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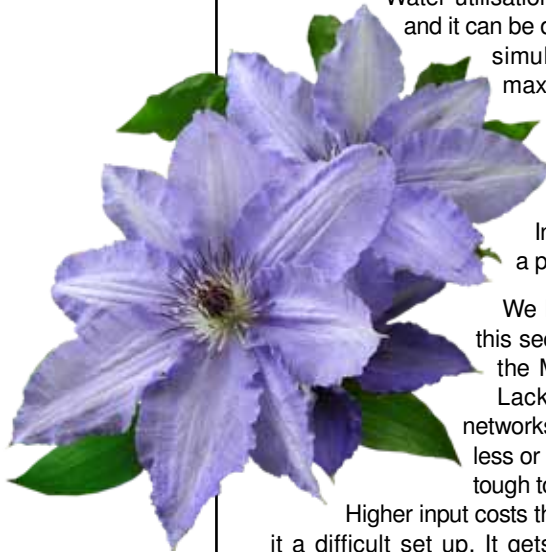
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Horticulture: The Sunrise Sector

Horticulture is increasingly being recognised as a sunrise sector, owing to its potential to raise farm income, provide livelihood security and earn foreign exchange through export. The horticulture sector has become one of the major drivers of growth as it is more remunerative than the agricultural sector. In tune with the emerging demands, India brought forth several technology and policy initiatives for promoting horticulture.

The diverse agro-climatic conditions and rich diversity in crops and genetic resources enable India to produce a wide range of horticultural crops round the year. This sector provides employment possibilities across primary, secondary and tertiary sectors. Horticulture crops, fruits are more resilient to change in weather conditions and the vegetables augment the income of small and marginal farmers.



Water utilisation is very low, minimising the risk of crop failure and it can be done on smaller farms. Multiple crops are planted simultaneously to get more yield and to use the maximum of the fertilisers. This sector enables the population to eat a diverse and balanced diet for a healthy lifestyle. It became a key driver for economic development in many of the states in the country where the Division of Horticulture of Indian Council of Agricultural Research is playing a pivotal role.

We have to address the challenges that we face in this sector. Horticulture does not enjoy a safety net like the Minimum Support Price (MSP) for food grains; Lack of good cold chain storage and transport networks to extend the life of perishable products; Very less or limited input by machinery and equipment so it is tough to minimise the time restraints.

Higher input costs than food grains make it a difficult set up. It gets challenging for marginal farmers to cope with the high price fluctuations.

Urban Farming is a positive, growing phenomenon. Metropolitan cities are getting crowded with a shift from farms and greenery to concrete houses, noise, and higher population density. Delhi Government has facilitated emergence of newer mechanisms to promote urban farming, under which people will be encouraged to grow vegetables and fruits in their houses. Urban farming would escalate aesthetic beauty of urban landscapes by increasing the green cover in the city, along with helping citizens to avoid harmful chemicals in the food products.

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Mamta





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RAJNI SHALEEN CHOPRA

UTTARAKHAND INITIATIVE FOR FARMERS' WELFARE

For mountain farmers, vegetables are cash crops. Fruits and vegetables grown in the clean mountain air and rich healthy soil carry innumerable benefits for us all. The Uttarakhand government is cashing in on the proximity of the mountain state to the National Capital Region. Multiple initiatives have been taken by the Uttarakhand Cooperative Development Project (UKCDP) so that farmers are able to find a robust market for their produce, and they get the appropriate returns for their efforts.

In this regard, UKCDP is creating a market platform for the farmers through various cooperative societies. The state government through UKCDP Project has provided well-equipped collection centers and POS (Points of sale) where the farmers are able to sell their produce and are assured a fair deal.

The Uttarakhand government has taken a visionary initiative to ensure that the benefits of all the central and state schemes are able to reach the farmers at the grassroots level.

Convergence has been done for the multifarious schemes, departments and institutions for impactful outreach to the farmers of the mountain state.

It has been carried out by the Cooperative Sector for UKCDP - MIDH, MGNREGA, PMFME, ATMA, MadhuGram, Centre for Aromatic Plants, Department of Horticulture etc.

The convergence for farmers' welfare is the visionary initiative of Dr BVRC Purushottam, IAS, Secretary Cooperatives, Rural Development, Animal Husbandry, Fisheries, Agriculture and Farmers Welfare. The objective is to create synergy for realising effective and sustained outcomes.

The major impact of convergence can be accessed in both quantitative and qualitative terms. Quantitatively it shall help in reaching out to a higher number of beneficiaries within the same earmarked financial outlay of a particular scheme. Qualitatively, it shall lead to quality management and monitoring of the schemes, sustained outcomes and wider project impact area.

Dr Purushottam said that convergence needs to be established as a good

practice across departments and schemes for overhauling the entire implementation mechanism. Through this initiative, the interest component can be reduced. The Multilevel Primary Agriculture Societies (MPACS) and Farmers. Directly or through the MPACS, the farmers will be benefited to a great extent.

Dr Purushottam said that this is a NCDC funded project. Being the secretary of all the inter-related departments i.e. Cooperatives, Agriculture, Rural Development, Animal Husbandry, Fisheries & Farmers Welfare, he has been working on the convergence of different government schemes for the viability of the project.

Dr Purushottam's vision and efforts for this convergence not only fill the gap of execution at the grassroot level, but also impact the farmers' livelihoods significantly.



HORTICULTURE: THE ROAD TO FARMERS' PROSPERITY



ANJANA NAIR

Horticulture holds the unique distinction of meeting the nutritional security of the nation, providing alternate rural employment opportunities, diversification in farm activities, and enhanced income option to the farmers. Indian horticulture sector contributes about 33% to the agriculture Gross Value Added (GVA), making very significant contribution to the economy. India's horticulture production today has surpassed food grain production. We have emerged as world leaders in the production of a variety of fruits and vegetables. With the increased in the income levels of the population, we are also witnessing a renewed interest in this group of crops among consumers.

