or at least 2 inches of organic material, working it evenly into the existing soil. For areas with heavy clay soil, improve drainage by planting the tree on a mound. Create a mound that is 3 to 5 feet in diameter and 1 to 2 feet in height. The ideal time for planting avocado trees is in the spring, allowing sufficient time for strong root establishment before winter. Avoid planting dur-



ing the summer, as immature trees may struggle to absorb water and could be vulnerable to sun damage. Handle the delicate root systems with care, ensuring the planting hole is wider than the tree's roots. The depth of the hole should match the height of the root ball to prevent issues related to water and nutrient access. Proper spacing is crucial for optimizing the growth potential of avocado trees. When it comes to watering, young trees should be watered 2-3 times a week. As the roots grow into the soil over about a year, weekly watering becomes sufficient, ultimately reducing water usage. For mature avocados, aim for about 2 inches (50 mm) of water per week. Seedlings require less water, and a handy indicator of proper moisture is if your handprint remains visible after squeezing the soil around the roots. Following these guidelines ensures the health and resilience of your avocado orchard while minimizing water usage.

### Pest and Disease Control

In the avocado plantation, the common pest found are mealybugs, scales, and mites. Accordingly control measure should be taken by following proper recommended dose of insecticides and pesticides. Major diseases include Fruit spot, leaf spot, and root rot. For controlling root rot metalaxyl should be applied by mixing soil just before planting the seedling.

**Modern advancements in crop improvement have led to the development of avocado varieties capable of tolerating temperatures lower than 0°C.**

### Controlling High Temperature

Extreme heat poses a significant threat to avocado farming, particularly towards the end of summer when trees are in bloom and producing fruit. Heat waves and hot winds can lead to necrosis of flowers and fruit drop, resulting in substantial yield losses for avocado growers. While mature trees are less susceptible to sunburn, protecting young avocado trees is crucial. Common farming practices include covering young trees with shade nets, painting trunks white, and strategically interspersing overstorey rows within avocado rows to shield them from the harmful effects of the sun. These measures help safeguard the delicate young trees and mitigate the impact of extreme heat on avocado orchards.

### Harvesting, Yield and Storage

Recognizing the optimal time for avocado harvesting is crucial for ensuring peak ripeness. As avocados mature,

their colour undergoes distinct changes, serving as a reliable indicator of readiness. For green varieties, the skin transitions from a bright hue to a yellowish tone, while dark purple or nearly black cultivars deepen in colour as they ripen. To confirm readiness, select avocados with a short stem and allow them to rest on the counter for a few days. Observe the stem for signs of shrivelling or darkening, signalling the fruit is ripe and ready for harvest. To avoid damage to the tree's branches during harvesting, employing farming shears or pruners is advisable, steering clear of pulling the fruit by hand. Wearing gloves is essential to protect the fruit's surface during the harvesting process.

The yield depends on the variety, age of tree and orchard management practices. The peak harvesting season can range from February to September, with the main months being April through August. Average yield varies from 200-500 fruits per tree. From a fully grown tree of 10-12 year of age nearly 300-400 fruits can be harvested.

Post-harvest, freshly picked avocados typically take three to eight days to soften, depending on ambient temperatures. Refrigeration can slow down the natural softening process that occurs at room temperature. Storing avocados at or slightly above 42°F (5°C) extends their shelf life to several weeks, providing practical insights for both farmers and consumers alike.



# SUSTAINABLE PRACTICES FOR WATER MANAGEMENT DURING KHARIF CROP SEASON

**M**onsoon is pivotal for India's \$572 billion (by Gross Value Added as of 2022) agrarian economy. It sustains a source of livelihood for nearly 150 million workers (a tad higher than Russia's population), and hence by extension, is a mainstay of India's \$3.5 trillion economy (as of 2022).

Currently, around 55% of the net sown area is rain-dependent, thus making a timely onset and deliverance of monsoon critical to India's underlying economic strength.

As India's farming communities gaze into the scorching summer skies in search for rain clouds, there is much to cheer. The India Meteorological Department (IMD) has forecasted an 'above-normal' monsoon this season, with rainfall expected at 106% of the long-term average of 87 cm. This augurs well for the upcoming Kharif season.

## Sustainable Water Management

Today almost 115 million hectares or 55% of India's gross sown area is irrigated. This implies that the rest of sown area (and a little more) is dependent on seasonal rainfall. Especially, considering the water intensity of Kharif and better production, there are a set of sustainable practices using better water management techniques to irrigate the Kharif crops.



**Projection indicates that by 2030, agriculture could contribute a whopping \$600 billion to India's GDP— that is an increase of 50 percent over its contribution in 2020.**

About the **AUTHOR**

**Ashish Dobhal,  
CEO, UPL SAS**



## Weather Data Utilization

One of the most promising approaches is the integration of weather data into irrigation practices. By utilizing historical and real-time weather information, including rainfall and temperature patterns, farmers can make informed decisions about when and how much to irrigate their crops. Technology platforms provide detailed insights into accumulated and daily rainfall, helping farmers anticipate dry spells or heavy rain events and adjust their irrigation schedules, thus reducing the risk of water stress or waterlogging.

## Rainwater Harvesting

It is another valuable technique for farmers to collect and store rainwater during the monsoon season in ponds, tanks, and other storage structures, creating a reliable water source for dry periods. This stored rainwater can be used during critical growth stages when water demand is high, ensuring consistent hydration throughout the crop's growth cycle.

## Sub-Surface Drip Irrigation Systems

For enhanced productivity, profitability, and sustainable water use, sub-surface drip irrigation (SDI) systems offer an efficient solution, particularly for crops like cotton, maize, and wheat. By placing the water delivery system below the soil surface, SDI directly irrigates the root zone, minimizing evaporation and runoff losses.

## Smart Water Management Systems

Integrating Smart water management systems, integrating meters and Internet of Things (IoT) devices, are revolutionizing the way farmers monitor and control water usage. Real-time data collection and analysis enable precise water dis-



*A significantly higher water intensive sowing season as compared to its counterpart Rabi, Kharif is characterized by major crops, such as rice, corn, cotton, soybeans, groundnut, and sugarcane. Barring corn, India ranks among the top five producers in each of these crops, making it a global leader in food and resource security.*

**By utilizing historical and real-time weather information, including rainfall and temperature patterns, farmers can make informed decisions about when and how much to irrigate their crops.**

tribution, reducing losses due to leakage or inefficiency, and informing better water management decisions.

## Technology Integration

Innovative technologies like Zeba, a climate-smart solution, are also making waves in the agricultural sector. Zeba helps retain moisture in the soil, reducing the need for frequent irrigation. This technology is particularly effective for water-intensive crops like sugarcane and groundnuts, as it absorbs water and releases it slowly, ensuring a steady water supply even during dry periods.

## Drones and Satellite Imagery

Drones and satellite imagery provide farmers with valuable insights into crop health and soil moisture levels, allowing for data-driven decisions on irrigation schedules and water requirements.

By ensuring efficient water usage while maintaining optimal crop hydration, these technologies are contributing to sustainable farming practices.

## Adaptive Management Practices

Additionally, encouraging farmers to adapt their planting schedules and crop management practices based on water availability and climate forecasts can significantly enhance water use efficiency. This includes shifting sowing dates and adjusting crop rotations to better align with expected rainfall patterns, optimizing the use of available water resources.

Projection indicates that by 2030, agriculture could contribute a whopping \$600 billion to India's GDP— that is an increase of 50 percent over its contribution in 2020. While it is achievable, the efficiency of agricultural activity is critical. Currently India's water usage per tonne of crop production exceeds twice as much as that in developed countries.

As the world grapples with the challenges of climate change and water scarcity, these innovative water management techniques offer hope for a more sustainable future in agriculture. By adopting a combination of these methods tailored to their specific needs, farmers can achieve higher water use efficiency, lower costs, and sustainable crop production, ensuring food security for generations to come.



## MS SWAMINATHAN GLOBAL LEADERSHIP AWARD FOR SUSTAINABLE DEVELOPMENT

# DR LINDIWE SIBANDA

## *Champion of Change*

The 3<sup>rd</sup> MS Swaminathan Global Leadership Award for Sustainable Development, instituted by Agriculture Today Group for the year 2024 was presented to Prof. Lindiwe M. Sibanda, Chairperson, CGIAR System Board. The award was presented at MSSRF, Chennai on August 7, 2024 by Thiru R Sakkarapani, Minister of Food and Civil Supplies, Government of Tamil Nadu.

Named after the great Indian scientist, Prof. MS Swaminathan, who played pioneering role in saving India from food starvation during late sixties through Green Revolution, which resulted into quantum jump in production, this single award @ INR One Million is annually presented to an outstanding leader, who has made globally impacting contribution to the food security and sustainable agriculture development through the work in research, academics, technology, policy, industry or development sectors.

As a Farmer-Science-Policy Interface Champion, Dr Lindiwe Sibanda has transformed over 50 public, private, and non-governmental institutions, including farmer organisations, government ministries of agriculture, and academic and research organisations. These institutions impact 300 million people, 250 million of whom are smallholder farmers in over 120 countries.

In her acceptance speech, Professor Sibanda expressed, "Receiving the MS Swaminathan Global Leadership Award fills me with gratitude and a deep sense of responsibility to continue our collective efforts toward a hunger-free world. Re-



**With over thirty years of transdisciplinary experience in agriculture, rural development, Dr. Sibanda has emerged as a prominent figure in shaping sustainable food systems globally.**

ceiving this award is not just an honour but a call to continue striving for a world where everyone has access to nutritious food, and where agriculture is a sustainable and resilient practice for future generations. Throughout my journey, I have been fortunate to work with incredible teams and partners who share a vision for a more sustainable and equitable world. This award is a celebration of our shared commitment and the impactful work we continue to do together."

