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- पैक हाऊस - साधी शैन
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उद्यान विभाग, हरियाणा

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CELEBRATING HORTICULTURE!

A sunflower is not just one flower. Both the fuzzy brown centre and the classic yellow petals are actually 1,000 – 2,000 individual flowers, held together on a single stalk.

There are more micro-organisms in one teaspoon of soil than there are people on earth. It's alive! Microbes are important for keeping your soil full of nutrients.

Butterflies might be more attracted to your weeds than your flowers. Colourful blooms aren't the chief reason these insects love your garden – it's more about the fragrance and nectar. So everyday weeds, like dandelions and clovers, might actually be more appealing to butterflies.

Some of your favourite fruits are actually from the rose family. Apples, peaches, and pears - Really! Plus… cherries, raspberries, strawberries, and a few more are rosacea, making them relatives to the long-stemmed Valentine's Day variety.

The right orchid combination can smell like dessert. Delicious! Did you know that the vanilla bean comes from an orchid? An orchid hybrid smells like chocolate. The cymbidium Golden Elf smells lemony, and the phalaenopsis violacea has a cinnamon scent.

The fastest growing woody plant in the world is Bamboo! It can grow up to 35 inches in a single day.

Cranberries can float! Small pockets of air inside cranberries cause them to bounce and float in water.

Fruits that have seeds on the outside? An average strawberry has 200 seeds. It’s the only fruit that bears its seeds on the outside.

Why do we cry when cutting onions? Sulphuric compounds are to blame for cut onions bringing tears to your eyes.

Peanuts are not nuts, but legumes related to beans and lentils. They have more protein, niacin, folate, and phytosterols than any other nut.

You can change a Hydrangea’s colour by altering the pH level of the soil. A more alkaline soil will result in pinker blooms, while more acidity will produce blue blooms.

Plants really do respond to sound. Talking to plants to help them grow is a well-known old gardener’s tale. Studies have also shown that vibrations like music, or perhaps even the sweet sound of your voice can affect plant growth.

Mushrooms are not plants but a fungus... and unlike plants, mushrooms do not require sunlight to make energy for themselves.

Join us to celebrate Horticulture in the August 2021 edition of Agriculture Today.

Happy Reading!

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Horticulture: The Harbinger of Change

If you want to see culture of India, see its agriculture. If you want to see the colours of India, see its horticulture, it is wisely said. The diversity of horticulture in India is possibly greater than Europe or the Americas. Every fruit, flower or the vegetable grown anywhere in the world is grown in one or the other part of India. From the days of acute scarcity to a situation of bountiful plenty, horticulture has played its role in farm profitability, food and nutrition security and farmer prosperity. Horticulture has grown more rapidly during the last 20 years from area of 16.59 million hectare, production of 145.78 million MT and productivity of 8.79 million per hectare in the year 2000-01 to the production zooming to 3.26 million MT and area to 27.1 million hectare.

This has been the result of the focused policy approach adopted by GOI by launching diverse horticulture missions, from Horticulture Technology Mission (HTM) to National Horticulture Mission (NHM) to Mission on Integrated Horticulture (MIDH). But even now, the export potential of Indian horticulture @ Rs 200 billion remains largely untapped. While there is need to raise horticulture export substantially, there is also need to educate the population to move up in food value chain. We need to shift from largely grain consumption to higher intake of fruits and vegetable for improved nutrition and health.

Plants have enough spirit to transform our limited vision, it is said. With a wide variety of climates and soils on which a large range of horticultural crops can be grown, India serves as the breeding ground for opportunities to grasp. Owing to better irrigational facilities, technological improvement, involvement of small farmers, agronomic practices and many more factors, India has a growth rate of 2.7 per cent per year and stands at the second position worldwide in the production of fruits and vegetables.

We also face several turbulences in his sector. The dearth of market facility, lack of processing facility, lack of skilled manpower, improper post harvest management and inadequate planting material often pose challenges. We also need to address the problem of land fragmentation, lack of urbane technical centers for horticulture, data management, a keener sense of agri-business etc. Over the past few decades, advancements in science have brought to us the incredible integration of Global Positioning System, Geographical Positioning System and Remote Sensing, in addition to planned monitoring. These technologies shall serve the larger agriculture sector, as also horticulture.
An Agri-Tech Start Up: The Journey of A Woman Entrepreneur

A

gri-tech start-up. We hear this word so often now. Who are the people driving technology in Indian agriculture? I met one such individual. Dr Rajul Patkar (Maheshwari), Chief Executive and Co-founder, Proximal, Soilsens Technologies Private Limited. Her journey is so interesting. It is produced below in her own words.

If I succeed, I’m a motivational story. If I fail, I’m just another woman who failed because of circumstances and insecurities, despite their potential. The stakes are even higher as I’m a woman and have the possibility of inspiring many other women. This simple and powerful thought has driven me for years.

Regardless of one’s gender, being an entrepreneur is tough. One finds oneself challenged at every corner. One may also feel insecure and vulnerable. In comparison with men, women face many challenges. The list of those is endless and could range from things like a lack of familial support to sexism while trying to raise investment funds. As a woman, I have got a strong sense of empathy and adaptability. These qualities have helped me in my entrepreneurial journey.

COVID was a challenging period for many SMEs. SoilSens wasn’t a different story. Key persons leaving the organization to pending orders and lockdown all appeared to be the end of SoilSens, but it was just a bend. My mentor network helped me a lot during this time. I approached and talked to many people and gained all the strength to fight back.

Last year, we launched a new portable moisture meter to help and support small farmers. We have prototyped NutriSens. This is a glucometer for soil analysis that will aid the government to generate employment at the village level and help the marginal farmers to get their Soil Health Card on-site in seconds.

We have received funding from Atal Niti Aayog to extend our technologies further and reach out to new markets. We clinched the tender from The Indian Institute of Oilseeds Research (IIOR) and worked with some foundations.

We developed a strong mentor network and got support from WIN Foundation, RICH (Research and Innovation Circle of Hyderabad), BIRAC (Biotechnology Industry Research Assistance Council), MILLENIUM-FICCI, T-Hub Hyderabad, PJTSAU (Professor Jayashankar Telengana Agricultural University)-Aghub, NABARD-MABIF (Madurai Agribusiness Incubation Forum), TSiC (Telangana State Innovation Cell), and IIT Bombay. Our network is growing. We are currently part of two crucial accelerator programs, The Land Accelerator, and ICAR-UPJA.

SoilSens has been a pioneer in sensor-based precision agriculture in India. My dream is to make SoilSens one of India’s leading sensor and IoT based companies in food, agriculture and environment.
Horticulture has emerged as a commercial enterprise in the last two decades, moving away from rural confinement as a result of technological advancement, policy changes, and investment in research, education and development. The production, productivity and export of horticultural produce has increased manifold. With increase in per capita income, higher health consciousness among people and rapid urbanisation, the demand for horticultural produce is on the increase. This is expected to further accelerate. But increased production has to be achieved with smaller land holdings, declining water resources and changing climate. Also, higher competition in an open economy demands competitive price for standard quality produce. This opens up opportunities and challenges. The potentialities which exist for horticulture have to be harnessed by utilizing the power of knowledge, innovations, value chain development and its

**ABOUT THE AUTHOR**

Dr HP Singh is Founder and Chairman, Confederation of Horticulture Associations of India (CHAI). He is former DDG Horticulture, ICAR; Vice-Chancellor, RAU, Pusa, Bihar and Horticulture Commissioner, Ministry of Agriculture.
Initiatives in Horticulture Development

The major thrust areas in horticulture research are as follows:

a) Effective management, enhancement, evaluation and valuation of genetic resources and development of improved cultivars, with high quality characteristics, productivity, resistance to pest and disease and tolerant to abiotic stresses.

b) Development of technologies to improve the efficiency of breeding to develop cultivars, which meet market needs including taste, freshness, health benefit and convenience beside resistant to biotic and abiotic stress.

c) Increasing the value of production by reducing variability in yield, quality, reducing crop loss and increasing marketability through development and site specific technologies for different horticulture crops.

d) Developing system for productive use of nutrients, water and reducing impact of pest and disease through the use of innovative diagnostic techniques.

e) Improve the understanding of interaction between native ecosystem and production system, and develop best practices to conserve biodiversity and sustainable use or resource.

f) Develop the production system that minimizes the production of wastes and maximises the re-use of waste.

g) Enhancing the shelf-life of horticultural produce, product diversification and value addition for better profitability.

h) Understand social needs of communities and build the capabilities to practice the change for effective utilisation of resources, adoption of technologies and respond to needs including bio-security needs.

Advantage Horticulture

Horticulture is the low hanging fruit in the agriculture sector. It has higher monetizable potential compared to field crops. It is thus considered as a high value segment. As a result of research, education, technology and policy initiatives, the sector has evolved as the best option for agricultural growth. Therefore it has become a viable option for small and marginal farmers. The technology-led horticulture sector has started attracting entrepreneurs to commercial ventures in a big way. The high value is attributed to the higher demand from consumers, and to greater awareness of the wholesome nutritional benefits that horticultural produce offers.

Challenges in Horticulture Gaps Needing Attention

Challenges to feeding a growing population suiting to their dietary needs and nutritional requirements demand science and technology-led development, backed by enabling environments, resource utilisation strategies and addressing the issue of post-harvest losses. But the gap between demand and availability continues to widen. In this context, it is pertinent to analyze the critical gaps which can be addressed in systematic manner.

Horticultural crops are amenable to different forms of cultivation – open field, atmospheric controlled (poly houses, green houses, shade nets etc.), orchard based etc. The emerging cultivation techniques include vertical farming, hydroponics, aeroponics etc. The major challenge for those who want to venture into this sector is access to capital and technology besides the initial learning that involves acquisition of skill, and knowledge management. The specific issues and critical gaps needing attention are as follows:

a) high cost of inputs that burdens farmers.

b) low benchmark productivity add to unit cost of produce.

c) large scale prevalence of old and senile orchards impacts productivity.

d) majority of the orchards also have low planting density.

e) non-availability of quality seed and planting materials impacts quality of produce.

f) poor tree canopy management, hence low quality produce.

g) rainfed cultivation with majority of the horticultural cultivation under rainfed system suffers from absence of dependable irrigation.

h) initial cost constraints in adoption of improved technologies.

i) facilities for post-harvest management have not kept pace with production growth.
j. unorganized supply chain, not suitably integrated for managing perishable produce
k. lack of appropriately trained extension services for horticulture
l. Lack of skill in horticulture production and its management
m. inadequacy of infra-structural facilities for post-harvest management and marketing
n. lack of appropriate database for effective planning
o. poor delivery system, credit support/and price support
p. slow pace of adoption of improved technology

**Approaches Needed for Development of Horticulture**

Adoption of sustainable path for development to meet challenges in horticulture production through proper technological innovations and interventions, specifically in areas like value chain management, is needed to improve global competitiveness. Inter-institutional mechanisms to network and review the ongoing program of biotechnology, cost effective production technologies, post-harvest technology, farm mechanisation, transfer of technology and organic farming are essential to providing a strategic direction. Improving the understanding of interactions between native ecosystems and production systems and developing best practices to conserve biodiversity is essential. Understanding of the social needs of communities and to build the capabilities for effective utilisation of resources and adoption of improved technologies and best practices and respond to needs including bio-security threats. Priorities for addressing the challenges include development of improved cultivars with high quality characteristics, productivity, resistance to pests and disease, and tolerance to abiotic stresses. There is need to adopt technologies for improving water and nutrient efficiency by reducing variability in yield and quality and reducing pre and post-harvest crop losses. The crop monitoring mechanism, ensuring timely availability of inputs, an efficient delivery system and technical backstopping will be needed for an integrated approach. Emerging challenges require sustained research and human capital to improve competitiveness, enhance efficiency of production system, assuring quality and safety and improved capability of community to manage the change. Technology-driven horticulture will significantly contribute to economic development. In the context of the threat of climate change, climate smart horticulture (CHS) has provided options for sustainability, but it has many technological challenges and issues of human resource development.

Maharashtra, Karnataka and Andhra Pradesh have been proactive in pursuing development through farmer participation. The same cannot be said for the eastern states. Thus approaches have to be different in the implementation of development programs in horticulture.

For increased production, stipulated vertical growth will be required through the use of new cultivars, efficient water and nutrient management, effective plant health management combined with strategies for reducing post-harvest losses, marketing and brand building including traceability with...
empowered human resources could be the approach. This shall require appropriate innovations and investment. Protected cultivation has shown yield enhancement up to four times, but it would need investment.

Plant architectural engineering and management can mitigate the problems associated with seasonality in many crops. Enhanced efficiency in water management and utilization of modern techniques will reduce water stress. Since horticulture provides variability and has the potential to adjust to different agro-climatic situations, technology-led development is inevitable. It is essential to empower the youth with new knowledge in this sector. Changes in technology, institutions, trade, the market, the policy environment – all have an impact on farmers. The next phase has to be predominated by skills of trade and value-addition. Therefore, we need development strategies which are knowledge-based, technology-driven and farmer-centric.

The majority of horticultural produce is perishable, making its marketing difficult. When there is overproduction, the market faces glut, and the farmers suffer losses. Regulation of the production of required quality on demand basis is essential. Various marketing systems have been implemented for horticulture produce like the alternate market, e-NAM etc. But the market infrastructure to support horticulture is not enough. There is a need to develop a specific market at district level and block level having backward and forward linkages to provide guidance to farmers regarding likely demand for the crops and for the inputs, and finally help in the sale of produce at a profitable rate. In this context, a complete approach to value chain management is suggested.

**Higher Production Expected**

Based on demand, population growth, higher income, export demand and growing health consciousness, by 2050 the production of horticultural produce should increase to 905 million tonnes. This is possible by addressing various issues, but not easy. With a concerted effort and a shift in approach to identifying and addressing issues, it is possible. This needs a holistic approach to address all the links in chain from production to consumption, i.e., technology, inputs, investment and delivery. Since all links play a critical role, any missing link will affect the outcome of expected results. Therefore, a value chain management approach would be much appropriate, which addresses all the activities starting from conceptualization to when the produce reaches the consumers in an acceptable form. This will call for the handholding of farmers in conceptualization, production and delivery by assuring new knowledge, inputs, logistic, credit and quality assurance. This approach will not only enhance the production to achieve the target, but will also provide employment opportunities for youth through various multiplier effects.

It is suggested that horticulture development must be addressed in the mode of value chain management as a mission. The Mission on Value Chain Management in Horticulture for Doubling Farmers’ Income will aim at value realization for farmers through targeted interventions in all the links from seeds and planting material production to consumption, strengthening production clusters, and linking them to the market. This will address knowledge empowerment, seed system, production management, inputs management, credit support, smart management for water, nutrient and plant health care, quality assurance, logistics, branding and delivery. The concept is total management and can further utilise the Internet of Things and Block Chain Technology for efficiency and output maximization.

A paradigm shift in strategy of investment is imperative. With this background it is important to focus in the sector with the following two-pronged strategies: (i) Value chain development and management in horticulture, and (ii) Development of urban and peri-urban horticulture.

Value chain development may further have two components: (a) Smart horticulture using innovative technology for productivity increase. This will focus on high/ultra-density planting for fruit crops, protected cultivation, organic production, identification and promotion of new technology, development of traceability mechanism of fruit crops for export, automation in micro irrigation, skill development, rainfed area development through horticulture, implementing mechanism for IPR protection of plants/varieties, utilisation of Artificial Intelligence for horticulture, efficient utilisation of resources in horticulture and (b) harvest and post-harvest management and creation of integrated cold chain infrastructure. This will include cluster identification of horticulture produce and creation of infrastructure for export, aggregation of the produce, pre-conditioning-cleaning, sorting, grading, packaging, transport and/or storage facilities, linked to holding life of produce, integrated cold chain infrastructure, minimal processing/processing for the processing variety, market linkages, market channels: distance, local, terminal market demand etc., market infrastructure and linking with export.

It is also suggested that a separate Ministry for Horticulture be established, with the mandate to manage the entire value chain, with special emphasis on quality seeds and planting materials, as well as efficient post-harvest management and marketing until the product reaches the consumer.
Dr Krishan Lal is revered as the Father of Golden Revolution in India. He has held several major positions such as Head CMRS, Lucknow (1972-80); Director, IIHR, Bangalore (1980-86); Deputy Director General (Hort.) (1987-96) and National Professor (Hort.) (1997-2001) and Adjunct Professor in Horticulture. Dr Chadha led the national horticulture development programmes as the first Horticulture Commissioner and also Executive Director, National Horticulture Board, in the Ministry of Agriculture, GOI (1986-88). He has provided leadership to the Horticultural Renaissance in India. Dr Chadha was conferred the prestigious national Padma Award by the President of India on March 22, 2012.

**Strengthening Research Infrastructure**

Dr Chadha aptly utilized the resources and positions to shape policies, build institutions, launch national R&D programmes, disseminate knowledge and energize the system, opening up employment and entrepreneurship avenues in horticulture sector, which has benefited millions of farmer in the country. He was responsible for focusing on innovative programmes like Hi-Tech Horticulture, Micro-irrigation, High-density planting, Micro propagation and Development of F1 hybrid seeds of vegetables through national agriculture research system in horticulture. He established the Central Mango Research Station (presently CISH, Lucknow) from scratch as Project Coordinator (Fruits) and Head and also set up 59 specialized laboratories at the Indian Institute for Horticultural Research, Bengaluru as its Director.

His scientific vision led to the strengthening of R&D infrastructure in the country. As Deputy Director General (Hort.) ICAR, he was instrumental in setting up eight National Research Centers (NRCs)
during VIII Plan one each on citrus, banana, grape, arid horticulture, onion and garlic, oil palm, cashew and medicinal and aromatic plants and establishing / upgrading 4 central institutes, namely CITH, Srinagar, IIHR, Varanasi, IISR, Calicut, and CIAH, Bikaner. This has brought the sector to the national focus for its enormous potential and has laid foundation for a Horticultural Revolution in India.

Promoting Horticulture Development

Being the first Horticulture Commissioner (GoI) he established the National Horticulture Board at Gurgaon, launched the first Market Information Scheme on perishable commodities, promoted sale of fruit juice through supply of fruit juice vending machines and promoted low energy cool stores for potato, onion, etc. He was instrumental in getting Solan (HP) being declared as Mushroom city of India and was associated with development of Horticulture in almost all the states of India. He is also credited with the introduction and commercialization of Oil Palm cultivation in India.

He was Chairman of the Planning Commission's Working Group on Horticulture Development for formulation of X and XI Plans. Earlier he was Secretary for formulation of VIII Plan. His efforts resulted in enhanced financial allocations and the launch of several innovative and Hi-tech programs in the country. He was closely associated in developing the Vision Documents for the states of Kerala, Rajasthan, Haryana.