Apart from the contribution of horticultural crops to nutrition and income levels, the sector can be considered as a harbinger of improved technologies to the Indian agricultural space. While the green revolution made the use of improved varieties, fertilizers, pesticides and tractors a routine, horticulture heralded the arrival of hybrids, biofertilizers, green chemicals, micro irrigation, green houses and precision technologies. With horticulture, we learned to be sustainable and efficient. Integrated models covering fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo helped the farmers to diversify. Marketing became important functions and emphasis was laid on post harvest operations, value addition and processing. Horticulture set in motion a chain of industries that relied heavily on technology to produce products of diversified nature. Horticulture became source of raw materials for many industries.

The opportunities are immense for horticulture. However, there are a set of challenges that need to be effectively addressed to realize the full potential of horticulture. Unlike food grains, there is no supportive price mechanism such as Minimum Support Price for Horticulture products. This often results in poor price recovery for the farmers.

As horticultural farmers fall mostly under small and marginal category, coping with the price fluctuations is a major challenge. Cold chain logistics are still in nascent stages. Farmers are yet to reap full benefits from it. Processing and value addition technologies are yet to be made economical, accessible and practical for small scale farmers.

Leveraging emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Blockchain, etc., can bring predictability to horticulture. The emerging agtech startups are a ray of hope to the segment. India can bring the emphasis on raising quality crops. Preserved cultivation, hydroponic & aeroponic should get more reach and acceptability. The horticulture sector can emerge as a significant factor for economic development, and technology can play a key role in this.



PROTECTED CULTIVATION IN INDIA PROBLEMS, ISSUES AND THE WAY FORWARD

Agriculture or Farming is done for more than 10,000 years now. Since then, till today agriculture or farming has always suffered because of harsh climates. Heavy rains, winds, snow fall etc ruin the cultivation with great losses to farmers. Agriculture scientists in 17th century were working on how to save and cultivate rare medicinal plants in such harsh climates. It was thought that farming should be protected the way a human being protects himself during harsh weather like snowfall rains etc. Obviously, he will find shelter/house to protect himself from these natural calamities. Scientists decided to conduct trials on cultivation of plants in a house. Such house was named as Greenhouse.

The First Greenhouse

Way back in 18th century, a first such practical greenhouse or structure was designed and built by Jules Charles, a French botanist. It was

built in Leiden, Holland and used primarily to grow medicinal tropical plants. Being available in plenty, wood was used as a frame and glass as a cladding/covering material.

It was quite successful. Slowly the technology spread in entire Europe and later on in America. While it was adopted by farmers in Europe and America, scientists were working on various aspects of climate, soil, water, varieties, structural parts etc in order to achieve more production, round the



Dr Anand R. is Executive Director, National Committee on Precision Agriculture & Horticulture (NCPAH), Ministry of Agriculture & Farmers Welfare MoA & FW, GOI. Dr Zambre has widely travelled in all states of India and 18 countries for official purpose. He has trained more than 12,000 farmers and more than 1000 Agriculture/Horticulture officers from various states of India and surrounding countries in the field of protected cultivation and plasticulture

About the **AUTHORS**

Dr Prabhat Kumar is Commissioner Horticulture, Government of India with 15 years experience in teaching, research and extension. He has been felicitated with the prestigious Himadri Young Scientist Award by Indian Society of Horticulture Research & Development

Greenhouse technology is the present and future of farming as it gives assured production and returns. Hence time has come for all concerned to come and sit together, find out the lacunas/mistakes made in the past and come up with new and latest advanced schemes/cultivation practices for the better future of the farmers and the nation

year production with better quality.

In 1940-41, polyfilm was first time introduced as a covering material replacing glass. Use of polyfilm as a cladding material became very popular being cheap, easy to install and with varying filtration/physical properties helpful for better growing crops resulting in more production and better-quality produce.

Promotion By National Horticulture Board

At central level, National Horticulture Board (NHB) under Ministry of Agriculture was given a task to promote the protected cultivation technology. In the initial phase, NHB was providing the subsidies to farmers and entrepreneurs in the form of soft loans. Later, instead of soft loan, NHB started providing subsidy to the beneficiary to a tune of 20% of the project cost. To avail the subsidy through NHB, it was a condition that the farmer/entrepreneur must take a loan from bank. After execution and verification of the project, the subsidy amount was added in

the bank account of the beneficiary.

National Horticulture Mission's Boost

In 2004-2005, Ministry of Agriculture GoI initiated National Horticulture Mission (NHM) for promotion of various Horticulture activities like greenhouse/protected cultivation, high density fruits in open plantation, use of plasticulture products like micro irrigation and mulching, rain water harvesting, pre-cooling chambers, cold storages and many such other initiatives for the benefits of the farmers in all regions.

For greenhouse cultivation, subsidy under NHM was given to a tune of 50% of the cost of greenhouse structures with micro irrigation systems. This initiative of GoI under NHM truly boosted the adoption of greenhouse technology among the farmers from all states of India including North Eastern states and Himalayan states. Later, under NHM, subsidy for planting materials (flowers or vegetables) under protected cultivation

to a tune of 50% of the cost of planting material was introduced for further help to interested farmers. Observing the success of greenhouse technology profitable to farmers, many states like Himachal Pradesh, Uttarakhand, Haryana, Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Telangana, Chhattisgarh, Odisha, Uttar Pradesh, Bihar, Zarkhand, West Bengal and North Eastern states started adopting protected cultivation through NHM. During 2013-14, NHM scheme was further modified and reintroduced as Mission for Integrated Development of Horticulture (MIDH).