Last year the award was presented to Ambassador Kenneth Quinn, Presi-

dent Emeritus, World Food Prize Foundation, USA and in 2022 to Dr. William Dar, Minister of Agriculture, Philippines. The awards jury is headed by Justice P Sathasivam, former Chief Justice of India.

### **Institutional Transformation**

Dr. Sibanda's institutional transformation contributions have been through several institutions where she worked, each with a distinct focus and mission: (i) LINDS Agricultural Services, a private company dedicated to realigning food system-related institutions; (ii) FANRPAN, a pan-African non-governmental organization committed to building resilient food systems across Africa through evidence-based policy creation, implementation, and assessment in collaboration with non-state actors; (iii) AGRA – the Alliance for a Green Revolution in Africa, which aims to catalyze sustainable food systems growth in Africa by influencing partners and fostering an enabling environment for the thriving private sector and empowered smallholder farmers; and (iv) CGIAR, dedicated to delivering science and innovation that drive the transformation of food, land, and water systems amidst the challenges posed by climate change.

### **Bridging the Gap Between Farmers, Science, Policy, and Society**

Lindiwe's deliberate engagement and zeal to realign food systems institutions has been driven by recognising the gap between farmers, scientific knowledge, and policy actions in the sustainable food systems and climate change agenda. Under Linds Agricultural Services, Dr Sibanda undertook core-functional analysis studies for four ministries of agriculture in Africa (Malawi, Namibia, Uganda, and Zimbabwe), helping them define core businesses, privatize agencies for implementing non-core businesses, and ensuring the Ministries are fit for purpose. Given the high percentage of smallholder farmers in these countries, the restructuring impacted over 40 mil-



In 2023, Dr Sibanda took over as CGIAR Systems Board Chair, and this is where her greatest impact in realigning CGIAR has been most visible. One CGIAR, the umbrella body for 13 CGIAR Centers with a staff of 10,000, working in 81 countries and a budget that is pledged to grow from USD1 billion to USD4 billion, is now the most trusted, public-funded, global research entity working on delivering science and technologies to transform food, land and water systems in the face of climate change. The impact will reach 682.40 million in Southeast Asia and the Pacific, 486.55 million in East and Southern Africa, 552.60 million in Central and West Asia and North Africa, 1843.10 in South Asia, 534.50 million in West and Central Africa and 449.50 million in Latin America and the Caribbean.

**Through initiatives like the Global No Agriculture, No Deal campaign which she championed, Dr. Sibanda has raised awareness and mobilized action to prioritize agriculture in climate change negotiations.**

lion people.

For farmer organisations, Dr Sibanda worked on professionalizing the secretariat that serves those organisations, helping them create membership databases, establishing commodity associations, and creating linkages with research organisations at the national level to transfer knowledge directly. This

was done in Uganda, Malawi, and Zimbabwe, with over 7 million farmers eventually benefiting from the realignment.

At FANRPAN, Dr Sibanda successfully increased the number of Node countries from eight in 2008 to 17 in 2015, significantly broadening FANRPAN's geographical footprint Africa-wide. FANRPAN has membership in Angola, Benin, Botswana, DRC, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe. In each country, there are over 550 organisations as registered members of FANRPAN serving 50 million farmers.

She forged partnerships with 70 international organisations, a remarkable increase from the initial 41, enhancing FANRPAN's influence in shaping global agendas and fostering sustainable solutions to preserve and sustain the continent's food systems. At the CGIAR, Dr Sibanda has been in-



# PADDY CO-CULTURE FARMING FOR GLOBAL FOOD SECURITY

**P**addy cum animal co-culture farming, an ancient South-east Asian practice, is a profession of poor fishermen. This method of farm-

ing has helped many Asian countries to enhance the production of paddy yields, and reduce nitrogen runoff, leaching, and methane emissions compared to monoculture farming. According to the Global Seafood Alliance report in 2023, this method of Paddy cum animal co-culture farming also helps to keep the environment healthy by reducing annual nitrogen runoff and leaching by 3.0 lakh tons and decreasing annual methane emissions by 1.9 lakh tons. Global adoption of this technology is estimated to provide additional revenue to the tune of \$152 billion to \$171 billion to the producers annually, according to the study.

## Co Culture on the Decline

Rice is a staple food for many, and world's half of the population depends on this cereal. In the recent past, co culture has become rare with only 1 percent of global rice production coming from these farms. To this date, there are several case studies on the performance of rice cum animal co-culture throughout the world, and from these studies, it was revealed that adopting this technique helped the farmers to enhance their yield by 4% while reducing nitrogen runoff by 16% and leaching by 13%. The study also revealed that there was a decrease in methane emissions by 11% with rice monocultures. It has been observed that adoption of the paddy cum animal co-culture system all over the world is on a slow track because it requires co-culture-specific technologies, resources such as capital, labour, infrastructure, market networks, and national policies that promote



**In India, about 0.2 million ha of paddy fields are in operation under the rice co-animal culture system.**

rice monocultures

## Rice Cultivation and Green House Gas Emissions

Rice-fish farming constitutes a unique agro-landscape across the world, especially in tropical and sub-subtropical Asia.

## About the AUTHORS



**Dr. S N Harke, Director of MGM Institute Biosciences and Technology, MGM University, Aurangabad;**

**Dr. A D Diwan, Former Assistant Director General (Fisheries), ICAR and**

**Archana N. Panche, Post Doc Fellow, Novo Nordisk Centre for Biosustainability, Technical University of Denmark**



involved in the CGIAR reform processes since 2004; between 2009 and 2015, she actively participated in five Consortium Research Programmes aimed at promoting cross-center collaboration among researchers and bolder impact at the farmer level. Her influence in the institutional realignment of individual centres was mainly during her tenure as ILRI Board Chair and nominations committee chair at CIMMYT.

## Innovative Tools

In Dr Sibanda's career portfolio, the alignment of institutions was coupled with strengthening farmer capacities for the uptake of technologies and engagement in policy processes. She is the originator and designer of five major tools that have improved farmer engagement in the farmer-science-policy interface. These are the Household Assets Vulnerability Assessment (HAVA), Partner Institution Viability Assessment (PIVA), Theatre for Policy Advocacy (TPA), Multi-stakeholder Policy Dialogues and the Policy Leadership Awards. These tools have been the main conduits for promoting the farmer-science-policy interface in all 17 countries where FANRPAN operates. Dr Sibanda developed the Household Assets Vulnerability Assessment (HAVA), a tool designed to Measure Vulnerability to Climate Change in Africa. Since its development in 2004, the livelihood data of over 30,000 households in eight southern African countries has been collated. The HAVA has been integrated with climate data to determine the most

cost-effective climate-smart agriculture policies in Lesotho, Malawi, Swaziland, and South Africa. This tool has since been adopted for use by World Vision International. In 2007, Dr Sibanda adapted the USAID Partner Institutional Viability Assessment (PIVA) tool to support institutional development of the FANRPAN node hosting institutions to examine organizational track record to identify areas for strengthening, and improvement indicators for organizational viability.

The Theatre for Policy Advocacy has drawn crowds ranging from 100 to 3000 people per event in over six countries. This tool has influenced major policies, including realigning agriculture markets to serve women farmers in Malawi and Mozambique, optimizing agriculture interventions to improve nutrition outcomes in Tanzania and Ethiopia, and adapting to climate change in Lesotho, Malawi.

## Achievement of Sustainable Food Systems

With over thirty years of transdisciplinary experience in agriculture, rural development, Dr. Sibanda has emerged as a prominent figure in shaping sustainable food systems globally. Her extensive tenure spanning various sectors, including academia, scientific research and international development, underscores her dedication to sustainable food systems globally. At FANRPAN, she led the first multi-country agriculture for nutrition study, a farm-to-fork approach to define what agriculture can do for nutrition.

The study helped academics appreciate that nutrition is a multi-sectoral issue cutting across agriculture, education, health, water and sanitation and behavioural sciences. This has helped cut the silos that have always pitted agriculturalists against nutrition scientists.

## Addressing Climate Change

Dr Sibanda has been a tireless champion of climate change issues, dedicating her career to advocating for sustainable climate-smart agricultural practices and policies. Since 2008, she has been at the forefront of global efforts to address the profound impacts of climate change on agriculture and food security. Through initiatives like the Global No Agriculture, No Deal campaign which she championed, Dr. Sibanda has raised awareness and mobilized action to prioritize agriculture in climate change negotiations. Her leadership as Co-Chair of the Global Alliance for Climate Smart Agriculture (GACSA), with a membership of over 200 global organisations and participation in the CGIAR Research Program on Climate Change, Agriculture, and Food Security (CCAFS) Independent Science Panel underscores her commitment to driving evidence-based solutions to mitigate climate risks in agriculture.

Dr Sibanda's African and global footprint in improving the farmer-science-policy interface has reached over 120 countries. This work has the potential to reduce poverty and increase incomes and food and nutrition security for nearly 250 million farmers globally.



The integrated farming system where the co-culture of rice and other aquatic organisms like fish, shrimp, prawns, crabs, and ducks are raised has been proposed as a new innovative technique to maximize the use of land and water resources to generate both grain and animal protein. Today, the impact of rice cultivation on the environment, including its effect on greenhouse gas emissions, is a matter of concern all over the world. Global climate change is closely linked to agricultural production. Two major greenhouse gases methane and nitrous oxide have been reported to enhance pollution in the environment. Methane emission depends on the anaerobic degradation of organic complexes such as plant residues, organic matter, and organic fertilizers under submerged conditions where there is a lack of oxygen. A total of 10-20 percent of methane in the atmosphere comes from paddy fields. This is significant as the Global Warming Potential (GWP) of methane is 25 times more than that of carbon dioxide.