Contribution to Private Sector

Dr Chadha has also been associated with several NGOs and private sector organizations. He worked for FICCI as Chief Agriculture Advisor to promote EUREPGAP in Horticulture crops. He has also served as Chairman, Indian Society of Agri-business Professionals (ISAP) and AGRIWATCH and carried out development activities of installation of radio stations, establishment of farmers' information cell and promotion of Agriculture production & training programmes in the states of Madhya Pradesh, Himachal Pradesh, Haryana & North-Eastern Region. The e-information programme carried out by ISAP under his guidance won the national award of the Ministry of Environment & Forests. He also served as Member of advisory Committee of Reliance Agrotech, member, Research Advisory Committee, World Noni Research Foundation, Chennai and member of the Board of Directors of ASPEE Research Foundation, Mumbai. He was associated with the launching of Agriculture Today, a monthly magazine to promote agriculture and establishment of the Institute of Horticulture Technology at Greater Noida, UP as its chairman.

International Assignments and Import of Technologies

Dr Chadha is internationally recognized having been Indian Representative on International Society of Horticulture Sciences, The Hague for more than 20 years; Chairman, International Mango Working Group (16 years); Secretary: Sub-Group on Viticulture for South-East Asia (15 years); Vice-Chairman: Commission on Tropical and Sub-Tropical Horticulture (7 years) and Member and Vice Chairman Board of Trustees, International Potato Centre, Lima, Peru for 7 and 3 years, respectively, Member, Editorial Advisory Committee (CABI) (1992-97), SAVERNET of Asian Vegetable Research and Development Centre, Taiwan as Member (1993-97) and Chairman (1996-97) and Member, RAC, INIBAP (1993-97) and Chairman (1996-97). He worked as FAO, World Bank, IPGRI and USAID consultant on Fruit Production, Genetic Resources and Mango Production in nine countries of South East Asia and Middle East.
sustained economic growth, rising per capita income and growing urbanization are causing a shift in the consumption patterns. There is higher demand for high-value food commodities like fruits, vegetables, dairy, poultry, meat, and fish products as compared to staple food such as rice, wheat and coarse cereals. This is leading to a silent revolution of agricultural diversification.

Crop diversification is a necessity. It is the only alternative for Haryana’s agriculture-based economy to enhance the income of small and marginal farmers. In Haryana, agricultural diversification towards fruits and vegetables started in early 90s. At present, horticulture stands at 7.15% of the total...
cropped area. The state intends to take this figure to 15% by 2030. This shall be achieved by bringing double the area under horticultural crops and increasing the productivity three times from the present level by making horticulture a profitable diversified farm activity.

In Haryana we are working on nine major strategies, from the basic strategy of farmer enrolment to dissemination of technologies.

**Crop Area and Farmer Enrolment Program**

A unique area and crop registration programme was started by the Haryana Government. All the farmers are being registered on Meri Fasal Mera Byora (MFMB). Farmers can register themselves and avail the benefits of the government schemes. The beauty of this portal is that farmers get automatically enrolled for horticulture price protection scheme (Bhavantar Bhavey Yojna - BBY) and Mukhyamantri Baagwani Bima Yojna (MBBY). Farmers are getting benefit under BBY. So far, Rs 10.35 crore has been disbursed against price fluctuations to compensate them against lower prices in the wholesale market. MBBY is another unique insurance programme for horticulture crops. It was launched this year in January with premium amount of 2.5% (Rs. 750-1000) and coverage of Rs 30,000 to Rs 40,000 per acre against natural calamities. This will certainly help farmers to mitigate their risk in diversification. Once all the farmers start registering their area and crops, then policy decisions shall be lot easier for launching of new programs specifically targeting the weak areas.

Haryana is blessed with robust market opportunities. We grow almost all types of vegetables to supply fresh produce to the consumers. We support our fruit and vegetable area expansion program by simultaneously working on allied activities for greater sustainability.
under comprehensive programs. Our allied activities ensure the success of the program. For example, we have integrated vegetable cultivation programme by integrating hybrid vegetable, bamboo stacking, mulching and micro-irrigation. Another highly successful program ensures water resource management by constructing more than 3000 water farm ponds with subsidy of Rs 20 lakh for community tank and of Rs 7 lakh for individual farm ponds. This ensures greater survivability of plantation with outreach to more than 16000 farmers, with catchment area coverage of 24000 acres for plantation and micro-irrigation.

Protected cultivation/vertical farming under poly house, net houses, bamboo stacking along with plastic tunnels and mulching is proving profitable for the farmers. Their net income is more than 200 times as compared to the present traditional type of cultivation. We have covered more than 2900 acres under poly/net houses, 8195 acres under bamboo stacking, 3075 under plastic tunnels and more than 14000 acres under mulching. One, productivity has increased tremendously through these means. Second, the quality of the produce has increased multifold.

**Lucrative options for landless farmers**

Mushroom and bee keeping are the other areas where we are concentrating to give boost to landless farmers. Haryana is the leading producer of white button mushroom. In 2020-21 alone, more than 71 air-conditioned units have come up. We produce more than 10,000 metric tons of white button mushrooms. Similarly at present Haryana is at the seventh place in the country with production of about 4500 metric tons of honey.

The department has made a ten-year action plan to increase honey production to 12000 tons with productivity of 30 kg per box. Special focus has been proposed towards industry-driven production system viz. production of polLens, bee-venom, bee-wax, royal jelly and propolis with output value of more than Rs 250 crore within a few years. To facilitate bee-keepers, we are establishing a Honey Trade Centre for wholesale buying-selling, quality testing and monitoring of trade up to traceability level.

We recognized very early the power of demonstrative technologies, and tied up with different institutes and organizations in India for import of established technologies. We have established a total of 11 Centers of Excellence. Four of these are under the Indo-Israel Work Plan. Seven others focus on specialized technologies. Like for potato, our project is in coordination with CPRI, Shimla and International Potato Centre.

We produce more than 1.5 crore seedlings of hybrid vegetables to cover more than 1000 acres under protected cultivation. We offer demonstration of more than 100 varieties of tomatoes, capsicum, cucumber, melons, organic vegetables, different advance technologies - poly houses, plastic tunnels, bamboo stacking, net houses, mulching, irrigation automation systems etc. We have more than 5000 tons of seed potato, 15 lakhs of mini-tubers, 4
We are concentrating on mushroom and bee keeping to give boost to landless farmers. Haryana is the leading producer of white button mushroom. In 2020-21 alone, more than 71 air-conditioned units have come up.

Lakhs of apical rooted plants at potato center. Our fruit centers have more than 1.5 lakh grafted fruit plant production under hi-tech conditions. Other farm management/canopy management techniques are demonstrated regularly. The impact of demonstrative technologies is tremendous. Now farmers in Haryana are very receptive. They are adopting newer varieties and learning the techniques for better farm management. In this way, they are increasing their net income.

Our challenge was to reach all the farmers in the state. This year, we have started the Farmer Outreach Program. We have selected 120 Villages of Excellence in 22 districts of the state. They are connected with our 11 Centres of Excellence. In each Village of Excellence, 10 farmers are being selected for the demonstration of proven technologies.

At the same time an integrated pest management (IPM) programme has been started with National Centre for Integrated Pest Management (NCIPM) to continuously monitor the pests and fruit fly and to issue real time advisories to more than 2800 farmers each year under weekly training programmes at Horticulture Training Institute (HTI), Karnal.

To facilitate the farmers and entrepreneurs, we have established two pesticide residue testing labs. We shall collect more than 2500 samples throughout Haryana to monitor the level of pesticides and advise farmers accordingly.

Information Technology is one of our core strength areas. We have 16 online portals where farmers can avail facilities under different schemes and programs of the department. All these portals can be accessed through one single link Khushal Baagwani. To further link our activities, social media channels are widely used under our outreach program.
The share of agriculture in our GDP is almost 20%. The horticulture sector contributes approximately one third of agriculture GDP. Horticulture sector has emerged as a growth engine for India’s agriculture sector. Despite being one of the most profit-generating sectors, the importance of horticulture was realised late. In the early 90s, attention was drawn for improvement of the sector. Existing plans were enhanced by focusing on proper budget allocation, knowledge sharing and technology adaptation.

The Mission for Integrated Development of Horticulture (MIDH) was launched in 2014 to propel Indian horticulture to realise its potential and augment horticulture production by converging all the ongoing missions and schemes. The idea was to bring all the ongoing initiatives under one umbrella in order to achieve better utilisation of resources. Although MIDH is a relatively recent initiative, it has contributed to some of the significant milestones in the history of India Horticulture.

About MIDH

MIDH is a centrally-sponsored scheme for the holistic growth of the horticulture sector. It encompasses fruits, vegetables, root & tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. Under MIDH, the Government of India (GOI) contributes 60% of the total outlay for developmental programmes in all the states except in the North East and Himalayas; 40% share is contributed by state governments. In North Eastern and Himalayan states, GOI contributes 90%.

There are various sub-schemes under the MIDH covering the whole nation and all the verticals of horticulture. The Centrally Sponsored Sub-Schemes under MIDH are National Horticulture Mission (NHM) and Horticulture Mission for North East & Himalayan States (HMNEH). The Central Sector Schemes under the MIDH are National Horticulture Board (NHB), Coconut Development Board (CDB) and Central Institute of Horticulture (CIH).

The main objective of the mission is to increase the area, production and productivity of horticulture crops by introducing...
the latest technologies, global best practices, innovations in the horticulture sector and generating employment opportunities. The mission aims for promotion of improved post-harvest management, marketing and processing leading to the enhancement of farmer’s income.

MIDH focuses on the holistic growth of the horticulture sector through area-based and regionally differentiated strategies, including research, innovation and technology promotion, post-harvest management, processing and marketing, in consonance with comparative advantages of each state/region and its diverse agro-climatic features. Over the years, with the support of the centre and state government organisations, the initiative has contributed to the desired agenda. Under the Mission, required infrastructure like hi-tech nurseries, seed banks and tissue culture labs were developed in order to fulfil the increasing demand. MIDH also has made fair contribution to the development of Water Sources, Pest Management, Nutrient Management, Organic farming and Horticulture Marketing.

**Area Under Horticulture Crops**

In the last two decades, the area of horticulture crops in India has seen a growth of almost 40%, while horticulture production has almost doubled. India is now the second-largest producer of fruits and vegetables in the world, contributing nearly 12% of the world’s production.

India is the largest producer of horticulture crops like banana, okra, mango, papaya and ginger. India’s horticulture production in 2020-21 is estimated to be 326.6 Million MT. This is the highest ever in the history of Indian Horticulture. Per capita consumption of fruits and vegetables has increased from 281 gm/day to 397 gm/day since the launch of the Mission. This is almost equivalent to the per capita requirements of fruits and vegetables. (General recommendation for the fruits and vegetables intake is at least 400 grams as per Indian Journal of Community Medicine).

The graph below highlights the area expansion under horticulture and increase in horticulture production since the launch of MIDH in April 2014:

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**Mr Panwar’s favourite activities**

are trekking in the Himalayas, travelling across the world, exploring remote destinations and spending time at home with family.
Horticulture trend
MIDH has contributed immensely for adoption of modern technologies for development of horticulture while keeping the socio-economic, agro-climatic and environmental aspects in mind. As a result of integrated approach for all round development of horticulture through MIDH, 30 Indo-Israel Centres of Excellence and 7 Indo-Dutch Centres of Excellence have been created along with coverage of approximately 38 lakh Ha. additional area and accreditation of 1657 nurseries. The scheme has also impacted in the creation of 20.86 Million MT of Cold Storage facility, 534 ripening chambers, construction of 1.05 lakh farm ponds as well as training of 23.93 lakh farmers.

New Strengths In Horticulture Sector
The ongoing interventions of MIDH, the growing interest of farmers, the continuous rise of start-ups and involvement of evolving businesses in the sector are rapidly increasing horticulture’s contribution to the Indian GDP. Thanks to the continuous efforts of the Mission, Indian horticulture is growing to expand its reach throughout the world.

India is home to some of the finest quality horticulture produce, even at the global grandstand. The Turmeric from Meghalaya, Pineapple from Tripura, Banana from Andhra Pradesh and Mango from Gujarat are some prime examples. Despite being the best in their grade, some of these varieties are still struggling to build an identity in the international market. The reason could be lack of pre-production and production initiatives, minimal fruit care practices, low branding initiatives, means of logistics, lack of awareness, post-harvest losses etc.

The focus has shifted to factors like research and development in production practices, nurseries, high-density plantations, organic farming, reducing the cost of cultivation, the need for post-harvest management infrastructure etc. All the sub-schemes under the umbrella of MIDH have been implemented to carry the best of both shifts to support modern day hi-tech horticulture.

One of the major objectives of the Indian horticulture sector is to increase the horticulture market share in the global trade while improving the quality of production. Therefore, we need to build more holistic and sustainable strategies to develop a more robust picture of Indian horticulture. The sector demands such programmes that can continuously evolve and adapt to future challenges, consequently shaping the horticulture sector.

Roadmap for Growth
The NHB is creating a roadmap that has convergence of all the resources available in the country. The idea is to bring together all the relevant organisations – whether public or private, government or non-government – to to achieve a common goal. It is a system to leverage the established synergy of various policies and to distribute opportunities among the stakeholders involved in the horticulture value chain. This approach envisages providing mutual benefits to all the relevant stakeholders by knowledge and resource sharing.

The Horticulture Cluster Development Programme (CDP) is the key step in that direction. Launched on May 31st, 2021, the programme is designed to leverage geographical specialisations of horticulture clusters and promote integrated and market-led development of pre-production, production, post-harvest, logistics, branding and marketing activities. MoA&FW has identified 53 horticulture clusters, of which 12 have been selected for the pilot launch of CDP. Based on
the learning, output, and outcome of the pilot implementation, the programme will be rolled out to cover all 53 clusters. The cluster-based approach is expected to address the concerns and common challenges of all the stakeholders. While individuals and institutions within a cluster will compete, they are also expected to collaborate and complement each other to function as an optimally aggregated group, optimising resources and achieving the desired impact through focused interventions.

High Success With Banana Export
The idea of the CDP is to make these clusters globally competitive; For example, Ecuador is the largest exporter of bananas in the world. Despite being the top producer, India still lags behind Ecuador when it comes to the export of bananas. But after some recent combined interventions of State and Central Governments, public and private sectors, and convergence of various schemes, the export and productivity of Banana in the Anantapur region touched new heights.

Anantapur, a district in Andhra Pradesh, is now attempting to compete with Ecuador in terms of global export. The CAGR growth for increase in production for the cluster went from 28.99 Lakh MT in 2011-12 to 69.86 Lakh MT in 2018-19. The CAGR growth for exports skyrocketed to 45,000 MT in 2019-20. It was 246 MT in 2016-17. The CDP is an attempt to make all the selected clusters competitive in a similar manner. It can only be achieved by improving their standing in the verticals of pre-harvest, post-harvest, logistics and marketing etc., for which the regional and national organisations will have to come together as one.

Benefits of Cluster Approach
The Cluster Development Programme will complement the ongoing efforts of MIDH. While the MIDH focuses on developing the horticulture sector throughout the Indian states, the Cluster Development Programme will only implement the interventions in the selected clusters. The idea behind the CDP is to act as a catalyst in the process of horticulture growth. The programme will provide subsidies for infrastructure, including farm-level, pack-houses, cold chain, post-harvest management and logistics. The programme’s vision is to develop an opportunity to handle 8 Million MT in the quantum of produce, which will eventually benefit about 1 million farmers and other stakeholders of the value chain. An estimated increase of 20% in export of the targeted crop is also envisaged. In addition, an estimated influx of Rs 10,000 Crore (Rs 3300 Cr max. subsidy and Rs 6700 Cr Private Investment) is also targeted for 53 clusters.

The demand for fruits and vegetables in India is rapidly increasing. By 2050, India’s projected demand for the same will substantially increase to 650 Million MT, which is double the current production. It is imperative to implement our policies more efficiently and adroitly.
It is important for India to move beyond food security and achieve nutrition security. Horticultural crops that provide a better balance between carbohydrates, protein, minerals, micronutrients and vitamins are crucial to achieve this. The consistent and rapid increase in production and availability of horticultural crops over the last decade gives a sense of emerging nutritional security. This sector is being considered as a driver of economic growth. It is slowly taking the shape of an organized industry with key linkages to seed business, value addition and export, leading to job-full growth. It is also well proven now that horticulture is playing a key role in doubling farmers’ income as we re-orient our focus from intensification to diversification, from sustenance to commercialization, turning agricultural units

**ABOUT THE AUTHOR**

Dr BNS Murthy is the Director of ICAR-IIHR, Bengaluru with over 35 years of rich experience in horticultural research and administration. He has also donned the role of Horticulture Commissioner, GOI and contributed to national level policy decisions to help farmers.
to enterprises and shift from traditional production orientation to income orientation.

**Food and Nutrition Security**

Substantial progress has been made towards improving the food and nutrition security in India during the last decade. Horticulture has been a major contributor to this end, surpassing agriculture production since 2012 consecutively. To sustain and strengthen growth in this sector, we need technologies addressing the challenges. These include emerging pests and diseases, declining and degrading land and water resources coupled with a threat of climate change.

The growth during the last two decades in this sector is actually led by major technological interventions. These include improving the propagation efficiency, adaptability and window of yielding in fruit crops, realizing the potential of F1 hybrids and disease resistant varieties in vegetable crops and improving resource use efficiency across various horticultural crops. Tissue culture protocols improved propagation efficiency in several fruit crops like banana, strawberry, pineapple etc. Large scale adoption of root stocks (Dogridge of grape, Rangapur lime of citrus, M7, MM101 and M9 of apple) increased the adaptability and area in perennial fruit crops. Pruning and growth regulator formulations helped in extending the window of flowering and fruit set in these crops, resulting in an enhanced yield and quality. Tapping hybrid vigour has almost revolutionized vegetable farming, especially with the emergence of a strong private sector participation in the production of hybrid seeds of vegetables.

Development of male sterile lines and their commercial exploitation economized hybrid seed production. Disease resistant varieties especially from public sector research institutes like Kufri Jyoti of potato, Pusa Sawani and Arka Anamika of okra, Arka Komal of French beans, Arka Manik of watermelon, Kashi Kanchan of cowpea, recently Arka Rakshak of tomato etc have been widely adopted. They are popular among farmers even after two to three decades of their development.