Under NHM/MIDH, Ministry of Agriculture & Farmers Welfare GoI started various Precision Farming Development Centers (PFDCs) attached to various State Agri Universities and ICAR, IIT Kharagpur etc. The main objectives of PFDCs are to conduct applied research in precision agriculture and plasti-culture products including protected cultivation, demonstration of flowers and vegetable cultivation under protected structures and open fields, training and awareness programs for farmers in the field of protected cultivation and precision farming techniques. There are such 22 PFDCs all over India monitored by National Committee on Precision Agriculture & Horticulture (NCPAH) under MoA & FW helping farmers for their success in protected cultivation.

Under NHM/MIDH, MoA & FW



Vegetable cultivation in Greenhouses in Leh-Ladakh region





initiated various Centers of Excellence (CoEs) in collaboration with Israel and The Netherlands for demonstrations of latest technologies in protected cultivation and various floriculture/vegetable crops along with practical trainings for farmers. Such CoEs are located in various states and farmers are trained at such centers.

Challenges

Though protected cultivation technology is proved a successful technology for cultivation of high value crops and able farmers to earn good profits from such units and government machineries helping the farmers through trainings, promotions and subsidies, it is not that everything is fine and set. There are many problems/issues that need to be discussed and sorted. Many farmers/entrepreneurs were forced to close their units due to heavy losses caused by certain factors. Following are some problems/issues faced by farmers.

Adverse climatic conditions – Normally, the greenhouse structures are designed to withstand a wind velocity of 100 to 120 KM/Hr. However, if the structure is not designed properly and not oriented as per standard wind directions, there is always a possibility that the polyfilm will get torn or the structure may collapse. Such huge damage is observed many times specially in high windy regions like Haryana, Rajasthan, part of Gujarat, Maharashtra, Karnataka and other states as well. It becomes very difficult for farmers to recover from such heavy damage being high costs involved.

Various climatic zones – India is a country with full of diversity and various climatic zones exist. It is very important to design the greenhouse structures as per the climatic conditions in the specific region. Unfortunately, greenhouse designs suggested through Gol schemes and SHM schemes for various locations

are more or less same. Though such structures are technically correct but are installed at wrong location. As a result, they are not able to produce estimated production and quality produce. It is very important to design the structures as per the existing climate and crops to be grown.

Training and awareness – The concept of greenhouse technology is about 25 years old in India. But being a totally different cultivation practice as compared with open traditional farming, skill development, training and awareness of end users is a must. Lot of research in this field is required rather than copying the technology from Israel or The Netherlands. It is observed that farmers are very much interested to begin greenhouse cultivation. But without proper knowledge of cultivation and marketing, many of them could not grow the crops successfully, resulting in failure. It is also important to conduct/organize trainers training program regularly for the trainers/consultants in this field as the technology gets improved/changed very rapidly.

Market linkages and information – It is observed that many times the farmers are able to cultivate good quantity and quality produce in protected structures but are not able to get proper markets to sell the produce or may not get proper

rates for their produce. In such cases, because of high initial investments and high production costs, the returns are far below and farmers face big losses.

Release of subsidies – It is observed that many times the subsidies from NHB or state SHMs for greenhouses are not released in time. Since the end users take a loan for installation of a project, they have to repay in time even though subsidies are not released. Delay in releasing the subsidies in time to beneficiaries cause losses to the farmers.

Lack of infrastructure – The infrastructure or availability of inputs like quality planting materials, seeds, water soluble fertilizers, pesticides, transport, storage facilities and others are well established in some areas. But still many of these inputs are not available for farmers and beneficiaries in remote areas. Due to non-availability of such inputs, the farmers face great problems during cultivation.

Possible Way forward

* The farmers and Government are investing huge amount in installation of greenhouse structures. It is very important that the structures are designed properly with right specified components to withstand and adverse climate and provide benefits to the beneficiary for a



It is observed that farmers are very much interested in greenhouse cultivation. But without proper knowledge of cultivation and marketing, many of them are not able to grow the crops successfully, resulting in failure. Regular training is important as the technology gets improved or changes very rapidly

long period. In Israel and Europe, proper standards are developed for various components and greenhouse as a whole for designs and specifications.

In India, very few components like shade net, Insect nets, Indian standards are developed. However, there is no standard for various greenhouse designs and specifications prepared and published by BIS as on today. Such lack of standards may permit substandard materials to use in greenhouse structures ultimately resulting in huge damages to the farmers. It is necessary that BIS should formulate certain required standards for all the components as well as for all various designs and specifications for different structures used in India to stop malpractices in business and for the benefits of the farmers and industry.

Government agencies like BIS, NHB, MIDH, PFDCs, CoEs, and NCPAH etc need to pay attention for such standards and implement it to reduce and stop losses in this field. If required, help from technical institutes like IITs, CIPET can be taken for formulation of standards.

- Availability of inputs – All the stake holders need to check whether all inputs are available to start the greenhouse cultivation in particular area. It is observed that many times small things like EC or pH of soil and water is also not tested before sanctioning greenhouses to farmers. Such negligence may lead to future losses.

- Development of other infrastructures – The greenhouse cultivation should be cluster based. Near the cluster, facilities like nurseries, mandis (market), storage facilities, and transport facilities including cold vans should be made available. The produce from greenhouses are all perishable products. If such storage/transport facilities are not available, the quality of the produce declines and farmers

face problems in selling the produce at desired rates resulting in losses.

- Training facilities for farmers – Many state Horticulture departments have started training centers providing trainings on greenhouse technology for farmers. Horticulture Training Center HTC located in Pune district Maharashtra is a good example. Similarly, PFDCs, CoEs located in various states also provide such greenhouse trainings.

Recently since last year, NCPAH-PFDCs have started a one-month course on greenhouse operator under skill development program through ASCI. However, these efforts are not enough. There is need to develop specialized training centers with all required latest facilities under demonstrations. It should be made mandatory for the beneficiaries to undergo such trainings before installation of greenhouse. It is also important to train the trainers of such institutes from time to time as the technology improves very rapidly.