It has been reported that the rice-fish cultivation system is capable of lowering the emission of methane and other greenhouse gases. It is well known that aquatic creatures especially bottom

**Rice yields from the rice-fish system were 10-26 percent higher, labour inputs 19-22 percent lower, and material inputs were seven percent lower.**

feeders (crabs and carp) disturb the soil layers by their movement or sometimes searching for food, and thus they influence the methane production processes. Potentially, aquatic creatures increase diluted oxygen in field water and in soil, which shifts anaerobic digestion to aerobic digestion and helps to reduce methane emissions. Recently, it has been estimated that methane emission from a rice-animal co-culture cultivation

**Economically Efficient**

As far as the economic aspects are concerned, this system of integrated farming indicates that its adoption has led to an increase in the economic efficiency of farmers. According to a report, in Ban-

gladesh, the net income return from rice cum fish with other animal co-culture was over 50 percent more than that from rice monoculture. Rice yields from the rice-fish system were 10-26 percent higher, labour inputs 19-22 percent lower, and material inputs were seven percent lower. Additionally, fish production increased net income.

Indonesian figures show that the rice-fish system yielded a 27 percent higher net return with fish, as compared to a single crop of rice. This method ties the aquaculture industry to the agricultural industry in a social way, which is not possible in the case of monoculture. A co-culture program provides a platform for farmers to find new ideas and share their knowledge and experience to develop the farming and aquaculture industries. With these benefits, farmers are willing to adopt the technology of co-culture as it improves their economic status and is encouraged to increase contacts among various stakeholders that provide or share useful skills and technical knowledge.

**Additional Benefits**

It has been reported that the integrated farming method of rice cum animal co-



culture system significantly enhances the production of paddy by 4% when compared to rice monoculture method. Similarly, in one of the studies it was noticed that in the rice cum animal co-culture system, an increase in the rice yield by 11% was noticed, followed by rice-duck culture yield at 7% and rice-fish culture at 5% only. The increase in the amount of rice yield in the different combinations of culture systems is due to animal waste and unutilized feed which act as organic fertilizers and provide nutrients for rice.

In addition to this predation and movement of animals largely eliminate weeds, pests, and pathogens in the paddy fields, as well as enhance the aeration and nutrient exchanges at the water-soil-atmosphere interface which in turn strengthens rice roots and closely associated mycorrhiza, thus promoting rice growth. In the rice monoculture system, there is no intervention of any animals, and pesticides and fertilizers are to be added from the external source therefore there is a limitation in producing the rice yield. It is a well-established fact that rice production is important for national and regional food security in many developing countries where rice is a main staple, which could be threatened by a decline in rice yield. Therefore, it is essential to maintain a balance between animal and rice production to ensure the rice cum animal co-culture system remains efficient overall.

**Awareness and Promotion of Paddy Co-animal Culture System**

It is necessary to create more awareness and promotion of this technology for adaptation, particularly for the poor and developing nations. Even for the sustainable intensification of agriculture all over the world, this technology is promising. Hence global promotion of such systems with multiple benefits for food security, poverty alleviation, and environmental sustainability, would contribute substantially for achieving progress toward the Global Sustainable Development Goals. Both for enhancing rice production and generating additional animal protein for

alleviating malnutrition in those nations that are very poor, this technology will be a boon. This would make a difference in these regions, which are traditionally prone to extreme famine and poverty.

**Constraints and issues in the implementation of technology**

In India, about 0.2 million ha of paddy fields are in operation under the rice co-animal culture system. However, there are several other regions where the use of this technology has been limited due to several factors like resource deficiency, lack and support of proper policies, and potential risks. The implementation of this system involves a complex interaction between co-culture species and requires in-depth knowledge and skill compared to operating of rice monoculture system. The selection of animals and rice species and the timing of introducing animals to the paddy fields are important factors for maintaining the complementary and beneficial interactions between rice plants and animals.

A second important factor is the risk of failure to maintain interspecies balance, which may result in yields becoming unreliable. Lack of knowledge and skills would lead to low motivation to take the risk of converting from conventional approaches. Even the farmers might have limited access to scarce resources including capital, labour, infrastructure, and market networks. The existing agriculture policy favouring intensive rice

monoculture can be also a barrier to the adoption of the rice co-culture system in many countries. Potential pollution risks also exist during the transformation of the rice field into a co-animal culture system, deriving from construction activities or overuse of agrochemicals. To advocate and propagate this technology at the global scale stakeholder-driven strategies are needed to reinforce collaboration between public and private sectors.

Policymakers should encourage the promotion of the rice co-animal culture system and corresponding organic products in public places providing public ecological benefits via subsidies and rebates and simultaneously controlling the overuse of agrochemicals and conserving the natural environment. Successful development of sustainable aquaculture and agriculture in general also requires improved infrastructure, the implementation of effective rules and regulations, and accessible market networks. The farmers could be encouraged to cooperate to share resources and exchange experiences.

Furthermore, the successful implementation of this technology at global levels requires further research to ensure the stability of the operation and output for agricultural sustainability. Further targeted studies, surveys, and pilot projects on this technology should be established outside of Asia, to generate reliable information and data and fill gaps in current geographical coverage.



# Developed India 2024

## MAKING AGRICULTURE READY

The ambitious vision of the Government of India 'Developed India- 2047' is not only being discussed across the country, but being worked upon on a mission mode to give it a concrete shape. In this line, the Central Government is focusing on the goal of achieving an average economic growth rate of more than 7 percent annually in the coming years. About 60 percent of the population in India is associated with agriculture, the backbone of the economy. In India, agriculture is carried out on 51 percent of the total land area. Food grains produced from Indian agriculture feed 17 percent of the world's total population. The development of agriculture leads to improvement in nutrition, improvement in global hunger index, increase in income and increase in employment. Perhaps this is the reason why agriculture is called the main key to economic and social development.

### Scientific Approach for Agriculture Development

As India approaches 100 years of its independence and moves towards achieving the goal of developed India 2047, experts believe that restructuring the agriculture sector will be important. For this, India's agro-food system needs to be transformed in the coming years. Padma Bhushan awardee Dr. R.S. Paroda, Founder President of Trust for Advancement of Agricultural Sciences (TAAS), said that India needs to adopt self-reliance and local-to-global approach to become 'developed', especially when the country will complete 100 years of its independence in 2047. He said, "New

India should focus on global markets, promote innovations in agricultural research, reduce imports of pulses, oilseeds and fertilizers and achieve the target of a 5 trillion dollar economy by 2027.

### ICAR's Developed India Resolution of 2047

To achieve the goal of Developed India in the agricultural sector by 2047, the Indian Council of Agricultural Research

**A total of 323 varieties of 56 crops including cereals, oilseeds, fodder crops and sugarcane were released during the year 2023-24.**



has started many new initiatives on its 96<sup>th</sup> Foundation Day. The Director General of the Council, Dr. Himanshu Pathak, directed all the scientists to work in this direction and said that by the time we celebrate the 100<sup>th</sup> Foundation Day of ICAR, we should prepare the foundation of Developed India in such a way that we do not face any problem in achieving the goal in the coming years. Dr. Pathak started many new initiatives during this time which is a strong foundation of Developed India in the agricultural sector.

### 100-day Action Plan

The Indian Council of Agricultural Research is working on a plan to develop 100 new seed varieties and 100 agricultural techniques within a time frame of 100 days to boost the agricultural sector of the country. This initiative is part of the government's 100 days action plan, which mainly focuses on climate-friendly and bio-fortified seed varieties apart from agricultural techniques. It is developing new seed varieties for various crops including rice, wheat and horticulture with its workforce of 5521 scientists across the country.

### About the AUTHORS

**Gulab Chaudhary, Suresh Chand Kantwa, Vikramjit Singh and Ashok Choudhary**  
Krishi Vigyan Kendra,  
Hanumangarh-II (Nohar),  
Rajasthan Veterinary and  
Animal Sciences University,  
Bikaner

### Union Agriculture Ministry's Developed India Resolution by 2047

In order to fulfill the ambitious concept of Developed India by 2047 of the Central Government, Shri Shivraj Singh Chauhan, Union Agriculture and Farmers Welfare Minister recently organized an interactive meeting related to collaborative research and technology commercialization between ICAR scientists and industry representatives and underlined the role of the agriculture sector in the sustainable development of the country. During this, the Agriculture Minister released forty selected technologies to encourage innovations in agriculture and recognized the efforts of the developers. A total of 323 varieties of 56 crops including cereals, oilseeds, fodder crops and sugarcane were released during the year 2023-24. These varieties include 27 bio-fortified varieties and 289 climate-resilient varieties for various biotic and abiotic stresses. Based on breeder seeds, bio-fortified varieties of various crops will be grown in about 16.0 million hectare area during the year 2023-24, which includes wheat (13.0 million hectare), rice (0.5 million hectare), millet (1.5 million hectare), lentil (0.50 million hectare) and mustard (1 million hectare). The use of climate-resilient technologies has increased production even during abnormal years. Variety improvement, one of the major mandates of ICAR, and farmers' access to quality seeds of improved varieties has consistently increased the productivity and quality of agricultural produce.