Government subsidy schemes to support techniques that improve resource use efficiency like micro-irrigation, farm ponds and mulching sheets had an enormous impact on their adoption. This has resulted in better yields of various horticultural crops. To sustain and strengthen the growth in this sector, we need technologies addressing our various challenges. Salient priority areas that are currently being pursued include the following.

**Augmenting collection and utilization of Horticultural Genetic Resources:** Efforts are being made to catalogue horticultural biodiversity for better access, maintenance and their molecular characterization for IPR—National wealth. NBPRG-National Active Germplasm Sites (NAGS) have been established for major fruit, vegetable and plantation crops in different horticultural institutes. India hosts the International Coconut Gene Bank for South Asia under Coconut Genetic Resources Network of Bioversity. Regular efforts are being made to survey biodiversity hotspots of North East and the Western Ghats in collaboration with NBPRG for collecting and preserving the eroding germplasm. Special efforts are being made for collection of germplasm in native crops and species along with bioprospecting of native medicinal crops.

**Exploring natural diversity in fruit crops and promoting custodian farmers:** Natural populations of cross pollinated fruit crops are highly heterogeneous in nature. These result in a considerable variation in their yielding abilities,
fruit quality and maturity parameters. This provides enough opportunity for clonal selection of promising strains for various purposes. Participatory surveys are being carried out to identify such well-adapted elite clones and their custodian farmers. ICAR has been making efforts to link such native fruit biodiversity to livelihood security, empowering the custodian farmers. Jackfruit and Tamarind have proven the success of this strategy. ICAR has given wide publicity and created a model for commercialization of such elite types. 75% of the earning would go to the custodian farmer, providing him additional livelihood security and this strategy will be strongly taken forward.

**Linking genetic resources and breeding programs:** Pre-breeding efforts are being made to utilize wild species and thus linking genetic resources and breeding programs especially to incorporate disease resistance in crops like papaya, potato, tomato, chilli, okra etc. Resistance breeding is being carried out for fungal diseases like wilt in pomegranate, coconut, banana, guava; root rot of ginger; Phytophthora in solanaceous crops; Fusarium wilt in cucurbits and okra; Gummy stem blight of cucurbits; bacterial diseases likeRalstonia of solanaceous crops; Xantho monas in pomegranate and citrus; and viral diseases like PRSV of papaya, GBNV in tomato, Leaf curl virus in chilli etc. Artificial screening protocols have been developed for screening these breeding populations. In fact, out of 72 vegetable varieties identified during the last five years (2016-20) through AICRP trials, seven are resistant to important diseases viz., Tomato ToLCV, Brinjal bacterial wilt, Okra YVMV and Pea Powdery mildew.

**Breeding for abiotic stresses in fruit and vegetable crops:** Inter-specific breeding lines using Solanum pennelli and S pimpinellifolium have been developed for heat tolerance in tomato and Capsicum annum in sweet pepper, which are under testing. An early cauliflower variety Pusa Kartiki, garden pea variety Arka Chaitra and low chill varieties of apple, peach and pear suitable for subtropical temperatures are under cultivation. Salinity in grape, mango and citrus is being tackled using suitable root stocks. Flooding tolerance in tomato has been induced using brinjal cv. Arka Neelkant as a rootstock and has been widely demonstrated. Recently varieties have been developed in crops suitable for drought prone arid areas viz., Kachhri (AHK-119), Snapmelon (AHS-82) and Kejri (Thar Shobha).

**Marker-Assisted Breeding and Genomics:** Marker assisted breeding is being routinely used in breeding of various fruit, vegetable, spice and plantation crops. Arka Abhed of tomato resistant to four diseases ToLCV (Ty2+Ty3)+Bacterial wilt+Early blight+Late blight (Ph2 + Ph3) is an effort of marker assisted pyramiding. Similarly, pyramiding for bacterial wilt and nematode resistance is being carried out for developing root stocks for chilli. Markers have been developed for WBNV resistance through metaQTL analysis and fusarium wilt resistance through association mapping in watermelon. ICAR has participated in international potato genome sequencing consortium. Genome sequencing has been carried out in pomegranate cv. Bhagawa (356.98Mb), coconut cv Chowghat Green Dwarf (CGD) and mango (450 Mb). First Oil Palm Microsatellite database (OpSatDB) was developed. Di-

Immunity boosting cucurmin rich milk and milk powder has been recently commercialized under the name Golden milk. Mushroom fortified instant rasam mix and protein rich instant moringa soup mix have been commercialized.
agnostic markers have been developed to distinguish Pisifera, Dura and Tenera hybrids of oil palm at a seedling stage.

A three pronged strategy to tackle malnutrition by developing biofortified varieties, promoting native crops with nutraceutical value and fortified/probiotic value addition is being followed. Though fruits and vegetables are naturally rich in vitamins and minerals, several varieties possessing significantly better nutritional qualities have been developed. Some of them include Arka Rashmi of guava (235 mg/100 g ascorbic acid), Solapur Lal of pomegranate (iron, zinc and Vit C), Kufri Manik of potato (iron, zinc and carotenoids), Pusa KesariVita-1 of cauliflower (beta carotene 8-10 ppm), Bhu Krishna of sweet potato (Anthocyanin 90.0 mg/100g) etc. Improved varieties in native crops with nutritional and nutraceutical values such as CISH A-33 of Aonla, CISH Jamwant of Jamun, Shankara of Jackfruit and Bhagya variety of Moringa have been developed.

Fortification and probiotication through value addition is being intensely pursued. Immunity boosting cucurmin rich milk and milk powder has been recently commercialized under the name Golden milk. Mushroom fortified instant rasam mix and protein rich instant moringa soup mix have been commercialized. Similarly, anthocyanin rich microencapsulated products from Garcinia indica and probioticated pomegranate fruit juice have been developed.

Post-harvest losses in fruits and vegetables

Total post-harvest losses in fruits and vegetables as per the recent ICAR studies range between 6-16% (excluding losses in retailing). Presently, only 2.2% of fruits and vegetables are processed in the country as per Ministry of Food Processing Industries. India’s exports of processed fruits and vegetables were Rs 7,373.77 crores in 2018-19 (APEDA) suggesting a huge potential. The processing sector is being seen as a game changer to reduce post harvest losses, for price stabilization, value addition and to tap foreign markets.

ICAR has been working to develop varieties that are suitable for processing in various crops. Recently two hybrids of tomato (Arka Apeksha and Arka Vishes) suitable for ketchup and paste; onion variety Arka Yogith suitable for dehydration; potato variety Kufri Frysona suitable for french fries; turmeric variety IISR Pragati for cucurmin extraction; pomegranate variety Solapur Anardana suitable for anardana; grape variety Anjari Medika suitable for juice making have been developed.

Novel tools to improve breeding methodologies: Genomics assisted breeding is being regularly used in most of the horticultural crops as whole genome sequences and markers are already available. The future thrust should be to generate genomic resources for native crops. Gene editing using CRIS-PRcas9 strategy is being pursued for PRSV resistance in papaya. This strategy has been demonstrated for PDS gene of potato as a proof of concept. Doubled haploid strategy is being pursued in vegetable crops like chili, sweet pepper, cauliflower, onion, cucumber. Phenomics for trait discovery has been successfully demonstrated to study NUE in potato. Speed breeding is being tried in tomato, medicinal crops.

Along with improved varieties that can contribute to the increase in production levels, today we also need matching agronomic techniques to exploit their full potential in future. Few such emerging technologies include dwarfing and semi dwarfing root stocks of mango, citrus, guava, litchi, apple, pear, peach etc., managing canopy architecture and flower regulation in fruit crops, vegetable seedling grafting technology etc.

Emerging and disruptive propagation techniques such as bio-reactors for banana and ornamentals; embryonic cell suspension culture and macropropagation in banana; hydro/aeroponics in potato; leaf cutting propagation in guava etc are revolutionizing the horticultural planting material industry.

Environmentally safe management of biotic and abiotic stresses: Pesticide residues have always been a major con-
cern in horticultural crops. Of late, focus is on novel techniques to manage these stresses. RNAi based nano clay dsRNA formulation has been developed against late blight of potato and management of potato cyst nematode. In vitro bio-immunization technology for Fusarium wilt TR4 tolerant banana has been successfully demonstrated. Biopriming for protecting ginger seed rhizomes has been patented. Vegetable grafting to avoid soil-borne diseases such as bacterial wilt in tomato, nematodes in capsicum and Fusarium wilt in watermelon have been developed.

Traps have been designed for invasive pests like Tuta in tomato. Diagnostics kits like dip sticks (Lateral flow immuno strip) for BRMV and CMV in banana, lateral flow technology for potato viruses, NASH detection for Banana Bunchy Top Virus/ Banana Streak Virus and Real-time LAMP assays for viruses in spices have been developed. UAV & AI technologies are being used for pest & disease surveillance/ management especially for detecting damage symptoms of rhinoceros beetle, leaf eating caterpillar, root (wilt) disease and sooty mould associated with spiraling white fly infestation of coconut and other plantation crops. Bio-pesticides like ICAR-FUSICONT with strains of Trichoderma and Pseudomonas for management of panama wilt of banana and nutrient solubilisers like Arka microbial consortium for better nutrient mobilisation and Penicillium pinophilum for potash and phosphorous solubilization developed for pomegranate have been commercialized. The strategy of all these efforts has been to minimize pesticide use. In addition, food safety and referral laboratories have been established in major horticultural institutes to monitor pesticide residues.

Technology-led import substitution: As per the 2019 statistics of Seednet, Gol, India imports 7 lakh apple, 1 lakh Kiwi, 2 lakh date palm and 1 lakh oil palm planting material every year. ICAR has been laying stress on technologies to substitute this import. To that effect, low chill apple and peach varieties have been developed. Technologies for cultivation of exotic fruits like walnut, durian, kiwi, dragon fruit etc have been standardized and are being commercially followed. Multiplication technology for date palm has been developed and oil palm hybrids suitable for our subtropical region have been bred. In flower crops, varieties suitable for polyhouse cultivation of rose (Arka Swadesh) and gerbera have been bred to substitute imported material.

Horticulture contributes over 326.58 million MT (188.91 million MT of vegetables and 102.03 million MT of fruits) of production in the country growing at an impressive decadal rate of 4.8% (agri-coop.nic.in). To sustain previous years’ production, we need to work on mission mode to make up for the losses. Making seeds and fertilizers available, giving timely farm advisories, mechanization if intermittent lockdowns persist – all these shall all be integral components of this strategy.
Indian Institute of Information Technology, Nagpur (IIITN) launched its plantation campaign in the presence of Dr P M Padole, Director, Visvesvaraya National Institute of Technology (VNIT) and other dignitaries at the permanent campus of the institute located at Waranga village, Dongargaon (Butibori).

Dr Pooja Jain, IIITN Social Media Coordinator said that the development of state-of-the-art permanent campus of the institute is being undertaken over a sprawling 100 acres. The construction of Phase 1 consisting of Academic Block, Hostel Block, Admin Block and the Residential Block is in final stages. The institute has started operating from the campus and is committed for development of a green campus. It shall continue the plantation campaign with target of 500 trees within the campus.

Dr O G Kakde, Director, IITN; Dr Avinesh Keskar, Professor, VNIT; Dr MB Diagwane, Joint Director, Technical Education Regional Office, Govt of Maharashtra and Dr Arvin Kumar, Centre Head, Tata Consultancy Services, Nagpur were also present on the occasion.

Dr Ashwin Kothari, I/C Dean, IIITN; Mr Kailash Dakhalke, Registrar, IIITN, head of the departments along with R Adhyapak, AGM, NBCC (India) Limited and Surendra Gard, Director, Krishna Builders, New Delhi; Regional Manager of SBI joined the plantation campaign. Dr Tapan Kumar Jain, HoD, Electronics and Communication Engineering proposed the vote of thanks.
The vast production base offers India tremendous opportunities for export. During 2019-20, India exported fruits and vegetables worth Rs. 9,182.88 crores (1,277.38 USD Millions). This comprised of fruits worth Rs 4,832.81 crores (668.75 USD Millions) and vegetables worth Rs 4,350.13 crores (608.48 USD Millions).

Grapes, Pomegranates, Mangoes, Bananas, Oranges account for the larger portion of fruits exported from the country. Onions, Mixed Vegetables, Potatoes, Tomatoes, and Green Chilly contribute largely to the vegetable export basket. The major destinations for Indian fruits and vegetables are Bangladesh, UAE, Netherland, Nepal, Malaysia, UK, Sri Lanka, Oman and Qatar.

Though India’s share in the global market is still nearly 1 per cent only, there is increasing acceptance of horticulture produce from the country. This has occurred due to concurrent developments in the areas of state-of-the-art cold chain infrastructure and quality assurance measures.

India’s export of Processed Food was Rs 31,204.78 Crores in 2019-20. This included many...
product categories in value-added horticulture space like Mango Pulp Rs 584.32 Crores (81.90 USD Millions), Processed Vegetables (Rs 2760.53 Crores/ 386.62 USD Millions), Cucumber and Gherkins (Prepared & Preserved) (Rs 1241.21 Crores/ 173.49 USD Millions), Processed Fruits, Juices and Nuts (Rs 3086.44 Crores/ 432.04 USD Millions).

Mother Dairy has been one of the pioneer organized players in the horticulture business in India. It has many firsts to its credit like fresh fruits and vegetables retailing and frozen peas launch in India. It ventured into exports of fresh and processed horticulture produce in the year 1995.

Currently Mother Dairy is one the leading exporters of horticulture produce from India with its products reaching more than 45 countries worldwide. Mother Dairy exports products like alphonso mango pulp, totapuri mango pulp, guava pulp, preserved gherkins, frozen green peas, fresh banana etc. Over the years Mother Dairy has emerged as a preferred supplier of horticulture produce from India for many global names of repute like Coke, Pepsi, Unilever, Danone etc. It is known for its quality and consistency. The plants operated by Mother Dairy are certified to meet the international food standards.

**Backend Initiatives**

Mother Dairy has taken several initiatives at its backend to meet the export demands. It has undertaken extensive work in sustainable farming of mango in collaboration with Coke (world's largest beverage company) and Innocent (a reputed beverage maker in United Kingdom). It is supplying mango pulp made from SAI (Sustainable Agriculture Initiative) certified mango farms. Such an initiative (SAI certification) helps the farmer to gain and implement the latest knowledge of good scientific agricultural practices in his farm.

Mother Dairy is encouraging the use of bio/organic pesticides so that the produce is well accepted in the global market. Two of its fruit processing plants are organic certified and are processing organic products.

In the process he can manage his farms in a more organized and scientific manner which translates to improved earnings year after year.

Customer service and customised product deliverables consistently have been the hallmark to retain and grow brand India at the global platform. One such classic case has been the demand for chlorine-free food ingredients from Europe for baby food applications. It is pertinent to mention that chlorinated water is used to wash fruits before processing to make them germ free. So, the challenge was to use non-chlorinated water and still get the same results post washing in terms of outer surface germ levels. Mother Dairy rose to the occasion and developed a process to produce a chlorine free food ingredient on a commercial scale. The product was not only well accepted but also generated repeat orders and demand from other European customers. Such initiatives will go a long way to cement India’s position as an emerging destination for world class food ingredients.

Mother Dairy is encouraging the use of bio/organic pesticides so that the produce is well accepted in the global market. Two of its fruit processing plants are organic certified and are processing organic products also.

Going forward, Mother Dairy plans through to further augment its horticulture-based export portfolio through addition of new products and new markets. It will also continue to make significant backend interventions to support its plans and create meaningful value proposition for the farmers at large.
The horticulture and plantation sector has witnessed significant production growth in the past few years. This has led to enhancement of exports of fruits and vegetables to the major traditional markets of UK, UAE, Bangladesh and Middle East countries.

Realization from India’s fruits and vegetables exports rose to Rs 11,019 crore (US$1487 million) in 2020-21 from Rs 10,114 crore (US$ 1408 million) reported in 2019-20. The value of processed fruits and vegetables exports grew to Rs 10,277 crore (US$ million 1386) in 2020-21 from Rs 8315 crore (US$ 1164 million) in 2019-20. APEDA has made persistent marketing efforts with European Union markets resulting in exports growth of more than 9% in 2020-21 over the year 2019-20.

APEDA has been making efforts to boosts exports of fruits, vegetables and plantation crops through taking a series of measures including creating adequate infrastructure, ensuring supplies of quality input material, controlling pests and diseases, ensuring compliance of phyto-sanitary norms and establishment of market linkages for boosting exports through collaborations with various institutions.

**Infrastructure development**

APEDA has assisted exporters for setting up modern integrated packhouses having facilities as per requirements of importing countries. APEDA has provided assistance for purchase of refrigerated vehicles to support the supply chain in horticulture. This has largely helped exporters of fresh horticulture produce

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**About the Author**

Dr Madhaiyaan Angamuthu is an IAS officer of the Assam-Meghalaya Cadre, with ample experience in several key sectors of public administration. He is currently Chairman, Agricultural and Processed Food Products Export Development Authority (APEDA), an apex organisation of the Ministry of Commerce and Industry, GOI, created specifically for export promotion of agro and allied products from India.
like mangoes, pomegranates, grapes, bananas, fresh vegetables and the floriculture sector. Due to the short shelf life of most fruits and vegetables, more than 50 percent of exports are through air cargo to destinations such as the UK, Netherlands, Germany, Australia, Japan, Korea, Singapore, Africa and Middle East.

The modern integrated pack houses which are able to meet the requirements of issues associated with quality and post -management have helped the horticulture export sector. APEDA has assisted in the establishment of around 250 export-oriented European Union compliant pack houses in the private sector. The financial assistance provided to state governments as part of infrastructure development has also enhanced their export capacity.

Cluster-based approach
For the implementation of the Agri Export Policy (AEP) announced in 2018, 14 product clusters spread across in six states dedicated to horticulture products have been identified. The policy aims at achieving doubling farmer’s income and doubling exports with focus at providing adequate resources to farmers to become direct exporters without intermediaries.

States have approached APEDA & Ministry of Commerce for adoption of more and more product-based clusters. The models of banana exports from the clusters of Anantapur and Theni in Tamil Nadu, Jalgaon and Solapur in Maharashtra have been testimony to this fact. Similar success has been achieved by increasing export of mangoes from clusters in AP, Telangana, UP and Maharashtra. Other successful models have been for grapes from Nashik, vegetables from Uttar Pradesh and Bihar.

The farmer centric model of cluster development has taken place in Varanasi (UP). The export hub project of vegetable and fruit has been able to demonstrate usefulness of backward and forward linkages.