- Training of verification officers – Before release of subsidies, all the greenhouse structures are inspected by the team of government agencies like NHB or SHM. It is very important that the officers inspecting the greenhouses are trained in inspection/verification. The officers should not be asked to verify the greenhouses without proper training. Further, re-verification should also be done

Recommendations For Success

Overall, to increase the success rate in greenhouse cultivation, following measures need to be taken with immediate effect.

- A mass survey to be conducted on national/state level and visit each and every greenhouse structure installed since the inception of the scheme. Check

the conditions of greenhouses if they are successfully running or closed. List out the closed greenhouse project and find out the reasons for shut down of the project. Once the reasons are known, remedies/measures can be sorted out with the help of experts and the projects can be revived again. Such study will be helpful to avoid future mistakes and the success rate in greenhouse cultivation will be higher.

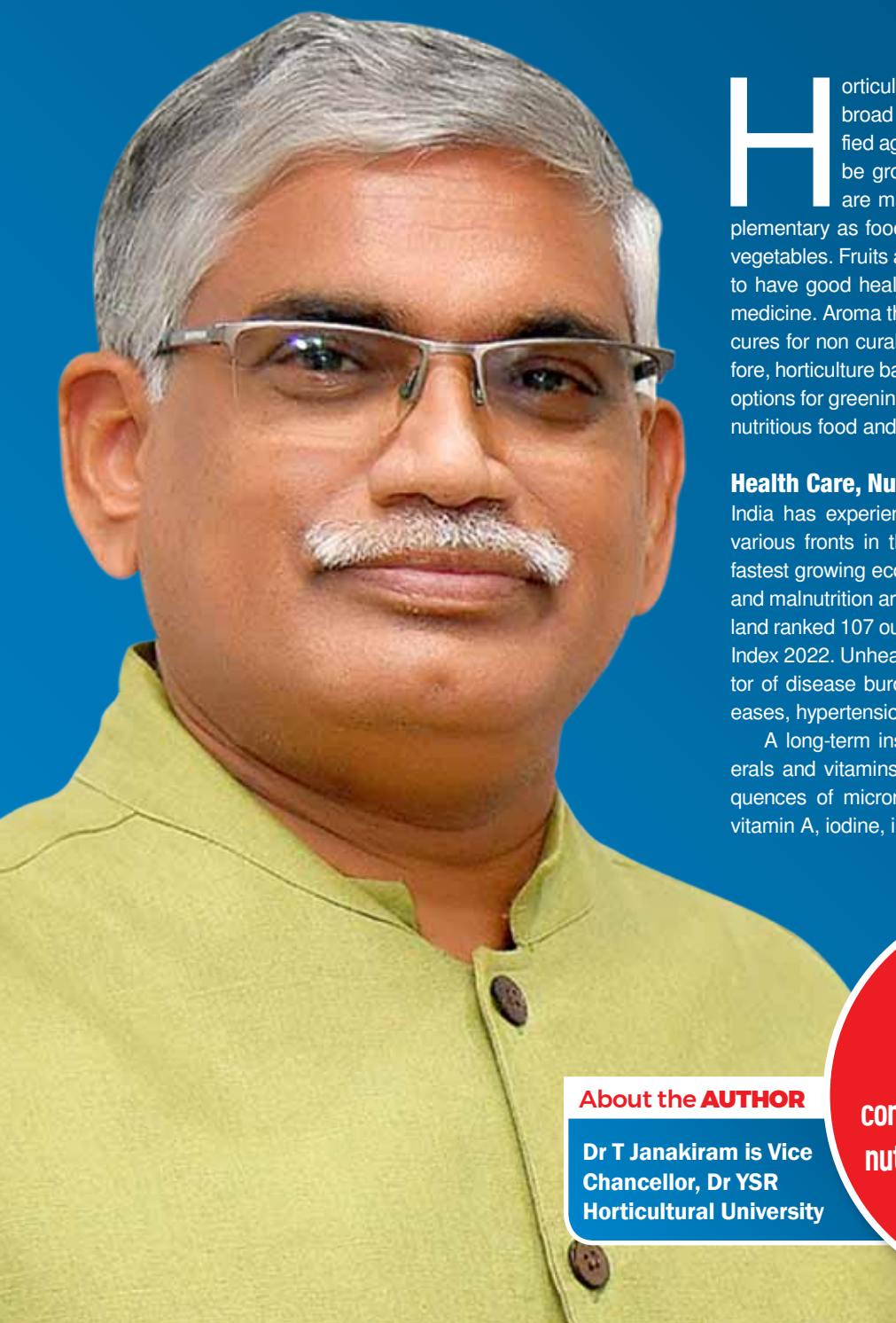
- State wise data of greenhouse erected along with crops is not available with any Govt agency, NGOs/Associations or private sector. The consolidated data representing state wise/area wise/district wise/type wise greenhouses can give an idea to policy makers how much area in India is under protected cultivation. This information can help policy makers for taking appropriate decisions in future. Similarly, data for crops vis vegetables/flowers/fruits need to be collected and consolidated. A portal at central level can be developed and detailed information can be sought from state officials on regular basis so that such data can be available to policy makers at any given time.

- A committee of experts need to be formed at National level that include ICAR/NCPAH/PFDC experts, state officials, MIDH/NHB officials, BIS, Greenhouse associations, progressive farmers to study the existing schemes thoroughly to find out the lacunas and improve as per the existing needs.

It is very clear and everyone knows that due to global warming and climatic changes, it is becoming very difficult to continue farming in open field and farmers are facing great problems. Greenhouse technology is the present and future of farming as it gives assured production and returns. Hence time has come for all concerned to come and sit together, find out the lacunas/mistakes made in the past and come up with new and latest advanced schemes/cultivation practices for the better future of the farmers and the nation.