The Union Agriculture and Farmers Welfare Minister said that the development of 23 new equipment and machinery by ICAR is a major step towards mechanisation and modernization of agricultural practices. In his address, the Agriculture Minister said that ICAR has increased UG, PG and PhD seats by 10%. 9651 students were admitted in AUs across the country through centralized ICAR examination in UG, PG and PhD in 2023-24. During the ceremony, the Union Minister observed the technology exhibition and industry interface and praised it and said that we are moving fast to fulfill the dream of developed India in the agricultural sector.

The 100-day period will end in mid-September.

### One Scientist One Product Scheme

Indian Council of Agricultural Research is working on 'One Scientist-One Product' to improve research in the field of agriculture and animal husbandry. Scientists under ICAR are working on the goal of bringing one product, one technology, one model, one concept or one good publication.

### Oilseeds and Pulses Seed Hub

'Seed Hubs' are being established in ICAR institutes and Krishi Vigyan Kendras. Under this scheme, oilseeds hubs are being expanded in 174 districts

and Adarsh Gram Hubs for pulses seeds are being created in 130 districts.

### Long Term Action Plan

In the long term, ICAR has outlined a five-year strategy to work on new products and technologies. Progress is being monitored at both institutional and headquarters levels, so that continuous attention can be given to agricultural innovation and development.

### Vision of Developed India in Agriculture in General Budget 2024-25

Efforts to conceptualize and realize the concept of Developed India of 2047 in the agriculture sector are also clearly visible in the General Budget 2024-25. The interim Union Budget for 2024-25 presented by Union Finance Minister Nirmala Sitharaman is a reflection of this. The budget focuses on empowering farmers, women, youth and the poor

Large scale vegetable production centres will be developed near major consumer centres. Financial provisions have been made in the budget to establish a network of nucleus breeding centres for shrimp broodstock. Overall, if we look at the budgetary provisions, it is clear that in the year 2023-24, the budget for agriculture was Rs 1.25 lakh crore, which has been increased to Rs 1.52 lakh crore this time. This will not only accelerate the all-round development of the agriculture sector but will also strengthen the concept of Developed India 2047 in the agriculture sector.

It also proposes several initiatives aimed at developing a more robust and sustainable agricultural ecosystem, which is a great start to strengthen the foundation of developed India. A provision of Rs 1.52 lakh crore has been made for agriculture and related sectors in the Union Budget 2024-25. Digital crop survey of Kharif crops will be conducted in 400 districts using digital public infrastructure. A strategy is being prepared to achieve 'self-reliance' in oilseeds.

**The Indian Council of Agricultural Research is working on a plan to develop 100 new seed varieties and 100 agricultural techniques within a time frame of 100 days to boost the agricultural sector of the country.**



# GREEN CREDIT PROGRAM REWARDING VOLUNTARY GREEN INITIATIVES



The Green Credit Program (GCP), a novel market-based mechanism, is intended to encourage individuals, communities, and private sector businesses, to take up eco-friendly activities that improves environment like afforestation. The Green Credit Program (GCP), presented by MoEFCC, Ministry of Environment, Forest and Climate Change in India, aims to implement environmental and forestry policies and programs.

## Programme Specifics

The GCP encourages environmentally friendly practices rooted in tradition and conservation, aligning with the 'LiFE' (Lifestyle for Environment) concept. The Green Credit Rules, 2023, were notified on October 12, 2023, under the Environ-

The GCP encourages environmentally friendly practices rooted in tradition and conservation, aligning with the 'LiFE' (Lifestyle for Environment) concept.

## About the AUTHOR

Ms. Sakshi Paritosh,  
Manager,  
SBIRD Hyderabad

ment Protection Act 1986. These rules set up a component to encourage environmental activities taken up voluntarily leading to issuance of green credits.

An inter-ministerial Steering Committee oversees the GCP. Program implementation, Monitoring and operations of the program is responsibility of The Indian Council of Forestry Research and Education (ICFRE). The initial focus Areas would be Water conservation and Afforestation

## User-Friendly Digital Platform

Individuals and entities register their activities through the central government's dedicated app/website (moefcc-gcp.in). Designated agencies do the verification process, and for small projects self-verification is done. Once verified, stakeholders receive tradable Green Credit

certificates.

## Ecomark Scheme

The program provides accreditation and labelling for environmentally-friendly household and commercial products through the Eco mark Scheme. As part of the "LiFE" initiative that the Prime Minister announced at the United Nations Climate Change Conference of the Parties (COP26), it is intended to encourage a sustainable lifestyle and environmental conservation.

## Implementation Illustration

With this background we have Rajesh Patel, at the heart of this story. Rajesh is a young architect disillusioned by the monotonous sea of grey that defined Mumbai's skyline. Rajesh had grown up amidst lush green fields, but now the city had surrounded him with its chaos and opportunity. However, the lack of open space bothered him.

One crisp morning, as Rajesh sipped his chai in a local café, he noticed a flyer about the Green Credit Program pinned to a noticeboard. Intrigued, he read about the government's plan to allocate credits to developers who incorporated green elements into their projects – from rooftop gardens to vertical forests. Inspired, Rajesh saw an opportunity to blend his passion for architecture with his desire to bring greenery back into the urban fabric.

He approached his friend Dev, an environmental scientist, and together they formed a small team dedicated to designing sustainable buildings. Rajesh and Dev proposed a design that included not just token green spaces but an integrated approach where every floor had gardens, solar panels adorned the rooftops, and rainwater harvesting systems were discreetly woven into the building's infrastructure. Their breakthrough came when a prominent developer agreed to collaborate on a high-rise residential project in the heart of Mumbai. The project faced its share of challenges. However, Rajesh's unwavering passion and Dev's scientific rigor kept them going.

## The Green Credit program includes eight vital activities aimed towards improving ecological balance:

- **Plantation of trees:** planting trees to combat deforestation and create more green space.
- **Management of Water:** putting strategies into action to effectively control and conserve water resources.
- **Sustainable Farming:** promoting environmentally friendly and long-lasting farming methods.
- **Management of waste:** Putting in place efficient systems for managing waste to cut down on pollution in the environment.
- **Reduction of Air Pollution:** Initiatives aimed at improving air quality and reduce air pollution.
- **Conservation and Restoration of Mangroves:** Restoring and protecting mangrove ecosystems for the sake of ecological harmony.
- **Aligned India's policies on the environment:** The Environment Protection Act of 1986 and the National Environment Policy of 2006, two of India's environmental policies, provide a framework for environmental protection and enhancement. These approaches, close by the GCP, plan to protect woodlands, untamed life, and the general indigenous habitat.
- **Aligned with India's Climate Goals:** India's efforts to adhere to international commitments, such as those made at COP 26, include the GCP.
- It broadens the scope of tradable credits beyond CO2 reductions to include a variety of sustainable practices, complementing the Carbon Credit Trading Scheme established by the Energy Conservation (Amendment) Act, 2022.
- **In sync with global efforts to restore ecosystems:** The GCP lines up with the UN Ten years on Environment Reclamation (2021-2030), which accentuates the increasing of rebuilding endeavors.
- In this regard, India's strategy involves involving all stakeholders in the restoration process and using traditional conservation and knowledge practices.

By adopting eco-friendly practices, industries can earn Green Credits, contributing to their corporate social responsibility (CSR) goals.

Months turned into years as construction began, and the building gradually rose into the skyline, a testament to sustainable urban development. As the project neared completion, Rajesh & Dev, had sparked a movement. More developers started embracing the Green Credit Program, encouraged by the success of Rajesh's project. The impact

was not just aesthetic but benefits of GCP were evident also.

## Improved Air Quality:

By promoting the incorporation of green elements such as gardens and vertical forests, the program significantly improved air quality in urban areas, reducing pollution levels and enhancing the overall health of residents.

## Enhanced Urban Aesthetics:

The introduction of green spaces transformed the visual landscape of cities, making them more aesthetically pleasing and creating a sense of well-being among residents.

## Energy Efficiency:

Buildings equipped with solar panels and green roofs reduced energy consumption, contributing to lower carbon



footprints and decreased reliance on non-renewable energy sources.

**Increased Property Values:**

Properties that embraced green features became more attractive to buyers and tenants, leading to higher property values and better returns on investment for developers.

**Community Engagement:**

Green spaces such as parks and community gardens fostered community interaction and engagement, creating cohesive neighbourhoods, and improving overall quality of life.

**Water Conservation:**

Rainwater harvesting systems implemented in buildings helped conserve water resources, mitigating the impact of water scarcity in urban areas.

**Health Benefits:**

Access to green spaces promoted physical activity and mental well-being among residents, reducing stress levels and enhancing overall quality of life.

**Economic Growth:**

The program stimulated economic growth by creating new opportunities in green industries such as renewable energy, landscaping, and urban agriculture.

Neighbourhoods once dominated by concrete skyscrapers, began to sprout with rooftop gardens, vertical farms, and community parks. The Green Credit Program had transformed lives.

**Way Forward**

Through these multifaceted benefits, the Green Credit Program in India is promising yet requires strategic enhancements to achieve its full potential in promoting sustainable practices across industries.

**Scaling Up:** Scaling up the program to cover more sectors and activities like waste management, renewable energy, and biodiversity conservation will enhance its impact

**Private Sector Engagement:** En-



couraging private companies to participate actively in the GCP is crucial. By adopting eco-friendly practices, industries can earn Green Credits, contributing to their corporate social responsibility (CSR) goals.

**Innovation and Technology:** Leveraging technology like Blockchain-based platforms for monitoring, verification, and trading of Green Credits could enhance transparency and trust in credit transactions.