APEDA has been able to arrange MOU between FPOs/FPCs with exporters for organizing procurement of quality produce directly by FPC for exports. The project has involvement of local university and state government for technical support. Forward linkages were established including supply chain and logistics to achieve a breakthrough of exports of horticulture products from the landlocked district of Varanasi. The export hub project has resulted in starting shipment of vegetables and fruits directly from Lucknow and Varanasi airports. This model can be replicated in other regions.

Prevention of Pest and diseases
To meet the challenges of managing pest and diseases, GOI and the state governments have Standard Operating Procedures for producing pest-free horticultural produce in their region. APEDA is collaborating with institutions such as ICAR, CSIR and CFTRI for export-oriented research to support Indian horticulture export. Linkages of organizations like IFFCO, ITC, agri universities and KVKs are boosting appropriate farm practices.

Scientific Pre & Post-Harvest Management
The establishment of a cold chain and implementation of pre harvest at the farm gate is helping farmers. Pre and post- harvest management is established by the corporate, leading processors, exporters at the farm gate or in the contiguous area by using techniques of mobile equipment.

Market Access and forward linkages
Many countries impose restrictions of market access and sometimes non-tariff barriers to inhibit imports. The tool is also used to bargain for market access of their produce in India. The horticulture produced in India is subject to competition in international markets. The absence of bilateral agreements between major importers and India has proved to be disadvantageous. The examples are exports of fruits and vegetables from Africa and Latin America to Europe. These countries enjoy preferential duty concessions. They face no technical barriers while exporting, as compared to India. APEDA proposes aggressive negotiations for bilateral agreement for turning the table in favour of India.

There is need for better marketing avenues to Indian exporters by undertaking huge branding exercises to place the produce in the shelves of major marketing chains. Efforts have been made by organizing product specific and country specific Buyer Seller Meets (BSMs) to help branding of Indian Horticulture Produce with the help of the concerned Embassy or Consulate and APEDA.
On July 15, the recently established Agriculture Advancement Group International organized an International Webinar to review the status of India’s Agricultural Education System. IAAG explored the need to reform and re-engineer the system in the context of the country’s National Education Policy (NEP) issued in 2020.

The NEP recognizes the problems currently faced by India’s higher education system including that for agriculture which include: rigid separation of disciplines; fewer institutions in socio-economically disadvantaged areas; limited teacher and institutional autonomy; inadequate mechanisms for merit-based faculty recruitment and career development; lesser emphasis on research, sub-optimal governance and leadership of higher education institutions; ineffective regulatory system; and low standards of undergraduate education. The NEP envisages a complete overall and reengineering of India’s higher education system to overcome these challenges. Therefore, it brings an excellent opportunity to bring major transformation.
in India’s SAU and motivate their faculty for higher level of accountability in research, teaching, and extension.

It is in this context, the webinar explored various issues that must be addressed while extending NEP to the agricultural education system. The main speakers at the webinar were Dr. H. S. Gaur (Dean, Agricultural Sciences, Sharda University, Noida and former Vice Chancellor of Sardar Vallabhbhai Patel University of Agriculture, Meerut); Padma Bhushan Dr Ram Badan Singh (Former President of the National Academy of Social Sciences); Padma Bhushan Dr Rajendra S. Paroda (President, Trust for Advancement of Agricultural Sciences (TAAS) and Former Director General of ICAR); Dr BS Dhillon (Former Vice Chancellor of Punjab Agricultural University); Dr Prabhakar Tamboli (Adjunct Professor and Director of International Training, University of Maryland, USA); and Dr Ramesh Kanwar (Charles F. Curtiss Distinguished Professor, Department of Agriculture & Biosystems Engineering, IOWA State University).

What is wrong with India’s Agricultural Education System?

From around early 1990s, when the Green Revolution began to wane and agricultural growth became sluggish, the SAU system also started facing a range of challenges in areas such as: (a) Governance (with little or no autonomy to Vice Chancellors), exacerbated by frequent interventions by government officials and politicians, (b) Lack of meritocracy in education; (c) Limited National- State coordination; (c) Fragmentation and disconnects among research, extension and education; (d) Inadequate investment and imbalance in resource allocation, together with a lack of reforms and slow or no implementation of adopted reforms; and above all (e) Outdated curricula and infrastructure and almost little and zero accountability of faculty performance in annual rewards or timebound promotions resulting in mediocrity in almost all SAUs. Once you bring mediocrity in higher education instead of excellence, entire nation suffers in technology and science innovations and will not be able to compete today’s digital age of global competition.

A fundamental shortcoming of the Universities was that their grant requests were mostly for construction of buildings (bricks and mortar) and permanent structures and little for “softer” components, i.e., research, teaching and training, equipment, talent development and academic activities” .... “About 90% of the recurring grants are exhausted in meeting salaries and hardly 10% for operational purposes. Teachers, scientists, and technicians’ salaries have improved considerably but that is not reflected in the increased responsibility, outcome, and accountability of faculty in performance as measured by number of citations and papers published in highly cited world class journals. Generally, there is initiative-, commitment-, and attitude-deficit, and “comfort with mediocrity” has become an accepted policy of university functioning at all SAUs as the trend of present and future.”

That was around 2012 and 2013. Recently, Dr. Raj Paroda, President of the Trust for Advancement of Agricultural Sciences (TAAS) and Former Director General of ICAR, in his book titled Reorienting Indian Agriculture made a series of recommendations including the following:

(a) There is a need to have a re-look at the status of the Land Grant System as a whole, to revitalize the Indian agricultural education system and restore and revitalize its basic concepts and principles while ensuring much-needed reforms for a change for good.

(b) The agricultural education system should be broad-based and must fulfill the needs of all stakeholders associated with agricultural production, processing, and the marketing value chain.

(c) The universities must have full autonomy and be free of political interference and nepotism, with the established preeminence of the vice-chancellor’s position.

(d) There is a need to establish an Agricultural Education Commission on the lines of the Farmers’ Commission, which was headed by Dr M.S. Swaminathan, to review and suggest needed reforms at the
national level.

(e) A statutory body like the Agricultural Education Council, on the lines of the Indian Veterinary Council, should be established urgently under the Department of Agricultural Research and Education (DARE), with the effective functioning of the accreditation system, linked effectively with federal funding.

(f) Boards of governors and university-level academic committees should include international experts to ensure excellence in research and education.

(g) Restructuring and amalgamation of agricultural education institutions, especially sub-discipline-based bifurcated universities, are urgently required to improve their relevance and quality of education in a holistic manner.

(h) Universities must be sufficiently funded to enable high-quality and advanced research, teaching and communication facilities.

(i) Besides salaries, operational funds in the ratio 60:40 should be ensured for all universities through provision of a competitive research grant system. Faculties should be encouraged to generate resources from outside sources/organizations.

(j) The recruitment and promotion system needs a thorough review with merit and excellence given prime importance in selection as well as career advancement.

(k) Agriculture must find a prominent place in the course content at primary and secondary school levels, especially to generate awareness by and attract youth to agriculture.

(l) The course content of agricultural universities should be relevant to the evolving needs of the country considering the rapid global scientific and economic advancements. Courses in new emerging fields such as nanotechnology, biotechnology, ICT, GIS, post-harvest technology, agri-business management and market intelligence should be included in the revised course curricula.

(m) The education system should be accessible to all stakeholders offering theoretical and practical training of different levels and durations, including informal vocational training programs. Due emphasis needs to be given to interdisciplinary courses that are highly relevant to the current agricultural production as well as the farming system’s needs. Also, inter-institutional collaboration must be encouraged, both for teaching and research.

National Education Policy (NEP) 2020: Does it show the way to Reform India’s Agricultural Education System?

The recently issued NEP talks little about agricultural education per se but does show the way to reform and reengineer India’s agricultural education system in conjunction with the systems for other branches of education, especially
such that it can deliver high-quality higher education, with equity and inclusion.

NEP’s Vision envisages the following key changes to the current system:

(a) Moving towards a higher educational system consisting of large, multi-disciplinary universities and colleges with at least one in or near every district, and with more HEIs across India that offer medium of instruction or programs in local/Indian languages.

(b) Moving towards a more multi-disciplinary undergraduate education.

(c) Moving towards faculty and institutional autonomy.

(d) Revamping curriculum, pedagogy, assessment, and student support for enhanced student experiences.

(e) Reaffirming the integrity of faculty and institutional leadership positions through merit-appointments and career progression based on teaching, research, and service.

(f) Establishment of a National Research Foundation to fund outstanding peer-reviewed research and to actively seed research in universities and colleges.

(g) Governance of HEIs by highly qualified independent boards having academic and administrative autonomy.

(h) “Light but tight” regulation by a single regulator for higher education, and

(i) Increased access, equity, and inclusion through a range of measures, including greater opportunities for outstanding public education, scholarship by private/philanthropic universities for disadvantaged and underprivileged students; online education, Open Distance Learning (ODL), and all infrastructure and learning materials accessible and available to learners with disabilities.

All the above themes are relevant to the potential reform of India’s Agricultural Education System. Specifically, NEP says that Agricultural Education with allied disciplines must be revived. NEP emphasizes that “although Agricultural Universities comprise approximately 9% of all universities in the country, the enrollment in agriculture and allied sciences is less than 1% of all enrollments in higher education. Both capacity and quality of agriculture and allied disciplines must be improved to increase agricultural productivity through better skilled graduates and technicians, innovative research and market-based extension linked to technologies and practices. The preparation of professionals in agriculture and veterinary sciences through programs integrated with general education will be increased sharply.”

NEP also notes that the design of agricultural education must shift towards developing professionals with the ability to understand and use local knowledge, traditional knowledge, and emerging technologies while being cognizant of critical issues such as declining land productivity, climate change, food sufficiency for the country’s growing population, etc. Institutions offering agricultural education must benefit local community directly, one approach could be to set up Agricultural Technology Parks to promote technology incubation and promote sustainable methodologies.

Four Major Structures
Many of the recommendations made earlier by various government appointed and non-governmental committees and review committee reports remain unimplemented and will need to be revisited in the context of NEP approach. The main thrust of NEP is to end the fragmentation of higher education and transform the higher educational institutions with large multidisciplinary universities, colleges and HEI clusters/ knowledge hubs. The NEP also emphasizes that the regulatory system for higher education needs a complete overhaul to re-energize higher education sector and enable it to thrive and suggests that the regulatory system of higher education should ensure that the distinct functions of regulation, accreditation, funding, and academic standard setting will be performed by distinct, independent, and empowered bodies. To this end, the NEC suggests four structures as follows:

- **NHREC**: The National Higher Education Regulatory Council as the common, single-point regulator for higher education.
- **NAC**: The National Accreditation Council will be a meta-accreditation body as an independent body for accreditation of higher education institutions based on basic norms, public self-disclosure, good governance, and outcomes.
- **HEGC**: The Higher Education Grants Council will carry out funding and financing of higher education based on transparent criteria including the quality and content of the proposals prepared by the institutions and the progress made in their implementation. HEGC will be responsible for development of scholarships and development funds. And
- **GEC**: The General Education Council will frame expected learning outcomes for higher education programs referred as “graduate attributes”.

ICAR has formed a six-member committee headed by Dr Tej Pratap, VC of G B Pant University of Agriculture, Uttarakhand, to suggest ways in which agricultural institutions can be nurtured in the spirit of the NEP.
Fruits produced in subtropics account for about 40% of India’s total fruit basket. Major subtropical fruits are mango, banana, papaya, citrus, guava, pineapple, litchi, sapota and pomegranate. Among the minor fruits, jackfruit, bael, aonla, carambola, phalsa, passion fruit and tamarind are grown in subtropical states. High-quality fruits of sweet oranges, kinnow, pomelo, grapefruit, lime and lemons are produced in the subtropical region of the country.

Temperate fruit production is growing rapidly in sub-tropical regions. The demand for temperate stone fruits is increasing, so prices are much higher than abundant tropical fruits. Subtropical regions are climate-friendly and can provide options for diversifying horticulture production systems due to the high quality of their products. They also provide livelihood support. A range of low chill requiring peach, plum, pear and apple varieties are becoming popular in subtropical regions. Strawberry cultivation is picking up in the subtropical plains as a commercial venture. Persimmon and loquat are well-suited crops for the subtropics of India.

Mangoes grown in Uttar Pradesh, Bihar, and West Bengal are famous around the world and are also exported from the region. The majority of litchi production is limited to subtropics. Kinnow, which has earned an important place in the Indian fruit basket, is excellent in quality only when grown in a subtropical climate. Banana, primarily crop of southern states, has also become a major fruit crop in parts of Uttar Pradesh and Bihar. Fruit production in the subtropics contributes to extend the period of fruit availability in the market because crop harvest season is late than the tropical areas of the country.

ABOUT THE AUTHOR
Dr Shailendra Rajan is Director, ICAR-Central Institute for Subtropical Horticulture, Lucknow. He has made outstanding contributions to mango and guava variety development and genetic resource management.
Guava is an important subtropical fruit of India. The world’s best quality guavas are produced in India’s subtropical regions. Northern India’s winter climate is ideal for growing high-quality guavas. In addition to UP, due to the introduction of new varieties and production technology, guava is becoming an important economic crop in Rajasthan, Madhya Pradesh, Haryana, Punjab and West Bengal. The cultivation is extended to an elevation of 4,500 feet in Arunachal Pradesh where ICAR-CISH varieties are performing outstandingly well.

Diversification of Fruit Industry

In the subtropics, the fruit industry is diversifying for supporting livelihood and consumers demand. Subtropical fruit production is not limited to traditional crops like mango, papaya, phalsa, lime etc. New fruit crops are being introduced into the production system. Banana has overtaken sugarcane as the most important cash crop in parts of Uttar Pradesh and Bihar. Fusarium Tropical Race-4 posed a threat to subtropical farmers. Thanks to ICAR-FUSICONT Technology, farmers were able to effectively manage the wilt in epidemic areas. Previously, the disease forced farmers to stop growing bananas in disease hotspot areas. Now commercial production of high-value fruit crops such as figs, avocado, longan, blueberries, and excellent quality sweet oranges is possible.

Based on the changing scenario of irrigation water availability in the traditional banana production areas of the south and Central India, considerable banana cultivation might shift to the subtropics where irrigation water availability in near future will be comparatively better than the other parts of the country.

Subtropical fruit production is also sensitive to climate change issue. Mango industry in subtropical region is facing disease and pest outbreaks, pollination and fruit set problems. Due to degrading ecosystem services pollinator population, in the orchards is declining. The use of pesticides has badly affected the naturally occurring predators and parasites in orchard ecosystem. Due to frequent rains during fruit development, fruit quality is also deteriorated.

Newer methods of mass multiplication of fruit crops have contributed to the expansion of the area under grafted plants for newer high yielding varieties. Wedge grafting is replacing traditional methods of inarching and layering in many parts of the region. The ICAR-CISH wedge grafting technique has enabled the production of millions of grafted guava plants by nurserymen. The technique is economical, efficient and has been adopted by subtropical nurserymen, creating job opportunities. Variety replacement is occurring in fruit crops as a result of the easy availability of grafted planting material.

Increasing Demand For Jamun

In the subtropics, jamun is a promising crop. Market demand is increasing due to their anti-diabetic properties and high bioactive compound content. Previously, Jamun was thought to be a forest tree or a plant that grew along the roadside. Seedlings were used to plant Jamun trees, and few people were interested in planting an organized orchard of Jamun trees, which take seven to ten years to bear fruit. The seeding trees are large, and it is difficult to properly harvest the fruits. The grafting technique for crops such as Jamun has been developed, and organized cultivation is becoming popular. Grafted plants of Jamun start fruiting within five years and the tree size is also manageable. Fruits are sold at a premium rate.

The availability of sufficient quantities of tissue plants facilitated the banana cultivation area to expand more than eight times in a decade in Uttar Pradesh and Bihar. Tissue culture banana plants are easy to transport and are generally disease-free. ICAR-CSSRI-CISH’s bioimmunization technology for tissue culture plants has been successfully demonstrated against banana Fusarium wilt in epidemic areas of Uttar Pradesh and Bihar.

The area under cereal crops is gradually being replaced by subtropical fruits. Farmers are looking to diversify their income streams in response to the growing demand for fruits, and one of the most important avenues for them is fruit production. In the country’s subtropical zone, government policies are also encouraging the introduction of new crops. This not only reduces the farmer’s reliance on a small number of traditional field crops, but it also improves his or her financial situation.

Subtropical fruits are closely linked to value addition and the supply chain. Farm-level processing and infrastructure are being established in other parts of the country, increasing the possibility of using raw materials produced in the region.
HELPING EAST-WEST SEED TO EXPAND ITS PRODUCT REACH TO SMALLHOLDER FARMS

G C Shivakumar, the General Manager of East-West Seed India, in conversation with Agriculture Today in an exclusive tete-a-tete

How has East-West Seed evolved since its inception?
We are a global leader in the tropical vegetable seeds market. Founded by Dr. Simon Groot, winner of the World Food Prize 2019, our focus is developing improved vegetable varieties to help smallholder farmers increase their production and incomes. East-West Seed ranked #1 on the 2019 Global Access to Seed Index, which recognizes the commitment and performance in providing the world’s smallholder farmers access to quality seeds.

Recently, East-West Seed ranked in the top 30 of FOR-TUNE’s 2020 “Change the World” list of global companies that are “doing well by doing good.” This again showcases the power of capitalism to improve the human condition by identifying companies that have made a significant social or environmental impact through their profit-making strategy and operations.

While we are among the top ten seed companies in the world, we are among the top six companies in India. Our goal is to be among the top three vegetable seed companies in India by 2022, driven by market-leading growth. We currently offer 150 varieties across 32 crops for Indian farmers and continue to expand in India with R&D centers, warehouses, people, and new products.

What makes your R&D approach unique?
We are a pure-play tropical vegetable seed company. Our approach to breeding is unique as we look at local factors and breed distinct varieties that will thrive in specific geographies. We also look at consumer preferences constantly and customize our breeding approaches.

How do you plan to expand your Knowledge Transfer activities?
Our Knowledge Transfer (KT) Initiative is an independently funded and managed nonprofit initiative that seeks to improve growers’ skills, knowledge, and techniques in the rural, underdeveloped regions. East-West Seed dedicates 1.25% of its

East-West Seed India, a Dutch-based tropical vegetable seeds company with 37 years of experience in breeding, producing, and delivering high-quality vegetable seeds, reaching new milestones
global sales profit to this initiative. About 150 staff train more than 1,00,000 farmers each year in eight countries in Asia and Africa. We have helped more than 50,000 smallholder vegetable farmers in India by providing better farming practices in producing quality vegetables.

The Knowledge Transfer team works alongside committed partners like USAID, ISSD, UKAID, Wageningen University, Solidaridad, Mercy Corps, who share our vision.