(Above article is based on online search, discussions with scientists, experts and experienced farmers in India and self-experience)

HORTICULTURE CONTRIBUTING DIRECTLY TO UN SDGs



Horticulture has wide adaptability. It provides broad choice of crops to farmers for diversified agro-climatic conditions. Some crops can be grown even in the degraded soils. There are many horticultural crops which are complementary as food, i.e. potato, tuber crops, banana and vegetables. Fruits and vegetable therapy is now a practice to have good health without medication and as a herbal medicine. Aroma therapy and edible flowers are the green cures for non curable ailments in the present day. Therefore, horticulture based farming system is one of the viable options for greening, environmental service and to provide nutritious food and enhanced farm profitability.

Health Care, Nutrition

India has experienced remarkable economic growth on various fronts in the recent years and remains one of the fastest growing economies in the world. However, hunger and malnutrition are the cause of concern and our motherland ranked 107 out of 121 countries in the Global Hunger Index 2022. Unhealthy dietary habit is the leading risk factor of disease burden contributing to coronary heart diseases, hypertension and diabetes in India.

A long-term insufficient or imbalanced intake of minerals and vitamins leads to "hidden hunger", the consequences of micronutrient deficiencies, in particular pro-vitamin A, iodine, iron and zinc.

About the **AUTHOR**

Dr T Janakiram is Vice
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Horticultural University

We
now need to work
now for the 'Evergreen
Revolution' so that we
continue to provide sufficient
nutritious food for the socio-
economic prosperity of
the nation

Horticulture is a sunshine sector and is capable of overcoming malnutrition. Fruits and vegetables are rich source of vitamins, minerals, proteins, carbohydrates, micronutrients and health-promoting phytochemicals and are often regarded as 'protective foods'. They assume greater significance in the prosperity of the nation, nutritional and health security of the people. However, challenges regarding availability, affordability and food safety of fresh fruit and vegetables and the conservation of processed produce are to be addressed.

Simple interventions such as kitchen garden seed kits, maintenance of community gardens is the major source for the nutrient sensitive approach.

As per ICMR-National Institute of Nutrition recommendation, Hyderabad- "My Plate For The Day"-A healthy diet needs to include nearly 500 g of rainbow colored vegetables and fruits accounting for at least 8% of the daily calorie intake. Increased horticultural crop production brings many other benefits to people, such as enhanced income for smallholder farmers and other value chain participants, employment opportunities throughout the value chain, empowerment of women, and more sustainable future.

Thus, horticulture has great potential to contribute directly to several of the UN Sustainable Development Goals (SDGs), particularly SDG 2 (Zero hunger) and SDG 12 (Responsible consumption and production).

Horticulture For Green- Environment

The growing population is the major concern and is the biggest challenge for meeting the nutritional needs and the green spaces worldwide. Indian Agriculture, even with high pressure on land (17% population from 2.3% land and 4.5% water) has fed the Indian population. In the prevailing circumstances of shrinking farm land, depleting water resources and changing climate, the situation has become more complex. Apart from this, the urbanisation is at faster pace as a result of immigration from rural areas.

In this context, a key aspect is to develop policy, strategies, and technical

**fun
FACT**



Dr Janakiram loves to listen to old songs, spend time with mother and play with pet cat Lucifer. He is also extremely fond of nature and pets

support mechanisms for the sustainable management of urban/peri urban horticulture addressing production issues within a border framework of environmental planning and management.

Advanced methods of farming systems viz., protected cultivation, vertical gardening, terrace gardening, soilless cultivation through aeroponics, hydroponics and aquaponics, vertical 'A' frame structures are few of the viable options to be taken up by providing skill set and training to the farmers.

Climate change and global warming challenges the productivity of the crops by water availability, energy efficiency, cultivation strategy and prevalence of pest and disease outbreak. Therefore, cultivated area under greenhouses, shadenets and tunnels along with vertical farming may be taken up for effective management of microclimate.

Challenges

Poor infrastructure, less shelf life, noncompliance of food quality and food safety issues, fluctuation of prices, small uneconomic land holdings, poor investment capacity of the farmer and implementation of age old technologies are the major impediments faced by the Indian farmers

Some horticultural based technologies with a scope of sustained income generation for the small land holdings:

- ❖ Production of superior quality planting material

and seeds of superior quality to meet the growing demands

- ❖ Development of cultivars to meet the requirements of high yield, sustain climate change, nutraceutical values, value addition and export competitiveness
- ❖ Production system management like canopy architecture, Good Agricultural Practices, Site Specific Nutrient Management, bio inputs and organic farming
- ❖ Need to establish low cost polyhouses, tissue culture labs, value addition labs, compost units, post harvest processing units and taking the advantage of unemployed youth
- ❖ Consistent supply chain managements for enhanced productivity, quality, and minimisation of post harvest losses
- ❖ Mechanisation for small scale farmers through development of low cost user friendly tools, by-product utilisation and secondary horticulture
- ❖ Expanding area under irrigation, revamp extension system, improve factor productivity and increase our investment in horticultural Research and development
- ❖ Reducing huge post-harvest losses needs to be attended on priority
- ❖ Growing high value crops under controlled climatic conditions is the need of the hour
- ❖ Tapping the potential of indigenous underutilised crops and their nutritional benefits
- ❖ Growing of high value seasonal horticultural crops for gainful employment of rural youth and perennial crops for long term benefits.

First green revolution saved almost a billion people from starvation and helped in maintaining peace around the world. We now need to work not only for second green revolution but for an 'Evergreen revolution' so that we continue to provide sufficient nutritious food for socio economic prosperity of the nation.





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being Patented in many
developed countries.



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Prathista Farmers Welfare Foundation was established with a mission to promote Organic Farming across India with Prathista's innovative **Nano Technology** products. The foundation aims to **encourage rural youth** in every village of the country to **become agripreneurs**, instead of migrating to cities for odd jobs.