**Awareness and Education:** Public awareness schools, colleges and community organizations can educate citizens about the GCP's benefits and encourage individual participation.

**Incentivizing Communities:** Empowering local communities to engage in environmental activities like Community-led projects, especially in rural areas, can contribute significantly to the GCP.

**Policy Support:** Continued government support through policy frameworks,

incentives, and regulatory mechanisms will be crucial. Regular reviews and updates of the GCP guidelines will ensure its effectiveness.

**Global Collaboration:** Learning from successful international models and collaborating with other countries on environmental credit programs can enrich India's approach. In conclusion, the future of the Green Credit Program in India hinges on proactive measures to enhance integration with ESG (Environmental, Social & Governance) frameworks, expand eligibility criteria, promote technological innovation, strengthen monitoring and compliance mechanisms, foster collaboration among stakeholders, and ensure policy continuity and adaptability. By addressing these areas strategically, India can accelerate its transition towards a more sustainable industrial landscape while fostering economic growth and environmental stewardship.

# SHAKTIMAN: PIONEERING SOLUTIONS FOR SUPERIOR HANDLING OF SILAGE MATERIALS WITH SSBM 850 E & SSBM 600

Shaktiman leads the way in agricultural innovation with advanced machines and solutions that revolutionize the conservation and handling of agricultural materials. Our commitment to core values—Integrity, Quality, Innovation, Commitment, and Customer Care—drives every facet of our company. The Shaktiman Silage Baler SSBM 850 E and SSBM 600 demonstrate our dedication to minimizing global food losses, particularly by addressing post-harvest challenges.

Unlike traditional balers, the Shaktiman Silage Baler SSBM 850 E and SSBM 600 employ a unique high-density compaction concept. This cutting-edge technology significantly reduces oxygen exposure, thereby preventing forage degradation and preserving nutritional value. By ensuring that oxygen is effectively restricted, these balers maintain the quality of your high-density forage during extended storage periods, ultimately enhancing profitability and sustainability in your production process.

**UNLOCKING THE ADVANTAGES OF SHAKTIMAN SILAGE BALE MASTER 850 E & 600**

In addition to improving forage quality, Shaktiman Silage Bale Master 850 E & 600 models offer several key advantages:

- **Enhanced Storage:** Shaktiman High-Density Bales can be stored for extended periods, providing greater flexibility in storage locations.
- **Optimized Forage Handling:** The reduced volume of high-density bales simplifies logistics, making transportation more cost-effective while minimizing potential feed loss.
- **Efficient Stacking:** Densifying your bulk material into sturdy, easy-to-stack unit packages allows for effi-



cient use of storage space. The bale density permits stacking of bales, significantly saving storage space.

- **Streamlined Handling:** The inner wide film and the outer wrapping film are made from identical plastic materials, simplifying recycling and waste management after the bale is opened.
- **Quality :** The SSBM 850 E and SSBM 600—Engineered for peak performance and durability. Our meticulous quality standards ensure these machines deliver extended longevity and reduced operational costs.
- **The Shaktiman Silage Baler proudly holds ICT and CE certifications,** reflecting its adherence to international quality and safety standards. These certifications ensure that the baler meets rigorous performance, safety, and environmental requirements, providing reliable and compliant solutions for modern agricultural needs.
- **Auto Lubrication System for Bale Chamber** - The Shaktiman Silage Baler features an Auto Lubrication Chamber for the bale chamber, ensuring continuous, hassle-free maintenance. This advanced system minimizes downtime and enhances machine efficiency by providing consistent lubrication, thereby pro-

longing the life of the baler and ensuring smooth operation.

- **High Productivity** - The Shaktiman Silage Baler is designed to maximize productivity, delivering a high volume of bales in a shorter season. Its efficient engineering ensures optimal performance, making it the ideal choice for boosting productivity.
- **Hydraulically Operated Telescopic Drawbar** - Offers superior manoeuvrability and ease of operation.
- **Less Power Consumption** - The Shaktiman Silage Baler is designed for efficiency with separate motors for each function, significantly reducing overall power consumption. This targeted approach ensures that energy is used only where needed, leading to lower operational costs and improved sustainability.
- **Safety** - wrapping unit is equipped with safety provisions to ensure secure operation. These features are designed to protect operators by preventing accidental contact and ensuring safe, reliable performance during the wrapping process.

Shaktiman's commitment to innovation and quality continues to drive our mission to deliver superior solutions for agricultural and industrial material handling, ensuring that your investment yields the highest returns.



# TRADITIONAL KNOWLEDGE FOR RESILIENT AGRICULTURE IN NORTHEAST INDIA

Climate change presents global challenges by affecting food security, human health, water availability, and socioeconomic development, potentially decreasing crop yields by 3-7 percent as temperatures rise. This could result in a higher likelihood of hunger and undernourishment for 86 percent small and marginal farmers in India. The importance of Indigenous Knowledge is its relevance to contemporary issues, including food insecurity, biodiversity loss, and climate change.

## Indigenous Practices

Indigenous knowledge system offers valuable insights and provides innovative solutions in the agricultural sector that optimize productivity and resilience while simultaneously reducing environmental impact.

- Shifting cultivation (Jhum) is a complex, multi-cropping, agricultural system that is well-adapted to certain conditions, environmental limitations of the tropics and poses significant challenges. Indigenous farmers in the Northeast engage in forest clearing, burning, and crop planting, contributing to the in-situ conservation of crop genetic resources and agrobiodiversity through forest regeneration. The practice ensures food security for the communities, facilitates high genetic diversity which is identified as a key element in adaptation strategies to climate change.
- Panikheti system of paddy cultivation helps to divert water from hills to terraces for judicious farming.

- In Zabo farming system of Nagaland, paddy husk is used to plug the earthen bunds of the crop fields to reduce seepage loss.
- Integrated Rice-fish farming system of Apatani plateau protects soil erosion, conserve water for irrigation and paddy-cum-fish culture. This farming is an eco-friendly, and required low inputs.
- Alder based agriculture crops are cultivated alongside alder trees as intercrops in an agroforestry system. This practice is highly profitable as it converts wasteland into agricultural land.
- In Rotating cowsheds with vegetable fields, urine, bovine dung, litter, and other materials are promptly mixed with the soil to accelerate decomposition, enhancing fertility management, followed by immediate ploughing.
- Traditional fishing with piscicidal

plant is employed to harvest fish making it biodegradable and maintains healthy food chain.

## Institutional Support

Recognizing the importance of local institutions and implementing strategies to strengthen their capacity will be crucial for maintaining or adopting diversity-rich approaches. These institutions, which include local seed supply systems, community networks and local social organizations of various kinds, play a significant part in providing the framework in which local communities organize and manage local production strategies in ways that support the use of agricultural biodiversity. The Dong Bundhs System is a gravity-based seasonal river channelization system that is community-led and primordial indigenous engineering knowledge. This system guarantees water security within the community, ensuring judicious distribution and preventing water wastage through traditional practices. Pakho Khet, Bun System of Cultivation, and the Bamboo Drip Irrigation System prevent soil erosion, conserve water and soil moisture, enrich soil fertility and preserves natural resources.



## About the AUTHOR

**Dr Dipankar Saharia,**  
Senior Director,  
Social Transformation  
and Strategic Alliance,  
The Energy and  
Resources Institute  
(TERI)

## Rooted in Culture

Indigenous agriculture system has deep rooted impact on the cultural attributes of the indigenous communities. Agricultural land is where people prized and cherished application of indigenous knowledge. The rituals related to agriculture are mainly associated with: work related rituals, seed sowing ritual, better germination ritual, pre-harvest rituals-protection from curse, worship for pest control, purification ritual, harvest rituals, storage ritual, etc. Moreover, people employed in agricultural practices function as symbolic representations of culture and tradition, while food items and cuisines hold significant cultural value.

Traditional clothing and performances at harvest festivals act as living history lessons. Songs, stories, and attire all come together to celebrate the agricultural past, strengthening cultural traditions and fostering a sense of community.

## A Balancing Act

Traditional agricultural systems are endangered by modern farming techniques that prioritize grain production over environmental health. These indigenous methods flourished with lower population densities but now struggle in areas like the NER, where increasing population have caused rapid deforestation and unsustainable practices. This has significantly shortened fallow periods, decreased crop yields, and deteriorated soil quality. Intensive cultivation further impedes soil resilience. Proper management and conservation of soil, water, plants, and animals are crucial to sustaining a healthy environment and preventing further degradation of natural resources in the region.

The assessment of potential management strategies under REDD+ suggests that sparing old-growth forests from conversion into shifting cultivation by intensifying cropping in a smaller area is the most optimal strategy for protecting landscape carbon. Maintaining a longer fallow cycle, for instance at a 15-year cultivation cycle can also sequester

considerable levels of carbon compared to landscapes with short fallow cycles.

The indigenous farmers of Northeast India possess a diverse knowledge for water conservation, pest and disease management, soil fertility management, organic farming, incorporation of fish and animal components, and forestry. Incorporating Indigenous Agricultural Knowledge (IAK) can enhance scientific data, significantly impacting climate adaptation and mitigation efforts. One such is the Phumdis and Ataphums of Manipur, Loktak Lake, Manipur. Phumdis are natural floating mats composed of decomposed vegetation, soil, and organic matter which provide unique habitats for diverse flora and fauna. Local communities have created Ataphums, which are artificial floating gardens, by piling layers of vegetation and soil on interconnected bamboo frames. Both these elements capture carbon, clean the air, hold soil, store water, and nurture crops, safeguarding wildlife homes.