Our KT teams aim to reach millions more through other media, such as crop guides translated into the local languages and instructions accessible to all education levels digitally via YouTube and FB.

**Is East-West Seed harnessing the power of digital technology in reaching out to farmers?**

Yes. Through our digital outreach e-Connect, our commercial teams connect with farmers across India, offering them crop advisory and helping them make the right decisions. In the past one and half years, over 100,000 farmers have been trained through the digital platform.

East-West Seed India has tied up with four rural-based major e-commerce firms, Agrostar, Bighaat, Dehaat, and Gramophone, to deliver vegetable seeds pan India. Under the partnership, farmers all over India can order East-West India seeds through the above digital agri-tech platforms and get last-mile delivery of seeds directly to their doorstep while following hygiene and social distancing norms.

**Is East-West Seed focussing on climate-smart agricultural approaches?**

The impact of climate change on agriculture and food production is one of the biggest challenges of these times. By breeding better climate-resilient vegetable varieties - e.g., drought-tolerant tomato, disease-resistant crops, East-West Seed promotes crop diversification, countering the resource-depleting mono-culture practices still applied in many of our markets. We are also training our farmers on climate-smart agriculture.

**Has EWS launched any new products during these times of the pandemic? Any new launches scheduled this year?**

Smallholder tomato farmers face many challenges posed by the COVID -19 scenario, transportability of their produce to the marketplace being a major one. East-West Seed India introduced two new high-yielding tomato hybrids Shreya and Ria, which smallholder farmers are praising for their consistency in size, color, and suitability for transport over long distances, helping them tide over logistical challenges in these testing times. These hybrids are suitable for cultivation from July to December in Karnataka, Telangana, Tamil Nadu, and Andhra Pradesh.

Similarly, Bitter gourd hybrid - Pia was launched in Tamil Nadu. The response for this product is very positive. Laava, our high-performing chilli hybrid, is very popular with smallholder farmers in Telangana and Andhra Pradesh. The hybrid reduces production costs due to its good virus tolerance and easy picking qualities, which helps to catch the market early in these times of the pandemic.

Orange Ball, a new marigold hybrid from East-West Seed India, is now popular with Karnataka and Maharashtra farmers. The hybrid presents firm flowers and deep orange color with good disease tolerance and easy picking qualities. This is helping smallholder farmers catch the market with repeat pickings.

There is an increasing trend towards urban farming, especially during these times of the pandemic. To tap into the segment, East-West Seed has launched ‘Go Grow’. This is a new range of 14 crops designed to help enthusiastic gardeners kick-start the cultivation of fresh vegetables. All products are carefully selected and curated based on urban consumers’ requirements of vegetables at home and easy-to-grow products. Go Grow packs come with a planting guide with handy information on cultivation practices such as sowing, spacing, fertilizing with planting, and harvesting calendar.

Another exciting crop category launched this year is the Butternut (Cucurbita moschata). It has a sweet, nutty taste similar to a pumpkin and a tan-yellow skin with orange fleshy pulp. It offers a good source of fiber, vitamin C & A, magnesium, and potassium.

This year, we are focussing on Icebox Watermelon with three personal segment hybrid launches - Sugar Dew, Mukasa, and Red Velvet to suit local preferences across India.
Horticulture, Landscaping

Changing Dimensions of Urban Gardening

The horticulture and landscaping industry has immense potential for generating remunerative self-employment among small and marginal farmers and unemployed youth. Planting material is the backbone of the horticulture and landscaping industry. The initial plants acts as a rootstock which is propagated further.

With increasing urbanization, the demand for fruits, vegetable, grasses, foliage, flowering and medicinal potted plants shall increase manifold. We need to gear up for the opportunity by adopting modern scientific production systems to deliver quality plants at reasonable rates. The need of the hour is to diversify and create newer and attractive options of plants to make the horticulture and landscaping industry even more attractive. Hydroponics, terrace garden and vertical gardens are becoming popular day by day. Horticulture and the landscaping industry should align themselves to cater to this demand by

About the Author

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growing suitable plants for different seasons.

With the introduction of tissue cultured plants and soil substitutes like light weight absorbent granules, soil rite mix, Perlite, coco pit and rice husk, the scope of horticulture and landscaping on the roof top, and on balconies, window boxes and containers has increased. Community driven and decentralized efforts shall boost the change. Plant lovers can be educated regarding composting of organic waste at point of generation, hundred percent recycling of waste water, installation of solar power plants etc. These practices in urban buildings will decrease the carbon footprint. They shall make the cities healthier and less of burden on our ecology.

**Green Wall/Vertical Garden**

Green Wall or Vertical Garden is the new concept of gardening. It is particularly suitable for cities, as they allow good use of available vertical surface areas. These may become commonplace in commercial and residential buildings. A Green Wall, also known as living wall, bio wall or a vertical garden, is a living plant based exterior or interior wall to buildings or homes which may be free standing structures or part of the building. They are more frequently composed of climbing plants, but there are other options that some designers have incorporated. For example, plants are grown in specially-made support structure and growth media such as soil. The benefits of a Green Wall go far beyond aesthetics.

Some vegetables can be grown vertically in small spaces. All three types of peas – snow peas, snap peas, and garden peas – grow well vertically. Other vegetable choices for green walls are green beans, cucumbers, pumpkins, tomatoes, winter squash, summer squash etc.

**Hydroponics**

Hydroponics and organic hydroponics are environment friendly technologies suitable for growing all kind of plants using balanced nutrients in a scientific way. This soilless culture technology not only supplements but also compliments the normal soil condition. It is a clean and scientific eco technology – a smart way to grow plants.

Hydroponics is highly productive and yields superior quality crop produce round the year, irrespective of the soil and climatic conditions. Organic farming is as good as hydroponic farming albeit with low and slow productivity.

**Rooftop Gardening**

Rooftop gardens form the main crux of urban gardening. They are beneficial not only to the roof owner but also to our society and city. A rooftop garden gives life to the roof. It helps in reducing energy costs substantially. It reduces air pollution and prevents the city’s storm-water drainage infrastructure from being overwhelmed.

There must be guidelines for rooftop gardening which take into account the modern methods of construction of rooftop gardens. These methods evolve with time and are constantly updated so that the correct systems and products are used for the construction of the roof. This would include a good waterproofing system and a right drainage system with the right type of geo-textile. These two components form the main foundation of the green roof. If even one of these fails, the whole system fails.

Rooftop gardens must be lightweight and also economical. One must use various modern technologies to reduce soil usage for the construction of green roof and also to reduce water usage. It is of paramount importance to select the right plants for the right climate. It would be a disaster to have an unhealthy garden after spending so much time and effort.
Jammu and Kashmir is known for its delectable basket of fruits like apples, walnuts, cherries and more. Livelihood of the majority of the population of the UT revolves around agriculture and allied sectors. In the latest of its many interventions in J&K, NAFED has undertaken procurement of Kashmiri Cherry directly from the growers for the first time. The purchase was initially done through farmers registered with NAFED supported Farmer Producer Organizations (FPOs) at the tehsil level in various districts of J&K and subsequently from the other farmers.

In the recent years NAFED has made several notable interventions in Jammu and Kashmir with the aim of bringing prosperity to the farm sector and improving the income of farmers. The Federation has been implementing the Market Intervention Scheme of Ministry of Agriculture and Farmer’s Welfare since 2019 for providing alternate marketing channels to apple cultivators.

NAFED is the designated GOI agency for providing subsidy under the scheme Operation Greens for transportation and storage of apples. NAFED is also in the process of implementing an investment plan in association with the UT Administration for high density plantation of temperate crops for increasing their productivity, creation of post harvest...
holistic development of cherry farmers

Role of FPOs

FPOs played a crucial role in mobilizing farmers and in buying directly from other farmers. The operation has empowered Kashmiri farmers with good market linkages for their produce pan India at the right time. NAFED shall promote cooperative marketing of agricultural produce for the benefit of farmers. Direct procurement from growers will provide better price recovery in comparison to the prevailing system of sale through traders and middlemen.

Future Prospects

The market response to NAFED’s intervention was overwhelming for good quality graded cherries. There is immense potential in future for undertaking the business of this hugely popular berry along with other popular fruits of the valley like Pears, Plums and Apples through direct procurement at farm gate. Payment of the sale proceeds directly to the bank accounts of the growers through direct benefit transfer (DBT) has empowered the cherry growers of the valley. There is immense potential for export of the produce, especially to the Gulf region. But there is fierce competition from Turkey and European varieties, particularly in terms of pricing. NAFED’s intervention for procurement of cherries in J&K will go a long way in providing marketing support and remunerative prices to cherry cultivators along with sustainable development of the agri sector in the union territory.

NAFED’s intervention brings respite to cherry farmers

The recent interventions of NAFED in Jammu and Kashmir are aimed at strengthening the efforts of GOI for bringing peace and prosperity in the UT. The cherry varieties procured by NAFED include the popular Makhmali and Mishri. The berries were directly procured from growers in Shopian, Pulwama and Baramulla districts. It was an extremely challenging operation considering the highly perishable nature and limited shelf life of the fruit. Most of the produce was dispatched by air to far flung destinations. To the closer destinations, dispatches were arranged via rail and road. To provide quality product to the end consumer, efforts were made to ensure that the produce arrives at the market within 24 hrs of the harvest and got liquidated within 48 hrs of the harvest across India.

The produce was distributed across different markets of Bangalore, Kolkata, Mumbai, Delhi, Jaipur etc. Farmers were paid according to the market prices. Direct payment was made to the farmers within three days of the purchase. The produce is being sold in the local markets at the destinations and also through the various retail outlets of NAFED Bazaars. Around 900 quintals of cherries were procured across J&K directly from growers. These were aggregated, graded and packed at the FPO collection centers before being dispatched to the destination markets for disposal.

Educating the cherry cultivators

NAFED’s endeavour is to work for the holistic development of cherry cultivators. NAFED is investing intensive efforts in educating farmers about the best practices of cherry cultivation and making them aware about the modern packing and grading techniques in order to revamp the entire supply chain. Farm level traceability for the produce was done with the joint efforts of FPOs & NAFED. To add market value with the aim of fetching better price realization, co-branding of the produce was also done.

Global and India’s Production Levels

Today, cherries are cultivated globally. India ranks 34 in global cherry production. Turkey, US, and Iran are the top 3 growers of the fruit with production levels of 8.23, 4.47 and 3.03 Lakh MT respectively in 2018. India’s production ranges around 10,000 to 15,000 MT.

In India cherries are cultivated in J&K, Uttar Pradesh and Himachal Pradesh. Jammu and Kashmir accounts for a significant part of the country’s cherry production. These states cultivate several varieties in colors ranging from yellowish-pink to dark red. The cherry harvesting season begins from mid-May and lasts up to the first week of July. The crop is extremely prone to weather conditions. Cherries are low in calories and contain antioxidants that help fight infections. The fruit is also known to reduce inflammation, blood pressure and uric acid levels.

infrastructure hubs and formation of crop specific FPOs in each district. The infrastructure being created includes end-to-end supply chain comprising pre-conditioning, controlled atmosphere storage (60,000MT), onion storage (20,000MT), processing facilities and more.
Known for the best quality of seeds, Syngenta vegetable seeds is globally recognized for its blockbuster tomato hybrids and has gained long term trust of growers. One in six tomatoes grown worldwide is varieties of Syngenta vegetable seeds.

Similarly in India, Syngenta is the market leader in tomato seed supply to growers. To name a few, the best tomato hybrids are Saaho, Abhinav, Heemshikhar, Heemsohna and TO-1057. In tune with changing tastes and ecological dynamics, Syngenta tomato hybrids have always innovated new trends in tomato cultivation, paved the path for improvement of yield and maximize grower’s income.

Heemshikhar is a Rabi or winter season indeterminate tomato hybrid. It was launched in 2010 when the growers were facing a challenge to transport tomatoes to long distance markets, affected by the TyLCV virus. Since its launch, Heemshikhar has become a favourite hybrid for tomato growers all over the country. It offers several benefits to growers and traders alike. Growers have excellent experiences of cultivating Heemshikhar. Mr Rakesh bhai Patel from Anand district of Gujarat shares: “For the last six years, I have been growing Syngenta tomato hybrid Heemshikhar. Vendors demand Heemshikhar due to its quality and pay higher for it. This hybrid has better shelf life and higher tomato virus tolerance. In 2020, I harvested 1600 crates (20 kg per crate) from three bighas, and got Rs 15-16 per kg. I thank Syngenta for this excellent hybrid.”

Another grower Mr Nitinlal Tadpatta from Gujarat has been cultivating Heemshikhar hybrid for 11 years. “Vendors demand it and pay higher for it. It adds to our profitability. Heemshikhar has better long distance transportability. It gives assured yield to growers,” he says.

Vendors are happy that Heemshikhar offers high yield potential, long crop cycle and better shelf life. It can be transported to long distance markets in India and abroad. “Whenever we send Heemshikhar, we are very confident that it will match the criteria with almost no wastage or shrinkage of tomato. So, we encourage growers to cultivate Heemshikhar,” say vendors.

Every year, nearly 10,000 growers experience the flavour of Heemshikhar tomato with more than 18,000 acres of crop. It has become the number one choice of growers because they get assured yield and higher price. Growers have been reaping the benefit of Heemshikhar crop for 12 years. They are thankful to Syngenta for this innovation. Heemshikhar tomato hybrid has significantly reduced wastage after harvest. Heemshikhar has truly added value to sustainable agriculture and to the income of growers!
How do we feed a growing world population?

- Farm new land
- Get more from existing farmland

The world needs more food. By 2050, there will be another 2 billion people on our planet. How do we provide enough high-quality food and preserve our environment? At Syngenta, we believe the answer lies in the boundless potential of plants. We develop new, higher yielding seeds and better ways to protect crops from insects, weeds and disease. So farmers can get more from existing farmland and take less new land into cultivation. It’s just one way in which we’re helping growers around the world to meet the challenge of the future: to grow more from less. To find out more, please visit us at www.growmorefromless.com

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Urban gardening is the new form of agriculture which utilises the limited city space like containers, rooftops, vertical walls, or wasteland for gardening for ornamental and edible plants. Urban gardening is the solution to modern day problems like pollution, hunger, water scarcity and increasing carbon footprint.

There are several types of urban gardens based on the space utilised and on the kind of concept utilized.

Roof top garden: These man-made green spaces can accommodate different plants which can help improve a building’s aesthetics and produce food. This concept is widely being used to increase urban green spaces in countries like Singapore, China, and various European nations.

Container garden: Plants are grown in containers such as pots and pans. One can also utilise old wooden shipping containers for raising a garden bed. It is space-efficient and mobile.

Organic Urban garden: These can include a mixture of ornamental and edible plants.

Mr. Vinu Jehoshaphat is a first-generation entrepreneur and the founder of Green Corners, one of India’s leading landscape contracting companies. He is now actively engaging with stakeholders in the Government, Education, Research and Corporates in advocating green education as the substrate of urban planning, building Smart Cities and regenerating dying communities.
Organic systems recognize that our health is connected to the quality of our food and ultimately to the health of the soil.

**Urban Herbal garden**

Most culinary herbs are easy to cultivate. Basil, Thyme, Dil, Chives, Oregano, Coriander, Mint, Parsley etc. thrive through all seasons.

**Hydroponics farming**

Vegetables are grown without soil in a solution of water and nutrients. Plants grow faster and are ready for harvest sooner. Hydroponic systems are vertical. Hence they require less space and produce large amounts of fresh harvests. This requires minimum labour, time and effort.

**Microgreens**

Microgreens are tiny plants, larger than sprouts, grown to just an inch or two in height, then harvested. Microgreens can be grown from the seeds of most salad greens or herbs, but the spicy and colourful plants are most widely grown, such as beets, arugula, mustard, kale, radish, sunflower and mustard. The growing cycle is less than two weeks for most varieties. A grower can easily produce up to two dozen crops per year.

**Living Walls or vertical gardens**

These can be used for both ornamental and edible plants. They purify the air, reduce ambient noise and look aesthetically appealing.

**Benefits of Urban Garden**

Urban Gardening provides fresh vegetables, herbs and flowers. It has a positive impact on the mental and physical wellbeing of an individual. It is also a good exercise. Gardening helps reduce screen time for kids and adults. The ones who opt for community gardening enjoy the benefits of socialization, collaboration and teamwork.

**Conceptualize a Style or Theme**

A garden must have the sense of place. It must fit with the surroundings. Then executed it step wise to achieve the goal.

**Watering/irrigation**

It is crucial to recognize water requirements of different plants. Conserving the water in the soil as well as storing and recycling water are of key importance.

**Methods of irrigation**

These can be hand watering or automation. You can choose from sprinklers, drippers, foggers etc.

**Some Important Tips**

- Work on starter vegetables like coriander, mint, radish, potatoes, lettuces, herbs, carrots etc. These are low maintenance and easy growing.
- Tend to gardening needs like pruning, mulching, weeding and anchoring on need basis
- Recycle compost

Creating and maintaining a beautiful urban garden which is safe and natural is becoming increasingly popular. It improves physical and mental health, aesthetic appeal of the neighbourhood and reflects the growing interest in fresh, healthy and chemical free vegetables and herbs. Studies show that gardeners consume twice as much vegetables and fruits than non-gardeners. Levels of physical activity are positively associated with urban farming – the local solution to global problems of urban life.
Floriculture that deals with the cultivation of ornamental crops is a farm-based income generating enterprise. It has high potential to earn foreign exchange and generate employment for rural and urban youth. Floriculture crops have a short gestation period and the income from the venture starts flowing from the very first season of operation. Commercial floriculture has higher potential per unit area than most of the field crops and is therefore a lucrative business. It is a fast-growing industry, and its success depends on development of new crop varieties. These must correspond to the evolving needs of the domestic and international market, quality planting material (QPM) production, large-scale cultivation, effective market linkage, and development of novel technologies and entrepreneurship for value-added floral products.

Opportunities in floriculture
The global floriculture business involving more than 145 countries is growing at a rate of 6-10 % per annum. The Netherlands, Japan and USA account for nearly half of the world flower trade. Despite the fact that India ranks second only next to China in area under cultivation of flower crops, its share in the global floricultural export market is only 0.61%. The country exported 20703.46 MT of floriculture products worth Rs. 507 crore in 2017-18. Major export destinations are USA, the Netherlands, UK, Germany and UAE. India ranks 18th in global floriculture trade. During the last decade, export increased at a CAGR of 4.33%. The Indian...
floriculture market was worth Rs 15,700 crore in 2018. The market is projected to reach Rs 47,200 crore by 2024, growing at a CAGR of 20.1% during 2019-2024.