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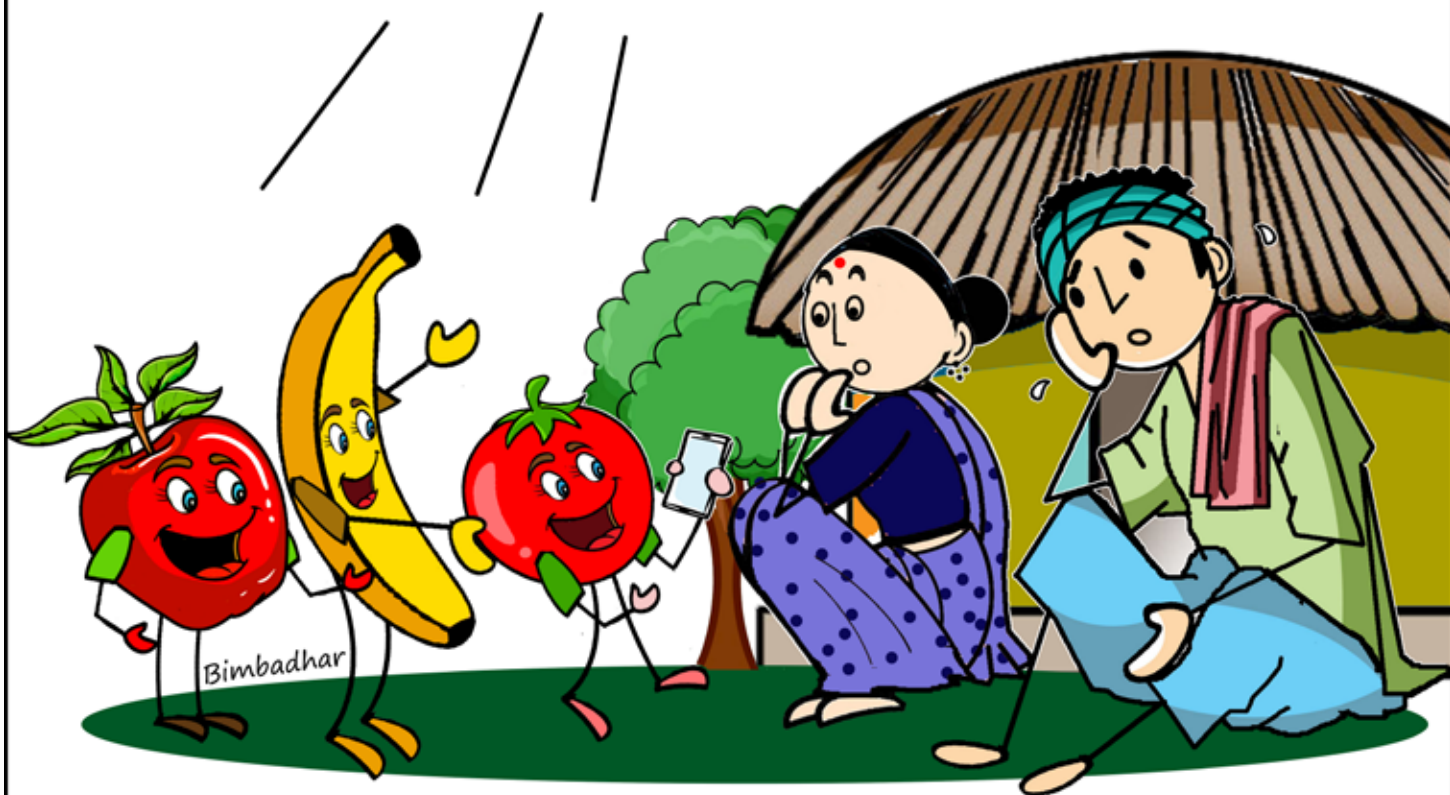


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LEVERAGING AIF FOR INFRASTRUCTURE DEVELOPMENT IN HORTICULTURE SECTOR



About the **AUTHOR**

Mr Samuel Praveen Kumar is Joint Secretary (AIF) , DA&FW , GOI

Infrastructure plays a vital role in agriculture at every single stage right from supply of inputs, sowing of crops, post-harvest management including processing, storage and transportation and access to better markets. Planned investment in the agriculture infrastructure sector is important to enhance productivity and to reduce the post-harvest losses. This will also result in capacity building and higher income generation.

In India, post-harvest losses are relatively higher in agricultural crops. About 10-15% of yield is wasted, which is relatively higher vs. other countries where it ranges between 5-10%. The loss is high because of gaps in basic agriculture infrastructures like storage houses, pack houses, absence of proper supply chain etc. When it comes to horticulture crops, it is much higher in the range of 25-30%. The loss is primarily attributed to lack of adequate post-harvest infrastructure.

AIF Launched In August 2020

It is an undisputable fact that the rate of agricultural and economic growth in the country is accelerated by fast-expanding infrastructure, which increases farm output and decreases farming costs. Infrastructure is known to play a crucial role in generating stronger economic multipliers when agricultural growth occurs.

Therefore, to address the issue of post-harvest infrastructure gap in our country, Government of India has formulated a Central Sector Scheme of financing facility named 'Agriculture Infrastructure Fund' which was launched by Hon'ble Prime Minister of India on 9th August 2020 for creating required pre- and post-harvest management infrastructure in the agriculture and horticulture sector.

Potential For Transformative Changes

Agriculture Infrastructure Fund aims at providing a medium/long term debt financing facility through 3% interest subvention and credit guarantee support on loans up to Rs 2 crore for creation of post-harvest management infrastructure



and community farming assets. With its unique feature of allowing convergence with other Central Govt schemes and State Govt schemes for projects eligible, AIF scheme has the potential to bring in transformative changes in the post-harvest infrastructure landscape of the country especially in Horticulture sector.