A study on mainstreaming community conserved areas for biodiversity conservation in Nagaland was successfully implemented by TERI supported by GEF. The work explored solutions involving village communities as well as rejuvenating traditional conservation practices. The outcome of the intervention showed a significant rise in the safeguarding of natural resources following the establishment of collaboratively managed Community Conservation Areas (CCAs), as well as an enhancement in the governance of shared resources.

**It is important to note that while indigenous traditional knowledge exists in the Northeast region, its documentation is not a priority among the local communities.**

## Raising Awareness

It is important to note that while indigenous traditional knowledge exists in the Northeast region, its documentation is not a priority among the local communities. Promptly recording and educating younger generations about the importance of Indigenous Agricultural Knowledge (IAK) alongside modern agricultural practices is crucial. This documentation serves to conserve and ensure continuity for future generations.

Optimizing investments in indigenous research capability can enhance adaptability, vegetation surveillance, resource conservation technologies, variety development, and land use management. Policies can effectively encourage resource conservation by providing incentives, enhancing resource use efficiency, setting appropriate resource prices, offering credit for adopting adaptation technologies such as investing in water management infrastructure and increasing farm insurance coverage, improving communication about climate changes and available adaptation strategies, developing alternative livelihood options, and reducing agricultural subsidies.

As affirmed by the UN on the Rights of Indigenous Peoples, indigenous peoples are entitled to their territories, resources, and participation in relevant decision-making processes, including FPIC for related laws and initiatives. Despite the efforts of indigenous communities and their organizations, effective participation in discussions regarding climate change mitigation schemes such as REDD has been denied. Furthermore, their rights to forest products, intellectual property, territories, and resources remain disregarded. Traditional wisdom of northeast India can build a resilient and sustainable agriculture landscape that sustain its rich heritage while supporting livelihood, ensuring food security, judicious uses of natural resources despite extreme climate like flood, cyclones and drought.



# TECH FARMING: A PATHWAY TO INDIAN FARMERS' REVIVAL

## Agriculture – A Lifeline of Indian Farmers

Agriculture is the foundation of rural India and is the backbone of the Indian economy. The bitter truth is that farm profitability is declining due to various socioeconomic factors, leading even to farmer suicides throughout the country. A lack of timely and accurate crop diagnostics and input management leads to crop failures, and the inability of farmers to pay back loans they borrow for raising crops. At the same time, in the run for profit, we've lost our concern for Mother Nature. Farming done out of need is now being exploited beyond sustainable recovery. We are struggling to address emerging challenges such as climate change and gambling of monsoons, the resurgence of pest populations due to injudicious use of chemical products, loss of the fertility and productivity of the land & whatnot.

Recognizing the damage caused by the commercialization of agriculture, we are now witnessing a shift towards more sustainable practices. Techniques like green agriculture, organic farming, precision agriculture, smart farming and digital agriculture are gaining traction. This shift is not just a trend, but a necessity for the survival of our farmers and our environment.

### Need for Digitalization in India

With the depletion of land resources and an immediate need to absolve food scarcity issues, people's attention shifted towards environmental conservation through optimal and minimal utilization of farm inputs, without compromising its productivity. This paved the way for the blooming of digitalization in agriculture, serving as the master key to existing issues in agriculture. Digitalization is a broad



umbrella term that encompasses several cutting-edge digital technologies like Sensors, Unmanned Aerial Vehicles (UAE), Artificial Intelligence (AI) automation and robotics, Deep Learning (DL), Machine Learning (ML), Internet of Things (IOTs), Big data analytics and Blockchain.

### Transition from Tedious to Tech-oriented

Few of the simple yet successful digital technologies that can be well-adapted to Indian Agriculture are:

- A sensor in irrigation pump sends a message to the farmer's mobile phone through radio signals, instructing him/her to initiate irrigation. Once the

farmer presses a specific button on his/her mobile phone, the pump will automatically start irrigating the field. On reaching optimum soil moisture condition, the sensor sends a warning message to the farmer's mobile instructing him/her to turn off the water flow. Thus, irrigation operations can be carried at a distance with simple & accessible technology.

- Farmers can get access to weather data for the next 5 days with the help of their own mobile, by installing "Kisan Suvidha" app.
- UAV/Drones can be exploited to monitor crops. Farmers can deploy drones for continuous and real-time monitoring of pests attack and application of fertilizers, pesticides and herbicides rather than depending on laborers.
- Agrochemicals can be sprayed effectively based on the need that can be detected by sensors, so that farmers can reduce their input cost.
- Tractors with GPS navigation are em-

ployed to apply inputs precisely based on the land records. Even now, driverless tractors are gaining momentum, where land preparation and other such operations can be done precisely, thus, saving substantial labor costs.

- Digitalization of Agriculture does not stop with the production aspects; rather, it extends to strengthening market linkage. Substantial growth in the E-Commerce sector provides farmers with direct access to consumers, thus eliminating the participation of middlemen. For instance, "e-nam" is a platform where farmers can list their produce and obtain transparent prices from different traders available on the platform.

### Benefits of Digitalization

Implementing DA technologies helps farmers achieve sustainable food goals, minimize their cost of cultivation, make timely decisions and acquire better access to knowledge of markets in the following ways:

- Blockchain technology enables record and verification of the whole history of a product, from its point of origin to the point of sale.
- Blockchain technology also eases certain processes, such as agricultural insurance, smart farming, the food supply chain and transactions of agricultural products.
- AI uses ML and DL algorithms to detect weeds, predict yield and identify plant diseases.
- Analysis of big data helps farmers uncover seed characteristics, weather patterns, inventory management, market trends & customer preferences.
- Use of electric tractors and robots for agricultural operations render less or no emission of gases, as they run on renewable energy source.
- Data obtained from remote sensing forecasts can be utilized to analyze the impacts of undesirable weather and pathogenicity of diseases on crop productivity, determine nutritional requirements of plants, nutrient content in soil, plant water demands and the

**Substantial growth in the E-Commerce sector provides farmers with direct access to consumers, thus eliminating the participation of middlemen.**

need for weed control.

### Obstacles in Embracing Tech Farming

"Every possible invention put forth into the market bears its equal range of problems". Thus, implementing digitalization in agriculture poses certain problems, which include:

- Lack of data collection efficiency due to land fragmentation. For instance, the average land holding of a farmer in India is 3.025 acres, which is not economically suitable for adopting digitalization whereas the average land holding of a farmer in US is 464 acres
- Lack of awareness on farm digitalization to small landholders
- Limited access to infrastructure and technology regarding internet connectivity and electricity in remote rural areas
- It is hard to convince farmers to leave their traditional practices of agriculture, as they are reluctant to change and are risk averted
- Crop diversity of India and lack of crop-specific digitized solutions
- Lack of support services for maintenance and troubleshooting of farm digitalization equipment
- Lack of extension services
- Lack of scalability
- It may take several years before the actual collection of sufficient data to implement the system fully
- Land ownership restrictions – According to the 10th agricultural census (2015-16), small and marginal farmers with less than 2 hectares of land account for 86.2% of all farmers in India but own just 47.3% of the crop area

- High initial investments
- Complexity of the technologies involved
- Lack of adequate support systems for technology development and implementation
- Farmers are not well educated and trained in handling the equipment used in farm digitalization

### "Farm to Fork" made easy!

Most problems can be solved by human ingenuity. Likewise, issues associated with e-agriculture could be settled by the coordinated efforts of Research, Extension & Policy measures. Combined endeavors of private and public sectors and individuals as a whole, help fix the bottlenecks of digital agriculture. Following are some of the proposed solutions, which are expected to create outstanding results when put forth into action.

- Skill-oriented training in vernacular languages to Farmers on technologies that can be adopted at their farm level
- Incentivizing banks to lend credit loans to digital entrepreneurs as well as adopters at minimal interest
- Enabling of subsidies from Government for purchase of high end equipments
- Enactment of a separate department for digital technology development and adoption
- On-farm testing and demonstration of pilot projects
- Development of local and site-specific technologies
- In-depth research on land use patterns and planning, to transform potential wastelands into cultivable arable lands
- Development of technologies that are crop agnostic, adaptable for a wide range of crops, focusing on sustainability rather than livelihood
- Provoking farmers to access open-source technologies of Indian origin including apps and websites like Agri Central, Agri app, Madras Mandi & TNAU Agri Portal for precise crop diagnosis, smart farming & e-marketing of their produce

### About the AUTHORS

**Durga. B Indra Priyanga S.R.  
Lakshmi Priya. M Sarath  
Sennimalai, Muthukumar  
Bagavathiannan**



# Melatonin

## *A Natural Ally in Reducing Salinity Stress in Plants*

**S**alinity stress, is a significant challenge facing agricultural productivity worldwide. It is characterized by high levels of salt in soil or water and results in oxidative damage (the excess levels of reactive oxygen species, ROS), osmotic stress and ion toxicity (Parihar et al., 2015), poses a significant threat to plant growth and development, leading to reduced yields and economic losses for farmers. Therefore, salinity disturbs ions uptake, photosynthesis, ROS homeostasis, and the integrity of the cell membrane. Plant respond to salinity stress by a wide of molecular, physiological, and biochemical mechanisms, which are at the whole-plant and cellular levels (Isayenkov and Maathuis, 2019). However, emerging research suggests that melatonin, a hormone found in plants and animals, may hold the key to mitigating the detrimental effects of salinity stress on plants.