As per National Horticulture Database (National Horticulture Board), during 2015-16 the area under floriculture in India was 2,49,000 ha with a production of 16,59,000 tonnes of loose flowers and 4,84,000 tonnes of cut flowers. Floriculture in India is growing in several states such as Tamil Nadu (contributing to 20% of the country’s total production), Karnataka (13.5%), West Bengal (12.2%), Madhya Pradesh, Mizoram, Gujarat, Andhra Pradesh, Odisha, Jharkhand, Haryana, Assam and Chhattisgarh (APEDA).

Export emphasis has now shifted from pot and garden flowers to cut flowers. Important crops in the international cut flower trade are rose, carnation, chrysanthemum, gerbera, gladiolus, orchids, anthurium, tulip and lilies. India's position stands at 29 among the flower exporting countries. In addition to cut flowers, floricultural exports from India comprise of fresh loose flowers, cut foliage, dry flowers, potted plants, seeds and quality planting materials. Dry flowers alone contributed 67% of the total export value in the year 2014.

On the other hand, India imports fresh flowers worth Rs 38 crore from Thailand, the Netherlands and China. The total floriculture imports of India including the fragrant materials stand at about Rs 800 crore per year. This necessitates consistent efforts for import substitution. GOI has identified floriculture as a sunrise industry and accorded it 100% export-oriented status. While export remains a key motivator for Indian cultivators, the domestic demand for flowers is also increasing exponentially, especially in the metros and large cities.

Ample opportunities for entrepreneurship development

Wide altitudinal variation in India creates varied agro-climatic conditions that favour cultivation of a range of floricultural crops in the country. India is endowed with large diversity of wild ornamental plants. Most of the present floricultural crops are progenies of the wild relatives that have been popularized and widely commercialized throughout the globe. Harnessing ornamental values of such wild species from the biodiversity rich areas of our country will pave the way for creating alternative livelihoods for the rural population in these areas.

Domestication of wild ornamentals will revolutionize India’s floriculture trade and enhance our floriculture export potential

Domestication of wild ornamentals will revolutionize India’s floriculture trade and enhance our floriculture export potential. Identifying and evaluating useful genetic traits with great demand will help in developing new varieties of ornamentals that have the desired traits. Development of cultivation practices to improve adaptability, enhance productivity and increase aesthetic value is crucial in domestication of wild ornamental plants.

In floriculture, there are ample opportunities for employment generation and entrepreneurship development for unemployed youth and rural communities besides generating wealth from floral trade. These include production of cut-flowers, loose flowers, flower bulbs, pot plants and landscape plants, mass production of QPM through tissue culture, and value addition in terms of dry-flowers, floral crafts and development of nutraceuticals and cosmeceuticals using compounds derived from flowers.

The growth opportunity in floriculture sector is huge and has not been realized in India. Most importantly, floriculture has the potential to multiply farmers’ income manifold, and it is much more lucrative than any traditional crop.

Challenges of Indian floriculture

The Indian floriculture sector has been facing several challenges including trade environment, inadequate infrastructure, insufficient cold chain facility, non-
## Challenges of floriculture in India

- Many farmers are not aware of the benefits of floriculture that can give five times more income than the conventional crops. This has resulted in limited area under floriculture cultivation.
- Non-availability of QPM is the greatest impediment for scaling up floriculture in India. Relatively less R&D effort for floral crop improvement, lack of adequate know-how on modern nursery techniques, and limited availability of skilled manpower are the causative factors.
- Availability of appropriate crop varieties as per the domestic and international market needs.
- Lack of market infrastructure, and appropriate market linkage with producers and traders, and other stakeholders involved.
- Insufficient post-harvest technologies, storage infrastructure, and transport facilities.
- Lack of awareness on the benefits of fragrant flower cultivation, and missing link between nectar-bearing floriculture and apiculture.
- The potential of urban floriculture has not been realized.
- Lack of awareness among students in schools and colleges about floriculture as a possible profession leading to scarcity of professionals in the domain.

## Dry flower industry in India: a success story

Since past 40 years dried flowers and plants have been exported from India. Today India is one of the leading countries in this field with more than Rs 150 crore export value per year. The industry exports 500 varieties of flowers to 20 countries including USA and UK. The dry flower products are: handmade paper, lampshades, wall quilt, decorations and candle holders. The flower arrangements using dried samples of cone, foliage, flowers like rose buds, lilies and other such plant materials enhance the beauty of dry flowers, adding more export value to this industry. Addition of fragrance to these value added products with floral oils further enhances their market value. Different drying techniques like air-drying, embedded-drying, press drying, microwave drying, glycerin drying, and freeze drying techniques are being deployed.

## Value addition for fragrance industries

- Fragrance formulation using aroma extracts of flowers
- Making perfume in packed bottles/pouches
- Application of fragrance in cream, sanitizer, lotion, room freshener.
- Flavour formulation using aroma extracts
- Aroma product development such as agarbatti, dhoop, cone using de-oiled materials of flowers
- Utilization of waxes, resins (after making of absolute) in creams, and lotions
- Honeybee wax from integrated floriculture-apiculture, and its value addition

## Launch of CSIR Floriculture Mission

During the past six decades, the Council of Scientific and Industrial Research (CSIR) contributed significantly to the development of floriculture in India. CSIR institutions have developed several varieties of different floricultural crops through improvement of desired traits including novel colours, floral and plant architectures, extended seasonality of flowering (early or late), improved vase-life of flowers, and disease-resistant varieties. All these activities have helped Indian farmers and entrepreneurs in enhancing their income.

CSIR institutions such as CSIR-National Botanical Research Institute (CSIR-NBRI), Lucknow and CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur have been involved in promoting floriculture in the country for several years. These institutes have standardized technologies for plant multiplication and availability of dedicated carriers and high freight rates. The most important crop production constraints are non-availability of basic inputs such as seeds and QPM, irrigation infrastructure and skilled manpower. The marketing network that comprises growers, retailers, auction houses, exporters and consumers needs to be well organized. The dedicated marketing infrastructure for floriculture needs to be improved e.g., the entire country has only one cut-flower auction center in Bengaluru. The other factors limiting the growth of floriculture in India are market trends, poor linkages between R&D labs and farmers, lack of technical knowhow and crop planning according to market demand, and quality control issues (Box 1). All these factors have led to dependency of India on international floriculture market for meeting its domestic need of cut flowers, fragrance commodities and flower oil.

### Value addition of floral crops

Value addition of flowers and flower-derived compounds e.g. lutein, pigments, and other fragrant, flavoured, and nutraceutical compounds holds key to entrepreneurship development and enhance India’s export potential (Boxes 2 and 3).
numerous varieties of chrysanthemum, gerbera, calla lily, rose, tuberose and gladiolus with unique colours, shapes and sizes. Agro-technologies have been standardized for different agro-climatic conditions for such diverse crops as Lilium, Alstroemeria, carnation, bird of paradise, gerbera, marigold, tuberose, jasmine, lotus, canna and gladiolus. India has rich diversity of attractive flowers in the wild with high potential as cultivable ornamentals.

Harnessing ornamental values of these wild native plants and their domestication and popularization would enrich global floricultural crop diversity. CSIR-Central Food Technology Research Institute (CSIR-CFTRI), CSIR-NBRI, CSIR-North-Eastern Institute of Science and Technology (CSIR-NEIST) and CSIR-IHBT have developed various technologies for value addition of flowers. The value-added products using flowers and primary floral products are in the market and are well appreciated. All these technologies, if deployed at a higher scale, can boost the floriculture industry in the country.

To enhance the export potential of India’s floriculture sector, domesticate wild floral wealth of the country as global ornamentals, create employment opportunities for urban and rural youth, and to provide enhanced income to farmers, CSIR has launched a floriculture mission (verticals in Box 4) in close collaboration with Indian Council of Agricultural Research- Directorate for Floriculture Research (ICAR-DFR), Indian Agricultural Research Institute (IARI-Division of Floriculture and Landscaping), The Agricultural and Processed Food Products Export Development Authority (APEDA), The Tribal Cooperative Marketing Development Federation of India (TRIFED), Fragrance and Flavour Development Centre (FFDC), and Khadi and Village Industries Commission (KVIC), Tamil Nadu Agricultural University, and Orissa University of Agriculture and Technology. The long experience and expertise of CSIR institutions (NBRI, IHBT, CFTRI, NEIST, Indian Institute of Integrative Medicine, Central Institute of Medicinal and Aromatic Plants, Indian Institute of Petroleum and Central Building Research Institute), and the above mentioned partner organizations should revolutionize the floriculture sector in India.

Floriculture can be a gamechanger for farmers with its potential to increase their income manifold. Farms with low income under conventional agriculture crops can be substituted by floriculture crops. Cut flowers, dried floral products and several value-added products from floriculture crops can enhance the income of farmers and entrepreneurs. Polyhouse cultivation both in urban and rural landscape can be a profitable venture with minimum impact of climate change, as it provides controlled environment and less pests and diseases. Opportunity for large-scale entrepreneurship development in floriculture includes nursery trade, value added products, and export of flowers and floral products. In addition, floriculture can provide employment opportunities to migrants who have returned from urban areas during COVID-19 pandemics, and also it can reduce migration of rural population to urban areas.
Indian horticulture has evolved into one of the major drivers of growth, as it is more remunerative than the agricultural sector, which is concerned majorly with food grain production. This remunerative sector is providing huge possibilities for employment across primary, secondary and tertiary sectors. Shifting from agriculture to horticulture is one of the best available options for the small and marginal farmers. The move ensures nutritional security, generates employment, enhances farm income and promotes sustainability in line with nature.

Among various horticulture crops, fruits are highly resilient to changing weather conditions, while vegetable crops augment the income of small and marginal farmers. The risk of crop failure is minimal due to reduced water usage, and is suitable for smaller farm lands. Multi-tier cropping systems have evolved for better utilisation of vertical space and maximum use efficiency of fertilisers. All this requires appropriate innovations and investment. Advanced methods of cultivation viz. protected cultivation has shown yield enhancement by four times, but requires huge investment in the initial stages. Studies on plant architectural engineering and management have alleviated the problems associated with seasonality in several crops. It enhances water use efficiency utilising modern techniques.

**Major Challenges for Indian Horticulture**

- No MSP fixed for horticultural commodities, especially for highly perishable commodities viz. mangoes, bananas, cucumber, pomegranate, custard apples etc
- Entry into horticulture segment is a challenging task for small and marginal farmers without any aid/assistance by public sector, as input costs are higher
- Product price fluctuations are very high. This is discouraging for marginal farmers
- Poor infrastructure facilities, lack of appropriate cold chain facilities poses great challenges for successful transportation and storage of perishable horticultural commodities
- Limited availability of market intelligence, majorly for export of horticultural commodities

**Opportunities and Challenges**

**Changing Dynamics of Indian Horticulture**

Dr Tolety Janakiram is Vice Chancellor, Dr YSR Horticultural University, Andhra Pradesh. In a career spanning more than three decades, he has outstandingly contributed to horticulture research and development.
* Most machinery and equipment is obsolete

**Recommendations for Indian Horticulture**

* Accomplishing technology-led progression along with drafting strategies concerning the utilization of resources
* Improvement in the availability of quality seeds and planting materials, and bringing newly introduced cultivators for quick and efficient cultivation process will accelerate productivity
* Empowering rural youth knowledge regarding various government schemes and modern equipment
* Educating farmers regarding post-harvest management practices, enabling them to increase product’s shelf life and value
* Value addition of horticultural crops is gaining importance
* Pollinators and pollinizers play a vital role in fruit setting and yield. Rearing of insect pollinators such as honey bee keeping should be encouraged
* Establishing better long-distance transportation network

**Human Resource Development in Horticulture**

Currently, there are seven universities in India exclusively focused on horticultural education. Dr YSR Horticultural University, Venkataramannagudam, Andhra Pradesh, is among the best. The varsity is enhancing the growth of the horticulture sector by providing leadership in teaching, research and extension services in horticulture and allied sciences through continuous innovations and assimilation of emerging technology.

**Horticultural policies**

National Agriculture Policy 2000 categorically emphasised on integrated development of horticulture, which should be knowledge-based, technology-driven and farmer-centric. The policy also emphasised on rural institutions, reforms and development of infrastructure. There is no policy document for horticulture. However, focus has been given on post-harvest management in the policy paper of food processing industries.

The most notable policy change is related to storage, processing and marketing of horticultural produce. Backward and forward linked marketing with reform in agriculture produce marketing act and encouragement for contract farming are essential for the achievement of this goal. Horticulture has been identified as a key factor for the achievement of this goal.

**Major challenges faced by horticulture sector**

* Need for huge investments/capital
* Access to technology
* Initial learning curve for development of required skills

The government tried to address these challenges in mission mode approach by launching Technology Mission for Integrated Development of Horticulture in 1999 for north-eastern regions including Sikkim. Analysing its impact and success, it was extended to Himalayan states in 2003. With the objective of doubling production from horticultural crops, the National Horticultural Mission for the rest of the country was launched in 2005. Both these missions merged later as Mission for Integrated Development of Horticulture (MIDH).

These missions ushered in the horticulture revolution in the country, referred to as the Golden Revolution. It provided greater opportunity for farmers to enhance their farm income and attract educated youth towards farming. Horticulture has proved to be economically rewarding and intellectually satisfying. In the recent call of nation for doubling farmers’ income, horticulture has been identified as a key factor for the achievement of this goal.

Proper implementation of value chain development and management shall benefit all the players in the supply chain and provide quality produce to end consumers. Horticulture must be declared as a priority sector for investment. We need to utilise technologies like AI, IoT and block chain management technologies for accelerating the growth of this sector.
Nature and plants have a positive impact on cognitive functioning, emotional well-being and other dimensions of mental health. Gardening and lush greens can be well utilized to cope up with the instability, stress, trauma and suffering that have been inflicted on us by the pandemic. Gardening in such distressful times can be your mantra to reclaim your planet and your health too.

According to research, there are both perceived and actual benefits to spending time in natural spaces as opposed to urban spaces, such as reduced mental fatigue and improved mood. In a study conducted in The Netherlands, they found out that every 10% increase in area for exposure to green space translates to an improvement in health equivalent to being five years younger. Another study conducted in Canada showed that how increased residential green space can decrease mortality over a four-year period, particularly mortality associated with respiratory disease.

Those who have constantly lived in green spaces and have indulged themselves in the pleasures of gardening have both lower mental distress and higher well-being. Plants are more than just pretty greens. The natural rhythms of a garden and plants act as an antidote to stress. Those who are battling Covid or are recovering from the post-Covid symptoms and anxiety can immensely benefit from gardening.

**Gardening Reduces Stress and Depression:**
A study published in the 2013 edition of the Mental Health Review Journal found that participating in various gardening activities lowers levels of the stress hormone cortisol. Active horticulture (gardening) reduces depression and anxiety while

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**About the Author**

Mr Nandu Singh is CEO, Nurserylive. Nurserylive sells about 4 lakh plants every month and brings plant happiness to every nook and cranny of the country.
improving emotional and physical health. It gives people a creative way to vent their frustration and unhappiness. It gives them higher quality of life and a higher sense of community.

**The Physical Benefits of Gardening**

Gardening is a total body workout. It has the capability of lowering our body mass index as it combines walking, stretching and weight lifting. Simple gardening tasks like lifting pots and digging soil can burn up to 300 calories in an hour. A survey conducted by Indian Journal of Community Medicine reveals that about 15 minutes of gardening uses up about 140 calories. Over 12 months, daily gardening uses up a total of 51,100 calories, equivalent of 14.6 pounds of body weight.

Exposure to and use of green spaces has been linked to long-term reductions in heart disease, cancer and musculoskeletal conditions, as well as lower levels of obesity and higher self-rated mental health.

**Gardening Can Give You A Sense of Purpose**

Creating life from your hand can be a feeling that changes your entire outlook on life. It feeds your soul with the nectar of love and contentment. When you care for your plants and watch them thrive and flourish, you can see a transformation happening in your own heart. You learn and witness their transformation from sapling to a beautiful plant, which is the one way to gain a sense of self-worth in the face of social pressure. It aids in the development of confidence and a positive outlook towards the adversities you face in your life.

Because my company’s entire vision is based on the mission of improving people’s lives through plants, my team and I at Nurserylive are ensuring that in these unprecedented times, we spread the positivity of plants.

We are living and breathing the idea of bringing more nature and gardens to the apartments during these testing times. We are continuously encouraging more and more people to take up gardening as a custom to give back to their planet.

We are helping people to grow their own organic food via kitchen gardens. We support them via workshops and social media sessions. The journey has been soul rewarding. We are making sure that through plants, happiness reaches people with utmost efficiency via our delivery partners.

We have also launched Expertlive, a path-breaking solution to spread the gardening information via online mediums. These connect gardening experts to gardening enthusiasts. We aim to help and guide people in their respective green journeys irrespective of the locations they reside in. This one of a kind product in the industry and we are devoted to create more green spaces by solving the roadblocks as efficiently as possible.

Gardening teaches you to care, love and patience. Right now the world needs all of it more than before. Strive to plant a seed of hope and watch it bloom in a better tomorrow.
Horticulture is a vibrant sector known for its greater revenue realisation per unit area. The diversity of crops in horticulture provides nutritional as well as livelihood security. It is a spectacularly reliable sector for boosting foreign exchange reserves of the country through exports.

The horticulture sector has become an important factor in the economic progress and accomplishments of most Indian states. The Indian Council of Agricultural Research (ICAR) Division of Horticulture is actively pursuing its set out tasks.

The horticulture sector provides immense employment opportunities in the primary, secondary, and tertiary sectors of agriculture. The agriculture ministry released the final estimates for Fiscal Year (FY) 2021, along with projections for horticulture production in FY20. Total horticulture production in FY21 is expected to be 326.58 MT, up 5.81 MT from FY20. Over FY19, there was an increase in the production of fruits, vegetables, flowers, and spices. There was a decrease in the production of plantation crops, aromatics, and medicinal plants.

Horticulture Innovation Lab scientists are testing and adopting a variety of technologies aimed at significantly improving the profitability of fruit and vegetable production around the world. There are a wealth of innovations that apply to both horticulture and other crops, including supply chain disruptors and horticulture’s specific challenges such as perishability and evolving demand.

Innovations for Horticulture Sector
Here are just a few examples: Sensors and IoT (Internet of Things) in greenhouses growing vegetables and fruits in controlled environments to allow remote monitoring of critical crop growth parameters. Mechanical harvesting tools improve plucking efficiency and reduce farmer reliance on manual labour. Imagery-based potato grading, in which mobile imagery and proprietary algorithms are used to grade potatoes based on key physical parameters. Terrace gardening and vertical gardening where the plants are grown on a vertically suspended panel by using hydroponics.