Eligible beneficiaries include Farmers, Agri-entrepreneurs, Start-ups, Primary Agricultural Credit Societies (PACS), Marketing Cooperative Societies, Farmer Producers Organizations (FPOs), Self Help Group (SHG), Joint Liability Groups (JLG), Multipurpose Cooperative Societies, Central/State agency or Local Body sponsored Public Private Partnership Projects, State Agencies, Agricultural Produce Market Committees (Mandis), National & State Federations of Cooperatives, Federations of FPOs (Farmer Produce Organizations) and Federations of Self Help Groups (SHGs).

Solution For Large Infrastructure Gaps

Despite horticulture accounting for a third of the total agricultural gross value added, there exist large infrastructure gaps ranging from 8.6 per cent for cold storages to 99.6 per cent in the case of

Horticulture specific infrastructure has been built under AIF in the identified 12 horticulture clusters for pilot phase 1. A total of around 400 total projects have come up in these clusters amounting to more than Rs 675 crores to bridge the post-harvest infrastructure gaps

pack houses compared to the production of perishable products like fruits and vegetables.

Though fruits and vegetable crops appear to be more remunerative than cereal crops, a substantial proportion of production is lost due to inadequate post-harvest management practice and infrastructure facilities with no benefit to producers and consumers

Under AIF, a lot of work has been done on building Horticulture sector Specific Infrastructure such as cold chains which include cold storages, reefer vehicles, ripening chambers, waxing plants,

sorting & grading units. Around 1600 Horticulture projects have been sanctioned entailing a capex of around 10,000 Crores (Project Cost value) under AIF. This coverage is across all the states with investments ranging from 1 Lac to more than Rs 10 crores per project.

12 Horticulture Clusters

Apart from this, there has been Horticulture specific infrastructure which has been built under AIF in the identified 12 horticulture clusters, for pilot phase 1. A total of around 400 total projects have come up in these clusters amounting to more than Rs 675 crores to bridge the Post-Harvest Infrastructure gaps.

Apart from bridging the infrastructure gap, employment for rural youth can be generated directly during the building and upkeep of such infrastructure. Additionally, a greater reliance on local resources like labour and agricultural and horticultural products will ensure both backward and forward linkages that will further boost the regional economy. Indirectly, sustainable assets thus created will provide perennial access to opportunities for both work and income and contribute to accelerate the economic growth and progression of our country.

NATURAL FARMING BASED HORTICULTURE

Transforming the economy and ecology of Himalayan mountainous smallholders

The smallholders of Himachal Pradesh are emerging as leaders in transforming the present input intensive farming including horticulture to non-market driven natural farming practices. These environment-friendly and sustainable techniques have helped improve their lives and livelihoods and now guiding many other states to transform their food and agricultural/horticultural systems, to mainstream sustainable agriculture on a large scale for policy implementation across the country.

A Farmer-Driven Initiative

This movement has now been tagged as an institutional supported and 'farmer-driven' initiative. The four principles of Natural Farming as proposed under ZBNF/SPNF being employed by the farmers to enhance productivity at low cost are *Beejamrit* (Seed treatments using local cow dung and urine); *Jeevamrit* or *Ghanjeevamrit* (soil inoculant made of cow dung and urine); *Aachhadan* i.e. Mulching (covering the whole soil surface with crop residue or live intercrops to create favourable microclimate in soil); and *Waphasa* (soil aeration i.e. creating a condition of moisture and air in 50:50 proportion).

Some other associated pillars are simultaneous growing of short duration intercrops including at least one legume and use of locally resource based decoctions for plant protection. Soil health has been enhanced, which is essential for plant health. Soil fertility has also been enhanced in tandem with a gradual replacement of chemical fertilizers

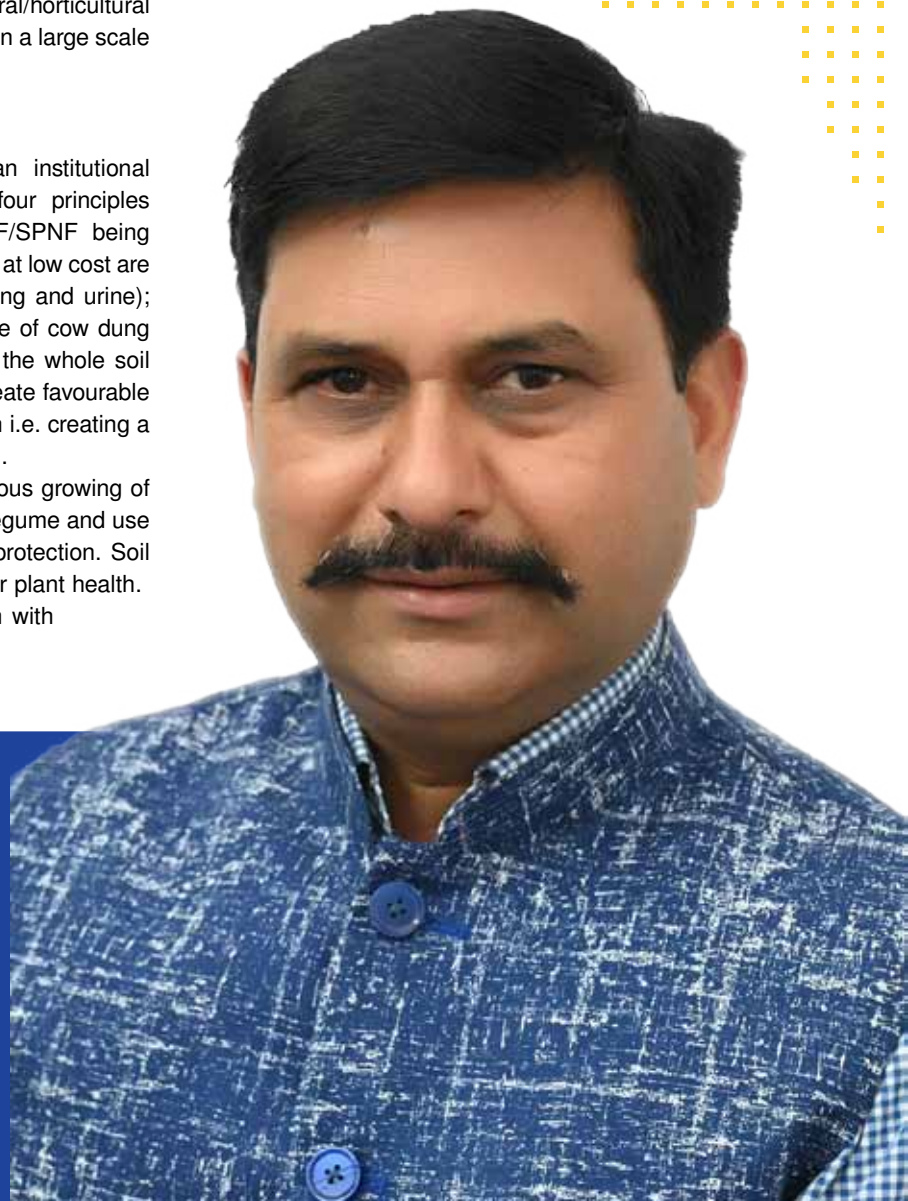
by using green ZBNF/SPNF recommended and locally prepared inputs.