Melatonin, primarily known for its role in regulating sleep-wake cycles in animals, has garnered increasing attention for its multifaceted functions in plants. Melatonin (N-acetyl-5-methoxytryptamine) is an auxin-like compound that has widely been identified in various plant species (Debnath et al., 2019). Beyond its traditional role as a signaling molecule in circadian rhythms, it also involved in regulating various physiological processes, including growth, development, and stress responses. In particular, melatonin has been shown to exhibit remarkable antioxidant properties, scavenging reactive oxygen



**Under salinity stress, plants experience osmotic stress, ion toxicity, and oxidative stress, which can impede growth and development.**

### About the AUTHORS

**Shweta and Ashish Kumar  
Chaudhary Charan Singh  
Haryana Agricultural  
University, Hisar**

species (ROS) harmful byproducts of cellular metabolism that accumulate under stress conditions, including salinity stress. This ability makes melatonin an attractive candidate for alleviating salinity stress in plants.

### Melatonin Biosynthesis and Regulation

Melatonin, a tryptophan derivative, was first discovered in the plant in 1995 (Li et al., 2019; Zhang et al., 2015). It is synthesized from tryptophan through a series of enzymatic reactions involving tryptophan decarboxylase (TDC), tryptamine 5-hydroxylase (T5H), and serotonin N-acetyltransferase (SNAT). The biosynthesis of melatonin in plants is regulated by various factors, including

environmental cues such as light, temperature, and salinity stress. Under salinity stress conditions, the expression of genes involved in melatonin biosynthesis is upregulated, leading to increased melatonin production in plants.

### Role of Melatonin in Alleviating Salinity Stress

Under salinity stress, plants experience osmotic stress, ion toxicity, and oxidative stress, which can impede growth and development. Melatonin alleviates salinity stress through multiple mechanisms:

#### ROS Scavenging

Melatonin acts as a potent antioxidant in plants, scavenging ROS, including superoxide radicals, hydrogen peroxide, and hydroxyl radicals, thereby reducing oxidative damage to cellular structures and macromolecules, caused by salinity stress. It enhances the activity of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and peroxidase (POD) as well as non-enzymatic antioxidants like glutathione and ascorbate, which detoxify ROS and protect plants from oxidative stress.

#### Ion Homeostasis

Melatonin exerts its protective effects against salinity stress is through the regulation of ion transporters and channels in plant cells. Salinity stress disrupts ion balance within plant tissues, leading to ion toxicity and water imbalance which cause cellular damage and growth inhibition in plants. Melatonin helps maintain ion homeostasis by regulating the activity of ion transport proteins, such as ion channels and pumps. The influx and efflux of ions such as sodium (Na<sup>+</sup>) and potassium (K<sup>+</sup>) in plant cells by melatonin, helping to maintain ion homeostasis and prevent cellular damage under salinity stress conditions.

#### Osmotic Adjustment

Melatonin promotes the accumulation of compatible solutes (osmoprotectants), such as proline, glycine betaine, and sugars. These osmoprotectants help

**The application of exogenous melatonin has been shown to alleviate the negative effects of salinity stress on plants and improve their growth and productivity.**

plants maintain cellular turgor pressure and osmotic balance under saline conditions. It protect proteins and membranes from damage under salinity stress conditions. Thereby minimizing the adverse effects of salinity stress on plant growth and development.

Apart from its antioxidant properties, melatonin has been reported to modulate the expression of stress-related genes, regulate stomatal closure, and enhance the activity of antioxidant enzymes. These actions collectively help plants cope with salinity stress and maintain physiological homeostasis. Furthermore, melatonin has been shown to interact with other signaling molecules, such as abscisic acid (ABA) and cytokinins, which play crucial roles in plant stress responses. This crosstalk between melatonin and other signaling molecules may enhance the plant's ability to withstand salinity stress and adapt to changing environmental conditions.

### Application of Melatonin in Agriculture

The application of exogenous melatonin has been shown to alleviate the negative effects of salinity stress on plants and improve their growth and productivity. Several studies have investigated the role of melatonin in mitigating salinity stress in various plant species (Gao et al., 2019; Li et al., 2019; Zhang et al., 2015). For example, in wheat (*Triticum aestivum*), exogenous application of melatonin has been shown to enhance salt tolerance by reducing oxidative damage and maintaining ion homeostasis. Similarly, in rice (*Oryza sativa*), melatonin treatment has been found to improve seed germination and seedling growth under

saline conditions.

Several studies have demonstrated that melatonin-treated plants exhibit enhanced photosynthetic rates, increased chlorophyll content, and improved water use efficiency compared to untreated plants under salt stress conditions. Furthermore, melatonin has been found to enhance the yield and quality of crops grown in saline-affected soils, making it a promising tool for sustainable agriculture in salinity-affected regions.

Moreover, melatonin has been reported to promote the accumulation of osmoprotectants, such as proline and soluble sugars, which help plants cope with osmotic stress induced by high salt concentrations. By bolstering photosynthetic activity and osmotic adjustment mechanisms, melatonin enables plants to maintain optimal physiological functions even under salinity stress conditions.

Furthermore, the application of melatonin in agriculture offers a sustainable and eco-friendly approach to mitigate salinity stress in crops. Unlike chemical-based interventions, melatonin is a naturally occurring compound with low toxicity and minimal environmental impact. Its compatibility with existing agricultural practices makes it a promising candidate for incorporation into crop management strategies aimed at enhancing resilience to salinity stress.

### Way Forward

Melatonin is a natural compound with great potential to alleviate salinity stress in plants. Its ability to scavenge ROS, regulate gene expression, and modulate signaling pathways makes it a valuable tool for enhancing plant tolerance to salinity stress. Further research is needed to elucidate the specific mechanisms of action of melatonin and optimize its application in agricultural practices. However, the current evidence suggests that melatonin has the potential to revolutionize salinity stress management in crops, offering a sustainable and eco-friendly approach to improve crop productivity in saline-affected areas.



# MILLETS CULTIVATION WITH SAGUNA REGENERATIVE TECHNIQUE (SRT): A SUSTAINABLE REVOLUTION IN AGRICULTURE

**M**illets, often referred to as “coarse grains,” have been the cornerstone of traditional agriculture in India for centuries.

These resilient crops, including Finger millet (Ragi), Foxtail millet, Little millet, Pearl millet (Bajra), Proso millet, and Sorghum (Jowar), are known for their ability to thrive in harsh conditions, requiring minimal water and input. However, despite their benefits, traditional cultivation practices often lead to challenges such as soil erosion, labour intensity, and dependency on tillage machinery. The Saguna Regenerative Technique (SRT), a groundbreaking method developed to address these very issues, has emerged as a game-changer in the cultivation of millets, offering a sustainable alternative that not only preserves soil health but also enhances productivity and nutritional density.

## The Significance of Millets in Indian Agriculture

Millets are an integral part of India's agricultural heritage, especially in semi-arid regions. They are highly nutritious, rich in fiber, and have a low glycemic index, making them a vital component of the diet in many rural communities. Millets are also environmentally resilient, requiring less water and fewer inputs compared to other staple crops like rice and wheat. Despite these advantages, millet cultivation has been declining due to the shift towards more commercial crops, which are often promoted by government policies and subsidies.

However, the recent resurgence of interest in millets, driven by their nutritional benefits and climate resilience,



One of the most significant advantages of SRT is its ability to preserve and enhance soil health.



### About the AUTHORS

Chandrashekhar Bhadsavle,  
Parshuram Agivale, Anil  
Nivalkar  
Saguna Rural Foundation

has renewed focus on their cultivation. The challenge, however, lies in modernizing traditional millet farming practices to make them more sustainable and less labour-intensive while increasing yields.

## The Challenges of Traditional Millet Cultivation

Traditional millet cultivation, while deeply rooted in the agricultural practices of many regions, comes with its own set of challenges. These include:

**Soil Erosion:** Millets are often grown on marginal lands with minimal vegetation cover. This exposes the soil to wind and water erosion, leading to significant soil degradation over time. In many cases, this has necessitated shifting cultivation practices, which further exacerbate soil erosion and deforestation.

**Labor and Tillage Dependency:** Traditional methods of millet cultivation are labor-intensive, requiring significant human effort for land preparation, sowing, and weeding. Additionally, these

methods often rely heavily on tillage machinery, which can be expensive and may contribute to further soil degradation through repeated plowing.

**Low Yields and Fertilizer Dependence:** While millets are hardy crops, traditional farming practices often result in lower yields. Farmers, in an attempt to increase productivity, may resort to using chemical fertilizers, which can lead to soil nutrient depletion and environmental pollution over time.

## Saguna Regenerative Technique: A Sustainable Solution

The Saguna Regenerative Technique (SRT) was initially developed for rice cultivation to eliminate the need for plowing, puddling, and transplanting, thus saving labor and reducing dependency on tillage machinery. Recognizing its potential, SRT has since been adapted for other crops, including millets, offering a comprehensive solution to the challenges of traditional millet farming.

## Key Benefits of SRT in Millet Cultivation

**Soil Health Preservation:** One of the most significant advantages of SRT is its ability to preserve and enhance soil health. The technique involves minimal soil disturbance, reducing the risk of erosion and maintaining the soil's organic matter content. This is particularly crucial in millet cultivation, where soil erosion has historically been a major issue.

**Labor and Machinery Savings:** The technique involves planting crops in raised beds with permanent furrows, which allows for efficient water management and weed control. This system significantly reduces the amount of labor required for land preparation and weeding, as the permanent beds do not need to be tilled or plowed before each planting season.

**Reduced Fertilizer Requirement:** The SRT method promotes natural soil fertility through keeping the root biomass of the crop and the diverse weed population. These practices help maintain nutrient levels in the soil, reducing the



The integration of the Saguna Regenerative Technique into millet cultivation represents a significant step forward in sustainable agriculture.

need for chemical fertilizers.