Solar conduction drying is an innovative technology in the processing of fruits and vegetables. It not only dehydrates the products to increase shelf life but also retains the nutritional value that would otherwise be lost in traditional drying. Many startups are working on extracting high-value ingredients like pectin from apple pomace and

ABOUT THE AUTHOR

Prof S Rajendra Prasad is Vice-Chancellor, University of Agricultural Sciences (UASB), Bengaluru. He has 27 years of meritorious service in the National Seed Project. As Director (ICAR), Mau, Gazipur, Ballia, and Azamgarh in Uttar Pradesh, he pioneered the seed village concept and raised major funds to establish model Seed Processing Farms
Post-harvest losses are significant in India’s horticulture industry, costing approximately Rs 400 billion per year.

There are encouraging innovations in micro cold storage, mobile packhouses, and smart packaging. Ecozen has created solar-powered micro cold rooms that are ideal for on-farm storage. Ycook has created an innovative packaging solution that allows minimally processed fruits and vegetables to be stored for up to 12 months without refrigeration.

To accelerate the growth of horticulture, preparedness in research should be of primary importance. Advanced training in research methodologies and instrumentation, biotechnology, micro-irrigation, fertigation, IPM, INM, biofertilizer, biopesticide, pesticide residue, PHT, and product development are all priorities for increasing the research capabilities of scientists.

Skill development for state-level development functionaries will improve extension staff capabilities through in-service training at various R&D institutions. Postgraduate programmes in fruit, vegetable, floriculture, plantation crops, and horticultural crop post-harvest management will aid in the provision of trained labour in specialized areas.

The pattern of technology adoption cannot be uniform across the country. It will differ from crop to crop and even across regions. It is therefore obvious that some degree of flexibility in research planning and research strategy is required. With the WTO’s opening of global markets and removal of quantitative restrictions, the export-import scenario is likely to change at a much faster pace. Market forces will become more powerful, and demand for modern technologies will rise. Horticulture research systems will need to be extremely vigilant and adaptable to changing conditions.

**Recommendations**

The development of both short-term and long-term strategies for modernizing Indian horticulture will be heavily reliant on research funding and strength of the research system. Some of the recommendations that would ensure the smooth operation of the Horticulture Industry and structural changes are as follows.

* Establishing a better long-distance transportation network should be a top priority in order to ensure the safe and efficient transportation of fresh horticultural produce.

* Horticultural crops shall benefit from additional layers of protection if they are stored.

* Adopting appropriate management practices to eliminate nutrient imbalance and monitoring nutrient dynamics is essential.

* Varietal expansion is required to meet cultivation requirements in non-traditional spheres.

* Precision cultivation, hydroponics and aeroponics should be incorporated to improve productivity and produce quality.

The horticulture sector in India has enormous potential due to its diversification and high remuneration when compared to the agricultural sector. In recent times, the Indian government has introduced a number of schemes and strategies to help the sector. These shall show wonderful results in the coming years.

**Fun Fact**

Dr Rajendra Prasad likes to connect with friends in his leisure hours. He enjoys reading, studying new topics, engaging in social activities and gardening.
AGRICULTURE TODAY

AGRI WEALTH, NOT AGRI WASTE

Agriculture is critical for sustaining the demand and growth of industry and service sectors and thus the economic growth of the country. All activities generate by-products which if not economically utilized are termed as waste. Agricultural waste is generated from farm and processing activities and comprises animal waste (manure, hair, feathers, scales, carcasses), food processing waste (only 20% of maize is canned and 80% is waste), crop waste (corn stalks, sugarcane bagasse, drops and culls from fruits and vegetables, prunings) and hazardous and toxic agricultural waste (pesticides, insecticides, and herbicides, etc).

India is a major producer of a vast range of agri-produce. As per estimates by different agencies the amount of agriculture waste generated in India is more than 600 million tonnes per annum. The Ministry of New and Renewable Energy projected that 350 million tonnes of agro waste can generate more than 30,000 MW of power every year, apart from generating green fertilizer for use in agriculture. At present only 25-30% is utilized for fodder and energy production.

Unfortunately due to lack of awareness of the economic value of agro waste, growers burn the crop residue in Punjab, Haryana and UP, where wheat and rice are prominent crops. This not only affects the environment but is also a direct loss to the farmers and the economy as it can be utilized for power generation and also biogas production. We must not ignore the domestic kitchen waste generated from households which forms one third of the biodegradable municipal solid waste.

Integrated Approach Essential
An integrated approach to the problem of agro-waste and crop residue burning is the need of the hour to save the air, soil and water pollution and also improve the soil health and micro-organisms, which help crop pro-

ABOUT THE AUTHOR
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duction. The first and foremost step is to educate the farmer and make him aware of the economic value of the products that he considers as waste. This must be done through the involvement of the FPOs and the KVK workers.

It also calls for training and skill development of the rural womenfolk in developing creative and useful items from the waste. Indian Council of Agricultural Research has initiated work on the waste generated from agricultural practices. It is converted into products that are useful either for humans, animals or for farm land. ICAR has published 140 technologies utilizing various waste material generated during crop harvesting, processing, product synthesis etc. Commercialization of these technologies will enable creation of business ventures around them and create employment opportunities in rural areas. This will in turn contribute towards a strong and Atmanirbhar Bharat.

Successful Initiative in Pune
Agriculture residue is being used in Pune region to produce second generation BioCNG which can replace LPG, petrol, diesel, and all commercial CNG. The beauty of the technology is that it can use any source of cellulosic biomass except for hardwood. It is not only economical but ensures stable price, and can reduce import burden of crude oil and gas. It is a high efficient technology as it has high calorific value. About 38 tons of agri residue is required for producing five tons of BIOCNG. It is environment friendly and carbon neutral.

According to the developers, if all available agro residue is used for making 2G BioCNG, then India will save Rs 3-4 Lakh Crore on fossil fuel imports. It will also directly benefit the farmers income as they will receive value for agri residue which they otherwise burn. In economic terms, such agriculture waste has economic value less than the cost of its collection, transportation and processing for beneficial use. But if it can save the environment and generate extra income for farmers, it should rather not be called waste. It should be called a byproduct of agriculture activities.

IIFPT Thanjavore has developed technologies for converting waste to wealth like eatable cutlery and ice cream cones from Jackfruit peels, and other vegetable peels which are otherwise a waste. The peels are also dried and powdered to produce flour which can help control blood sugar in diabetic patients, as it is fibre rich.

Poultry Waste
Coming to poultry waste, feather fiber has properties in common with cellulose, a type of starch that forms wood and paper. The surface area of feathers is much larger because the diameter of the fibers is smaller. As a result, the fiber can absorb more moisture than wool or cellulose fibers. The crystal structure of feather fibers also makes them naturally stable and durable. These are effectively being used to make diapers. Many companies are now working to scale up the production of absorbent feather-based products including diapers, filters, insulation, upholstery padding, paper, and even clothing. Similarly, animal hair can be utilized economically to produce high value amino acids used as fertilizers and other industry.

Agri-waste is not a concern but an opportunity in disguise that needs intelligent strategy to create value and also employment for rural youth. Let’s stop calling it waste. Let us focus on industry-research interface to create value from agri-wealth. We need to identify it as an industry and include in priority sector for easy finance. Start Ups in this area should be encouraged through incentives and awards. The ministry of Agriculture and Farmer Welfare and the Ministry of Food Processing should consider devising a policy for promotion of agri waste management to agri wealth. Why dump or burn to create pollution when we can process and treat to find a solution.
Empowerment of rural women through entrepreneurship is gaining importance in India in the wake of globalization and economic liberation. Although many rural women increasingly run their own business and contribute significantly in the development of rural economy, yet they represent a minority of all entrepreneurs. Currently, there are various schemes and initiatives to promote rural women empowerment, still challenges are existed towards gender equality, business development or self-sustainability.

Among the rural population, women constitute nearly 45 percent of the total lives and one quarter of the total work force. Empowering of rural women through entrepreneurship is vital for their social recognition and building them as independent decision makers. It makes them self-sufficient and financially stable, which shall lead to economic empowerment of rural society.

Rural Women Empowerment through Entrepreneurship
It is estimated that advancing women's equality can boost India’s GDP by $0.7 trillion in 2025. Women-led entrepreneurship remains critical to attain this. According to the Sixth Economic Census released by the Ministry of Statistics and Programme Implementation, women led entrepreneurship constitutes only 14 percent of India's overall entrepreneurial system. The percentage of rural women led enterprises is even more depressed. Sadly, most of the rural women do not have a dominant and independent financial or management control. It is estimated that only 12.8 percent of rural land is owned by women, only 8 percent has own rural small enterprise and among them also most are above the age of 45 years, divorced or head of the family. It means changes are required not only at financial aspect but also at socio-cultural and behavioural level.

Schemes, incentives, other support systems
The recent allocation of Rs 500 crore under National Apprenticeship Promotion Scheme and Implementation of Occupational Safety, Health and Working Conditions Code (Central) Rules, 2020 allowing women to work in all sectors and also night shift are welcoming steps towards women entrepreneurship. Initia-
tives from non-government bodies like Airbn, Humara Bachpan Trust etc to train rural women by collaborating with the government is appreciable.

**Skill development:** Google’s commitment to help one million rural women through training, tools and mentoring and economic empowerment through various programmes like WomenWill, Internet Sathis etc. is notable. GOI provides multiple schemes, incentives and promotions for women entrepreneurship. The need is to make rural women aware about the right source, right scheme and right benefits.

**Financial aid and assistance:** Funding is an important aspect for entrepreneurial success. The decision of GOI to offer MSME loans up to 1 crore with interest rates starting from 8% within 59 minutes is very encouraging for rural women. GOI’s Stand-Up India and Pradhan Mantri Mudra Yojana (PMMY) to help self-employment and the linkage of skill India and Mudra Loan to galvanize entrepreneurs are appreciable.

Various business loans with low interest, low to zero processing fee, no collateral has been initiated by public and private banks like Cent Kalyani from CBI, Stree Shakti from SBI, Shringaar and Annapurna from Bhartiya Mahila Bank etc. The launch of SVAMITVA scheme to provide the record of right to village household owner possessing houses at inhabited rural area and further use them as financial asset to take loans and other financial benefits is motivating. To support MSME which hit badly by Covid, the package of three lakh crore loans without any guarantee or collateral is a big relief.

There are no specific packages for rural women entrepreneurs. Considering the slow recovery due to low financial status of female entrepreneurs, a women-specific relief package shall be helpful.

Infrastructure and other capacity building programs: Inadequate infrastructure, market and overall business development knowledge are major challenges. NITI Aayog initiated The Women Entrepreneurship Platform which aims at overall development of women entrepreneurs starting from incubation and acceleration, skills and mentoring, funding and financial support, compliance and tax to marketing and networking.

To encourage innovative revolution in rural area MSME, GOI launched ASPIRE scheme to promotes innovation, entrepreneurship and rural industry. There are many incubators and accelerators like WEHUB, WBIP, W-Incubate etc. which help women entrepreneurs to launch their business. There is support from even global women-specific programmes like TiE Women. Most of these incubators, accelerators or chapters are limited to metro or Tier-I and II cities. Hence the objective, or accessibility towards rural women entrepreneurs is limited.

**Strategic Inputs**

Among the 63 million MSMEs in India, only 6 percent are led by women entrepreneurs. The percentage of rural women is even less. There is need to revise, relook and rework on policy design and implementation.

The establishment of sector specific incubators, accelerators in rural areas including remote accelerator, technical and business education institute, entrepreneurship development centre etc shall help promote rural women entrepreneurship.

As per the survey of International Finance Commission (IFC) for 2019, around 79.5 percent of the surveyed women entrepreneurs did not avail of any loan or financial service from banks as they found it complicated, or had limited access to collateral. There is need to create awareness programs at panchayat level to inform women entrepreneurs regarding schemes and benefits.

**Women FPOs**

The development of women Farmer’s Producers Organizations (FPO) will correct the gender imbalance in rural ecosystems. As women’s requirement in terms of training methodology or working capital is different, a strategic approach towards creating sector-specific women led FPOs will be helpful.

Self Help Groups (SHG) are successful in empowering women and communities. Further acceleration of women SHGs with specific support under Startup Village Entrepreneurship Program or converging of SHGs and FPOs under a common platform will create more women-led enterprises.
Lockdowns, the bane of the Corona Pandemic, have now become a part of our regular lives. They have forced us to think that the farm has to come closer to the fork!

Food miles, which were rising exponentially, will have to shrink drastically. Hyperlocal food chains will become more viable. Not only would this crash the fuel cost and the in-transit wastages but it would also give a new lease of life to the local growers. In very near future, a new category of local growers shall appear – The Urban Agripreneurs! They shall turn the clock back by converting the large barren rooftops of large buildings, like schools, hospitals, malls etc. into lush green Rooftop Organic Farms.

**CREATING A HYPERLOCAL COMMUNITY OF GROWERS AND CONSUMERS**

Rooftop Organic Farms shall spawn organic consumers around them. This shall lead to the creation of a hyper-local community consisting of growers and consumers. Consumers will consume fresh organic vegetables from rooftop organic farms. They will also be able to sell composted vegetable-waste, which is a nutrient-rich organic fertilizer, back to the rooftop organic farms. This shall create a closed-loop hyper-local organic community. This community grow and consume fresh vegetables. It shall also recycle back the wastages of the vegetables into the rooftop organic farm, as bio-fertilizers, to grow more organic vegetables.

A rooftop organic farm of 1000 sqr ft will grow almost 2000 metric tonnes of fresh vegetables in a year and would utilise about 2000 kg of composted kitchen waste. This 2000 kg of is created from 10,000 kg of raw kitchen waste.

**COOLING THE PLANET**

These rooftop organic farms shall grow
fresh and safe organic vegetables using a fraction of the water as compared to conventional agriculture. They shall also create a natural green cover on large buildings that guzzle electricity for cooling.

Besides offering a natural green cover to protect the rooftop from direct exposure to the sweltering sun, the vegetable plants will also do photosynthesis and thus sequester many metric tonnes of carbon di-oxide. Thus, rooftop organic farms will also act as Carbon Sequestration Sinks.

A rooftop organic farm of 1000 sqr ft can sequester 3-5 metric tonnes of carbon di-oxide in a year. Since the rooftop organic farms are acting as CO2 sequestration sinks, they shall also generate carbon credits. Thus the large empty rooftops of buildings in any city can also be converted into CO2 sequestration sinks that will also generate carbon credits.

GENERATE EMPLOYMENT IN CITIES
The rooftop organic farms shall also offer skill-development and employment generation opportunities to hundreds of rural youth who migrate from villages into cities, for doing menial jobs. Their agricultural background can make them excellent rooftop organic farmers. Besides growing fresh vegetables on rooftops, these rooftop organic farmers will harvest and deliver fresh vegetables to premium clients (both retail and institutional clients), on a bicycle. Thus, we will have a fresh produce supply chain with ZERO CARBON FOOTPRINT!

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Besides offering skill development and employment opportunities to unemployed rural youth, rooftop organic farms (with the financial support from government or NGOs) can also offer revenue generation opportunities for women of the weaker section of the society.

SAVE GOVERNMENT MONEY ON FRESH PRODUCE SUPPLY CHAINS
By creating such hyper-local fresh produce supply chains, we can save millions of rupees of the government which it invests in creating controlled-temperature fresh produce supply chains. Besides guzzling huge investments of the government, these controlled-temperature fresh produce supply chains also guzzle a lot of energy. In comparison to such highly capital-intensive and energy-intensive fresh produce supply chains, the rooftop organic farms are highly capital and energy efficient.

TANGIBLE IMPACT ON A CITY
A city has two kinds of rooftops – individual rooftops of houses and large vacant rooftops of commercial buildings like schools, offices, hospitals, colleges, malls etc. If a city is able to convert the rooftops of 500 commercial buildings (each 1000 sqr ft) and 1000 individual houses (each 300 sqr ft), its impact shall be as follows:

- Total cultivable area = 20 acres
- Annual production of fresh organic vegetables = 1500 metric tonnes
- Annual number of families that can receive fresh vegetables = 5000-6000 families
- Annual saving of electricity (cooling of buildings) = Rs. 25 crores
- Annual saving of fuel (due to zero food miles) = Rs. 50 lakhs
- Annual saving of water (by using drip system on rooftops) = 750 lakhs litres
- Annual creation of jobs = 5000 jobs
- Annual sequestration of CO2 = 2000 metric tonnes

It is time to convert our rooftops into organic farms and bring the farm closer to the fork by developing rooftop organic farms.
Export of grapes to Gulf countries started with elongated seedless grapes namely Sonaka and Manik Chaman. The export market started in Dubai mostly in 1975 and continued till 1985 with good growth. But due to lack of good agriculture practices and post harvest management, the fruit had a limited shelf life. As farmers started using better technology, lot of changes started taking place.

APEDA’s support has been highly valuable. APEDA intervened and supported industry by starting the Grape Net program. This assures 100 percent fruit traceability to customers. There were other incentives too, for this sector place.

Farmers from the grape growing areas and the State Grape Growers Associations started working on quality parameters. We came up with the idea of exploring the export market. With this, the farmers’ co-operative called Mahagrapes came into existence.

Mahagrapes imported technology from University of California called precooling and post harvest management. A special equipment for cold storage was imported with 95 % + relative humidity and air force +2 degree centigrade temperature-maintained units called air-han- dler. The first container of 20 feet reefer with 6 MT capacity with limited post-harvest management grapes was sent to the United Kingdom by sea. It was successfully delivered in the UK market and got net return of Rs 54 per kg. In the domes-
tic market, the farmer used to get only Rs 6-8 per kg. This handsome increase led to a major change.

Farmers faced many challenges. But Mahagrapes accepted the challenge. Within three seasons, we resolved all major issues. After bearing heavy losses and with improvement at every step, we reached 98-99 percent acceptance of fruits in the UK supermarkets with establishment of Brand Mahagrapes.

Mahagrapes changed the mindset of the farmer. It gave them a scientific outlook. The associations (MRDBS) arranged many study workshops to train non technical farmers in the areas of plant physiology, fruit physiology, climactic behaviour in growth of grape vines, water and fertigation management, different aspects to improve quality, pesticide residue management and post-harvest management.

Mahagrapes took care of the logistics. The success story started in 1991. By 1998, growers had formed small groups for their own cold store and pre-cooling unit. A total of 263 producer exporters were associated with Mahagrapes.