**Higher Yields:** Despite the reduced input requirements, SRT has been shown to increase crop yields. This is due to the improved soil structure, better water retention, and enhanced nutrient availability provided by the SRT method.

**Water Efficiency:** Millets are already known for their drought tolerance, but SRT further enhances their water efficiency. The permanent furrows and raised beds used in SRT facilitate better water infiltration and reduce runoff, ensuring that crops receive adequate moisture even during dry spells.

## SRT's Impact on Shifting Cultivation Practices

One of the most profound impacts of SRT on millet cultivation is its potential to eliminate the need for shifting cultivation. By adopting SRT, farmers can cultivate the same piece of land year after year without degrading the soil. The technique's emphasis on soil health and minimal disturbance means that the land

remains fertile and productive, eliminating the need to move to new areas. This not only preserves forests and reduces soil erosion but also helps farmers build a more stable and sustainable agricultural system.

## A Sustainable Future for Millet Farmers

The integration of the Saguna Regenerative Technique into millet cultivation represents a significant step forward in sustainable agriculture. By addressing the key challenges of traditional millet farming—soil erosion, labor intensity, and dependency on chemical inputs—SRT offers a holistic solution that enhances productivity & nutritional quality while preserving the environment.

For millet farmers, the benefits of SRT are clear: lower costs, higher yields, and a reduced environmental footprint. Moreover, by eliminating the need for shifting cultivation, SRT contributes to the broader goals of environmental conservation and sustainable land use.

As the world faces increasing challenges from climate change, water scarcity, and soil degradation, the adoption of sustainable farming practices like SRT becomes ever more critical. For millet farmers in India and beyond, SRT offers a pathway to a more resilient and prosperous future, ensuring that these ancient grains continue to play a vital role in our food systems for generations to come.



# CLIMATE RESILIENT AGRICULTURE COPING TECHNOLOGY AND GLOBAL INITIATIVES



**C**limate resilient agriculture (CRA) is an approach that uses existing natural resources sustainably for crop production and rearing of livestock to achieve long-term productivity and farm income in a changing climate. This practice will reduce hunger and poverty for future generations. CRA practices can transmute the present agrarian confronts leading to enhanced agricultural yield from local to global levels, specifically in a sustainable approach. Climate-resilient practices include amplified use of resource-saving

technologies, transparent trading systems, and adaptation of crops and livestock to climate stresses. However, food security is also affected by insufficient food stocks, price fluctuations in staple foods, high demand for agro fuels and rapid weather changes.

### Strategies and technologies for climate change adaptation

**Tolerant breeds in livestock and poultry:** Indigenous animals have unique personalities adapted to very specific ecosystems around the world and are characterized by drought

tolerance, thermoregulation, long-distance migration ability, fertility and maternal instinct, ability to absorb and digest low-quality feed, and resistance to disease.

**Feed Management:** Improving feed systems as an adaptation measure can indirectly improve the efficiency of animal production. Some feeding methods include changing feeding times and frequencies, changing feed composition, incorporating additional nutrients etc.

**Water Management:** Water-smart technologies such as furrow irrigation, raised beds, micro-irrigation, rainwater harvesting structures, intercropping, greenhouses, laser grading, wastewater reuse, deficit irrigation and drainage management can help farmers reduce the effects of climate change.

**Tolerant varieties:** Drought patterns may require different forms of adaptation. To achieve situations of insufficient rainfall, early maturing and drought tolerant varieties were cultivated. This resulted in yields 20- 25 percent higher than traditional varieties. For example, drought-tolerant early cultivars of pigeon pea (AKT-8811) and sorghum (CSH-14) were introduced to a field with a rainfall of 877 mm to achieve higher yields.

**Agro-Advisory:** Response farming is an integrated approach. It is receiving intelligence report from operators according to local weather condition. As climate change does not occur suddenly, responsive agriculture can be a viable option for climate change adaptation strategies.

**Soil Organic Carbon:** Various agricultural management practices increase soil carbon storage and promote soil functional stability. Conservation agriculture techniques (reduced tillage, crop rotation, cover crops), soil conservation practices (contour cultivation), and nutrient supplementation strategies can replenish soil organic matter by creating a protective soil cover.

**Bank support for CSA makes a realm of transformation:** \$345 million finance for **China Green Agriculture Rural Revitalization Program** supports China's



**A lack of agricultural emissions data prevents banks from informing customers about their progress in reducing emissions.**

global public goods program by promoting agricultural greening and rural development in central China's Hubei and Hunan provinces. The program will reduce greenhouse gas (GHG) emissions from crop and livestock production, increase carbon sequestration on agricultural land, and improve biodiversity protection and restoration in agroecosystems. **The Financial Sector Reform (FSRP) project and "Eastern and Southern Africa Food System Resilience Program (Phase 3)"** (US\$621 million) in Kenya, Comoros, Malawi and Somalia will improve food system resilience and address increased food insecurity for beneficiaries. The project includes strengthening the productivity and resilience of domestic food production to shocks and stressors by supporting the development and adoption of improved agricultural inputs and services, and climate-smart and gender-responsive agricultural technologies. It includes six elements, including building resilient agricultural production capacity, Crop pro-

duction, livestock and fisheries sectors. A \$200 million loan to the **Punjab Resilient and Inclusive Agriculture Transformation Project (PRIAT)** will facilitate Pakistan for improved access to agricultural water and productivity and improve income for farmers supported by the project. Specifically, PRIAT reduces differences in water availability between source, intermediate, and end users of waterways and increases agricultural output per unit of water used at the farm level for specific crops, increasing the proportion of area cultivated with high-value crops and increasing agricultural income for households participating in project activities, providing additional benefits important in climate change adaptation and mitigation. The \$125 million **ARDI (Agricultural Resilience, Value Chain Development and Innovation) program** will play a key role in strengthening Jordan's agri-food sector, which is in transition. Over the next five years, around 30,000 farmers will be facilitated to adopt climate-smart and water-efficient farming practices, provide responsive training, create approximately 12,000 job opportunities, and improve value chains through advanced market diagnostics. and assist in promoting export promotion. Special focus will be kept on strengthening the participation of women, youth and refugees.

### Role of Financial institutions

Banks require Farm -level emissions

### About the AUTHOR

Vani N, Chief Manager (Research)  
State Bank Institute of Rural Development





to build precise net-zero emissions and measure emissions reductions in agricultural portfolios. However, most of the ranches across the world are not gathering emissions data. To combat this hurdle, Rabobank employed the nation-level data to analyse its consumers' greenhouse gas radiations. They compare the estimated emissions with targets for the agriculture sector set by countries to meet emissions reduction targets under the Paris Climate Agreement. Estimating the emissions of an agricultural loan portfolio based on the assumption that agricultural emissions are close to the national average is currently sufficient but does not allow banks to track emissions reduction progress. A lack of agricultural emissions data prevents banks from informing customers about their progress in reducing emissions. It would also prevent banks from comparing their own emissions reduction progress with that of competitors, encouraging constructive competition.



**Meeting the challenges of collecting greenhouse gas data and setting net-zero emissions targets requires coordination among banks, regulators, public bodies, researchers, and nonprofit organizations.**

**Collaboration to Address Data and Methodological Gaps**

The challenges banks face in measuring agricultural lending emissions and setting net-zero targets can be addressed through collaboration between banks, non-profit partners, experts, and food and agribusiness companies. Banks can team up with competitors to find best methods for determining greenhouse gas emissions from their agricultural cases. Many Banks are taking part in the Banking for Climate Impact in Agriculture initiative organised by the World Business Council for Sustainable Development. In addition to that, banks are partnering with UNEP Finance Initiative, Carbon Accounting and Finance Partnership, and Environmental Défense Fund. (e.g., Rabobank, Santander, Wells Fargo and Barclays) to develop best practices for building net-zero emissions targets.

To support the collection of greenhouse gas emissions data and for emission reduction activities, the banks can also offer special financing programs

that comprise subsidies and incentives. This includes low-interest incentives for farmers who meet climate and water quality benchmarks and link financial performance data with environmental data.

Meeting the challenges of collecting greenhouse gas data and setting net-zero emissions targets requires coordination among banks, regulators, public bodies, researchers, and non-profit organizations. This will ultimately enable banks to drive low-emission investments in agriculture around the world. In conclusion, financing for CSA requirements to be strengthened for supporting sustainable transformation of agriculture and food systems.

**Way Forward**

➤ Reducing greenhouse gas emis-

sions from all agricultural and non-agricultural sources must be a priority. The introduction of neem-coated urea is one such policy interference.

- Structured training is essential to increase stakeholder confidence and awareness of climate change events.
- Fine tune the gap between current management practices and key agricultural recommendations.
- Advanced agriculture-focused programs are needed to increase skills in agriculture and related sectors.
- Farmers, research institutions and funding Collaboration between provider agencies, government and non-government organizations, and farmers Private sector strengths supporting CRA.

There is a Global food demand to feed an anticipated world population of 9.7 billion by 2050. The global agriculture and food systems presently producing 33.33 % of total emissions. The goals of the Paris Agreement cannot be achieved without significant climate protection measures in the agriculture and food sectors. Agriculture is a major cause of deforestation, threatening pristine ecosystems such as the Amazon and the Congo Basin.



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**Dubai Office :**

**Ms. Indira Kumari**, Vice President, Gulf and Africa  
+971-588323892  
Indira.kumari@iacg-global.com |

**New Delhi Office :**

**Ms. Ayati Singh**, Senior Manager  
+91 – 9311770523  
ayati.singh@icfa.org.in





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