Some private entrepreneurs also started export business. For Indian grapes in Europe, the window is very good. Mid April till first half of June is very good for business. In the recently-completed grape season of 2020-21, we exported 6842 reefer containers of 40 feet with volume of 92,342 MT only in UK and the European market. The total export in 2020-21 including the Middle East and other countries stood at 1,37,734 MT, valued at Rs 1,34,195. Many more unrecorded volumes were sent to border countries like Bangladesh, with good returns for growers.

Problems Faced by Exporters
Sometimes there may be concerns about the quality of fruit after arrival at the destination. Problems may include fungus on fruit, dullness, low shelf life, berry drop, pesticide residue, thermal shock to fruit etc.

The APEDA support has been highly valuable. APEDA intervened and supported industry by starting the Grape Net program. This assures 100 percent fruit traceability to customers. There were other incentives too, for this sector. Support was given to labs to upgrade up to international standards. A referral lab was established at Pune with the NRCG center of ICAR. There are many more schemes to support exporters and also growers. Farmers were supported for different kinds of certification required like Global Gap, BRC, etc. Pack-house upgradation and certification was provided to fulfill the requirement of importing countries. The buyers are mainly the supermarkets, where customers have different parameters for buying a fruit.

Benefit to Horticulture
The export of grapes has led to a major impact on the development of horticulture in the country. Maharashtra, the Union Agriculture Ministry through MIDH, National Horticulture Board – all these came up with different supportive and facilitation schemes. For example, in commercial horticulture plantation, support up to 40 percent of the project cost was provided. Andhra Pradesh, Karnataka etc also entered the export market for grapes.

The same way, pomegranates growers started export with fruit of good quality. Banana farmers from Jalgaon and Solapur did marvelously in the export market. Among vegetables, drumstick, okra (bhindi), gourds, beans and lemon have done well with export. In floriculture, roses and carnations find good markets in Europe. A major change is that policy makers, politicians, farmers, scientists, central government agencies – the mindset of all have changed. Now, they are proud of horticulture.

Challenges
1. The export market is very small at 1-3 percent, as compared to total production. The sky is the limit.
2. Climate change.
3. Change in each sector. The new variant demanded by the import market. Farmers must ensure minimum use of inputs and hormones. Big berry size, proper sugar-acid ratio, crunchiness of fruit – all this matters in grapes.
4. Reduction in cost of cultivation needed. Farmer expenses are too high.
5. Unavailability of skilled labor in grape production and post-harvest process. Farmers make a net profit of only 15 percent in gross sale price. He has to bear 85 percent cost for production, post harvest expenses, marketing of fruit etc. If something goes wrong in the chain, he is the big sufferer.
6. Every year, there is demand from various prime super markets for new certification for food safety and ethical audits. It is very difficult for small and marginal growers to meet these demands.
7. Price hike in sea freight, local inland transport due to fuel prices, input material for packing, labour – all these impact farmer revenue.

Cluster development will minimize fruit cost and facilitate the export of fruits.
Bihar is known all over India for its litchi and mango. In litchi season, production from Bihar can be found in all the major markets of India. Litchi produced in Muzaffarpur region especially, particularly Shahi litchi, is famous for its taste and flavour. Bihar is the largest producer of litchi in the country and accounts for 35% of the total production and area of cultivation.

But in litchi production, Bihar has registered a negative growth. Owing to adverse agro-climatic conditions, the average productivity of the state is declining. It is only marginally higher than the national average (of 6.2 mt/ha). Our productivity lags behind other emerging litchi producing states such as Jharkhand, West Bengal, Assam and Chhattisgarh. As a result, Bihar is losing the market share.

At 250,000 tonnes of litchi production, India is the second biggest producer after China. India exports around 1,300 tonnes of fresh and processed litchi, mainly to Europe and Asian countries.

More than 75% of the litchi is marketed through pre-harvest contractors. The price is fixed during the flowering or early fruiting stage. The contractor is then responsible for all risks and expenses related to undertaking the remaining farm operations including harvesting, sorting, grading, packing, transportation and marketing of produce. The contractor then arranges for the onward sale of fresh produce to the traders and aggregators.

For agricultural produce, India does not have a robust export market. Most of our produce is consumed within the country. The year 2014-15 saw a highest export of 961 tonnes in recent years, which is just 0.18% of the total produce. The major importing countries are Nepal, Thailand, UAE, France and Kuwait. However, export market reduced significantly to just 125 tonnes in 2016-17, due to competition from China. Significant interventions are required in value chain of the fruit to build the export market.

India being the second largest producer of litchi does not import the fruit much. Our import market for litchi is restricted to the varieties which are not produced indigenously.

**Measures for enhancing competitiveness for exporting Litchi**

The following measures can enhance India’s competitiveness for exporting Litchi.

- For the export of organic litchi in foreign markets, cultivation in Tripura and Assam must be encouraged. To facilitate export, packhouses should be established in a phased manner. The markets for organic litchi must be identified.
- Litchi producing areas in Gurdaspur and Hoshiarpur districts of Punjab are close to the Amritsar international airport. Export of litchi from this area can be enhanced by setting up packhouses.
• Technology for CA and MA storage of litchi needs to be standardized and perfected so that shelf life can be extended. To regions like the Gulf which are close, litchi can be sent by reefer containers through MA cartons.
• Residue analysis laboratory need to be set up in at least Muzaffarpur, Bihar to begin with.

Weaknesses in Indian litchi exports
Most litchi growers in Uttaranchal are not landowners and operate mostly on annual contracts. Hence, greater emphasis is placed on maximizing the output in a particular year rather than the long-term perspective. The rose-scented cultivar is highly perishable due to fruit splitting and skin burning. Despite the large amount of germplasm available, significant research and development has not been done to improve varieties and planting materials.

Planting material is obtained from unproductive and low yielding trees. Farmers are not willing to sacrifice productivity in the short term in order to replace or to rework trees with superior planting material. Over the years, the size of the seed has increased, which reduces the amount of pulp. Fruit quality has deteriorated.

In India, the litchi harvest season lasts for only about three weeks a year. In Taiwan and Madagascar, the harvesting season extends for two to three months.

The desired post-harvest infrastructure and transportation is not available to move the fruit from Bihar, the main producing area, to the international airport. The majority of exports from India are through small exporters, who have limited resources and market reach.

Although India has a well established food processing industry, it generally serves the domestic market. There are no world class food processing facilities available to process litchi. Canned whole litchi is the most popular processed form. In some states, due to manual peeling and destoning, a large percentage of the fruit is broken and is discoloured.

Opportunities for Indian litchi exporters
There is tremendous scope for the export of both fresh and processed litchi from India. The quality of the fruit readily meets the needs of international customers. The planting of successful varieties from other countries may provide an opportunity to extend the supply window and improve fruit quality.

The commercial viability of litchi processing in India can be enhanced by using processing facilities for other complementary fruit and vegetables which have good export potential, and for which the harvesting season does not clash. For baby corn, gherkins, snow peas, runner beans, guava, plum, pear and apricot.

International prices for fresh and processed litchi are highly attractive. Competition is limited, as only a few countries produce litchi. The European market is under-supplied during May to July.

Threats for Indian litchi exports
Taiwan, Madagascar, South Africa and Thailand have well-established export marketing networks. China, the top global litchi producer, is not active in world trade. If it decides to aggressively export litchi, it will present a major threat to India.

Several countries have begun litchi cultivation. Within the next two to three years, significantly higher quantity of fruit shall be available globally. Many countries have developed technology for extending the harvesting season to about two to three months through delayed ripening of fruit. In India, a stand-alone litchi processing unit based on modern technology is unlikely to be viable due to limited availability of the fruit.
many farmers prepare fruit orchards with a single crop like mango, papaya, guava, custard apple etc. The mistake they make is a) Lack of proper cost analysis and b) Poor assessment of revenue generation. The solution is to have a regular income from the farm every month to build a sustainable model. Integrated farming is the right choice.

The plants should be chosen based on their vegetative growth. Fruiting time has to be taken into consideration for selection.

The first crop can be like strawberry, which starts fruiting from third month to sixth month.

Second crop can start fruiting from seventh month to 13th month.

Third crop start fruiting from 13th month to 18th month.

Vegetable crops are grown at suitable distances and seasonal vegetables are also grown on the same land.

In above farming pattern vegetative growth and flowering time should be checked. For instance, in the line of custard apple, the distance is 10 ft. Then papaya plant can be grown in the centre of the line, say at distance of about five feet. This shall ensure that the canopy does not interfere with custard apple's share of radiation.

Marketing
You have a mixed integrated farm with vegetables and exotic fruits. Invite people to visit the farm. Weekend programs can be encouraged so they people can experience the farm. Build a good network and start home delivery of vegetables so you can earn a good income.

In fruits, try to sell at least 25% crop at retail price. The rest of it can be sold in the wholesale market with proper timings, enabling the farmers to earn benefits.

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**THINKAG RELEASES AG-TECH IN INDIA: INVESTMENT LANDSCAPE REPORT 2021**

**PANDEMIC’S IMPACT RESULTED IN LOWER AG-TECH INVESTMENTS OF $409.5 MILLION IN 2020, BUT A BOOST TO AG-TECH ADOPTION IN THE LONG RUN**

- Supply chain digitalization solutions dominate India’s Ag-Tech sector, accounting for 85% of total invested capital in 2020.
- Ag-Tech startups are pursuing a variety of paths to scale, ranging from full stack solutions and locally specific tech-enabled supply chains to pure-tech B2B SaaS models with potential for global scalability.

ThinkAg, an Ag-Tech platform working towards improved outcomes in Indian food and agriculture, has announced the release of its report titled ‘Ag-Tech in India: Investment Landscape Report 2021’ - an annual publication about the investment and innovation landscape in Indian Ag-Tech. It is supported by 3 organizations closely associated with the agriculture and Ag-Tech sectors: Rabo Foundation, ADB Ventures and Bayer CropScience Limited.

The Ag-Tech in India: Investment Landscape Report 2021, the second edition of this publication, looks at deal activity, capital flows, investor profiles and business models emergent in India’s Ag-Tech sector in 2020. Ag-Tech startups are grouped into relevant categories and sector-level trends are further broken down by the funding and innovation observed in each of them. A comparative analysis of India’s burgeoning Ag-Tech landscape and the more established global one, identifies areas with leads and lags.

These high-level findings are complemented by an in-depth analysis of Ag-Tech models and stakeholder perspectives. This includes comprehensive case studies on 6 promising Ag-Tech as well as insights...
derived from interviews with prominent ecosystem experts; ranging from leaders in development organizations to seasoned international Ag-Tech investors. To capture a systematic view, surveys of key stakeholder groups – innovators, investors and corporates – were conducted and the key findings have been featured in this publication. Providing a forward-looking view, the report identifies the likely drivers of innovations, investments and outcomes in the Indian Ag-Tech landscape in years to come.

Some key findings of this report include:

* Pandemic’s impact precipitated a slowdown in Ag-Tech investments in 2020, though the sector’s long-term prospects remain favorable
* Capital flowing into the Ag-Tech sector in 2020 amounted to $40.95 million, 35% lower than in 2019 and spread across 28% fewer deals. Investors leaned towards backing proven business models and chose to boost existing portfolio investments to tide over challenges posed by the pandemic.
* Supply chain solutions continued to see growth and corner capital
* Digitalization and optimization of India’s numerous and fragmented supply chains continue to dominate India’s Ag-Tech landscape, accounting for 85% of the total investment and two-thirds of first-time deals in 2020. There are also a growing variety of models in the sub-sector, particularly - agribusiness marketplaces for output in addition to consumer-proximate ones and, emergence of novel solutions for allied sector (dairy, poultry etc.) supply chains.

Healthier Ag-Tech investment pipeline

The 2020 edition of this report, covering investments from 2014 to 2019, identified a bloated-middle in the Ag-Tech sector’s investment pipeline, referring to many startups raising bridge funding, while first-time deals and late-stage investments remained low. In 2020, this was overcome to some extent with half of the startups raising follow-on capital, more than doubling their previous fundraise. Since 2019, first-time deals and investments in higher-end funding brackets (above $5 million) have grown in proportion.

Diverse investor profile

2020 saw a greater diversification of investors in Indian Ag-Tech, with greater participation from domestic and international private equity and growth capital providers, increased interest and investments by sector-agnostic venture investors and the entry of large e-commerce companies as strategic investors in the Ag-Tech space.

Ag-Tech startups are pursuing a variety of paths to scale

Hyper fragmentation in Indian agriculture, the need for locally specific solutions and the plug and play nature of some high-tech solutions are some of driving factors behind Indian Ag-Tech companies’ chosen paths to scale. Significant approaches include, full stack solutions spanning multiple agri-value chain players and services, locally specific tech-enabled supply chains, and pure-tech B2B SaaS models with potential for global scalability.

Boosting adoption among smallholder farmers

The high costs of accessing and onboarding individual smallholder farmers, coupled with it being one of the riskiest entrepreneurial ventures, poses an uphill battle for Ag-Tech startups to achieve scalability of their solutions. Identified approaches to overcome this include, providing post-harvest services integral to improving smallholder income (warehousing, better market access); and reaching smallholders at scale through aggregation channels such as Farmer Producer Organizations (FPOs) and investments in higher-end funding brackets (above $5 million) have grown in proportion.

Optimism among Ag-Tech entrepreneurs and investors, corporates hesitant to partner

Surveys conducted by ThinkAg reveal significant interest and some apprehension regarding Ag-Tech models’ scalability among investors and corporates. Many Ag-Tech startups are addressing this by growing to offer adjacent services, beyond their core offerings. Corporate entities have yet to arrive at a scalable and sustained way to partner with Ag-Tech companies.

Commenting on the report’s findings, Mr Ram Kaundinya, Director General, Federation of Seed Industry of India and Co-founder, ThinkAg said, “Given Ag-Tech’s tremendous potential to transform Indian agriculture, understanding the factors that drive its adoption, becomes an imperative. Solving for improved farmer incomes, robust agri-value chains and more sustainable agricultural practices; the sector is witnessing innovations across technologies and business models. We hope the findings of this report will inform ecosystem stakeholders about the solutions at play and encourage investment and engagement in this crucial space.”

D. Narain, CEO & Managing Director, Bayer CropScience Limited, said, “Indian farmers are rapidly adopting modern agricultural practices and technologies to enhance their yields and incomes. Together with advances in crop protection and agronomy, digital tools will help Indian farmers become globally competitive. To accelerate digitalization of Indian agriculture, we need strong collaboration between Ag-Tech startups, public and private players to invest further to enhance digital capabilities and enable last mile reach to farmers.”

Mr Arindom Datta, Executive Director and Head, Rural & Development Banking/Advisory, Rabobank, said it is vital for private capital to back businesses that tackle the critical issues of inclusiveness, access to finance and climate complexities present within the domain of agriculture.
Makhana is an emerging crop in Indian horticulture. It has been used in Chinese, Ayurveda and Unani system of medicine for over 3000 years in addition to being dietary source of fiber. Makhana ensures food and economical security to poor farmers. It also enhances productivity with aquaculture. That is why it is known as the wonder wetland crop.

A regional centre was set-up in Darbhanga district of Bihar under the ICAR Research Complex for Eastern Region, leading to improvement of Makhana crop. Suvarna Vaidehi is first variety of makhana released from this centre. This crop is adapted to the tropical and sub-tropical climatic conditions, particularly of the South-East Asian countries. Bihar, lower Assam, West Bengal and Odisha are some of the states in India where it is grown at commercial scale.

Makhana seeds are low in calories, saturated fats, sodium and cholesterol. Hence roasted makhana is considered as an ideal snack. High level of minerals likes magnesium, thiamine, potassium, manganese along with low glycemic index of makhana makes it useful for those suffering from cardiac and diabetic complications. In addition to being an excellent anti-aging agent and antioxidant, makhana has been used for the treatment of chronic diarrhoea, gonorrhoea, kidney disorders, constipation, stomach-ache and beri-beri traditionally.

**Cultivation and Harvesting**

A single plant of makhana gives around 450-700 gm of seeds. Makhana fruits split open inside water in May-July and the seeds come on the surface for some days. Then they settle in the bottom of the pond, from where they are collected by divers of the fisherman community in August-September. The collected seeds are washed frequently to remove mud and other debris. Yield of makhana ranges between 1200 to 1500 kg per hectare.

**Post- harvest processing**

Collected seeds are washed, cleaned and sun dried for two to three hours under broad sun light to minimize the moisture content. The dried seeds are then classified into 5 to 7 grades on the basis of size by means of different set of sieves. Dried and graded seeds are heated in an earthen pitcher or a cast iron pan. These pre-heated seeds are then stored under ambient conditions for 48 to 72 hours for moisture balance, a process known as tempering.

Tempering is done to slacken the kernels within hard seed coat. Now, treated seeds are roasted at a temperature of 250–300°C. They are cracked with a wooden hammer to get popped makhana lava. The recovery rate for popped makhana is 40-42 pc. On average, 100 kg of seed yield 38-40 kg of popped nuts. The popped makhana is

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**About the Authors**

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then packed in gunny bags with plastic lining and can be stored for long.

**Economic potential**

The major production hub of makhana is Bihar. With rising global demand, makhana has become a crop of national and global importance owing to its nutraceutical value. The demand for makhana is on the rise in most countries including the USA, the UK, the European Union, Australia, New Zealand etc. The exports of makhana from India have increased at 11.2% annually from 2013 to 2017 and in 2017-18. Europe emerged as the second most prominent regional market for makhana in 2018. India has exported USD 21.2 million worth of makhana to the world. The global market for makhana is all set to grow by USD 72.5 million during 2019-2023. The opening up of these untapped markets shall boost the economic potential of this wonder crop.

**Promotion strategies and scope**

Indian Agricultural and Processed Food Products Export Development Authority (APEDA) is giving pace to the economic/export potential of makhana. GOI has initiated interaction with the governments in the makhana-producing states and ICAR institutions to export and exploit the latent potential of makhana.

Bihar government has launched a number of initiatives for various stakeholders in makhana production and sale, right from farmers to retailers through processors, wholesalers etc. These include waiver of stamp duty and registration fee in lease/sale/transfer of land to set up units, tax rebates and reimbursement of deposited money to person engaged in makhana farming and other infrastructure, reimbursement on the capital investment on plant and machinery for captive power, and state level & district committees for the sanction of applications within stipulated timelines. The potential of makhana market in western countries like USA and UK still needs exploration. Start-ups and entrepreneurs can play a significant role by introducing processed makhana products to tap the high growth potential of markets in these countries.

The global market for makhana is all set to grow by USD 72.5 million during 2019-2023. The opening up of these untapped markets shall boost the economic potential of this wonder crop.
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