16K Farmers In Natural Farming

In Himachal Pradesh, out of over 1.7 lakh farmers transformed, so far around 16,000 farmers have adopted this.

About the AUTHOR

Prof Rajeshwar Singh Chandel, a natural farming scientist-cum-activist, is Vice Chancellor, Dr YS Parmar University of Horticulture and Forestry, Himachal Pradesh



practice in horticulture based farming, partially to fully, over an area of around 2.5 thousand ha. Out of 99% panchayats (cluster of few villages and the lowest administrative unit) covered under this programme in the entire state, women comprised over 60% of the trained and practicing farmers. The natural farming practices reduced the dependence of farmers on the external market and focuses on use of farm inputs made from dung and urine of "indigenous cow". This reduces the cultivation cost drastically and increases the net income of farmers.

A regional study conducted has reported a reduction in cost of cultivation upto 56.5% in apple and 26.5% in vegetables, whereas the net returns increased upto 27.4 and 18.8% in apple and vegetables Natural Farming systems, respectively. The incidence of various insect-pests and diseases were comparatively lower as against chemical farming practices. Interestingly, the incidence of some of the invasive insect-pests was delayed on crops than on chemical farms. The natural farms have demonstrated signs of soil regeneration in terms of enhanced activities of soil biome, enzymes, arthropods density and better soil moisture under rainfed conditions, besides enhanced biodiversity in terms of crop intensification. Due to the rising consumer awareness about the ill effects of chemical laden farming products on their health, the demand for natural farming products is increasing. In a study conducted in the state, 99.1% of the respondents reported a better taste of the food produced through Natural Farming practices.

HP – Leader In Natural Farming

Himachal Pradesh now is in a leadership role for the outreach of Natural Farming in the country. State governments of Gujarat, Haryana and Madhya Pradesh have been replicating the implementation model of Himachal Pradesh to roll out Natural Farming programme. The programme has been outreached through regular contribution

NET-ZERO HORTICULTURE

Besides increasing farmers' income and providing healthy food, Natural Farming practices reduce the danger of climate change. They encourage use of low cost local resources, enhancing crop diversity, ensuring nutritional security, sounding environment through enhanced soil biome, reduced use of water and attracting youth back to their farms. Moving towards a progressive vision, the Natural Farming programme envisions mapping 7 SDG Goals, 15 Targets and 18 indicators through creation of a Sustainable Food System Platform for Natural Farming. We need to move towards net-zero horticulture in order to mitigate climate change risks through reducing, reusing and repurposing agro-waste. This farming method will give Himachal Pradesh a unique place on the world map to fulfill the established standards of human welfare and environmental protection through natural farming based horticulture sector.



and collaboration to initiative by NITI Aayog, Government of India and has been engaging global organizations which are custodians of Sustainable Food Systems i.e. UN- FAO, IFOAM, INRAe, Biovision, WWF, ORFC etc. Farmers transitioning to Natural Farming

in Himachal Pradesh are implanted within a supportive network of peers, practitioners and formally trained extension functionaries, together forming a dense learning ecosystem planned to support a knowledge-intensive transition towards more integrated and complex farming systems.

Farmers are encouraged to experiment with Natural Farming principles and progressively deepening their practice. For early farmers, adoption has been restricted to simple input substitution using Natural Farming formulations in place of externally derived chemical inputs. Subsequently, they are encouraged to raise models adopting all principles of Shri Subhash Palekar. This initial success encourages further experimentation, and further attempt to move closer to adopting the whole ZBNF/SPNF package.



Prof Chandel loves traversing Himalayan small tracks to experience the strength of local farmers, crops, foods and culture

Strong Marketing Networks

HP government and Dr YS Parmar University have been working on creating a strong network between the producer and consumer through creation of a Sustainable Food Systems Platform for Natural Farming, Innovative Farmers' Self assessed Certification, Seed production of traditional crops, Canopies for marketing of Natural Farming produce, setting up of FPOs and Captive Market for SPNF produce.

DR KRISHAN LAL CHADHA

The Man Behind The Horticultural Renaissance Of India

A name synonymous with Indian Horticulture, Dr K L Chadha spearheaded it towards "Golden Revolution". An icon and doyen, Dr Chadha has steered policy, planning, research and development of horticulture in India for almost five decades. For his yeomen's service for bringing Horticulture Revolution in India, Dr Chadha was conferred the prestigious Padma Shri on March 22, 2012.

Early Life

Krishan Lal Chadha was born on November 15, 1936 into a family of four brothers and five sisters, at Bhopalwala in Sialkot district, now in Pakistan. He did his primary education in Arya High School. Following Partition, he and his family made a harrowing journey from Sialkot to India. He remembers that uncertain journey vividly. "I had put on a pair of trousers and three shirts, one over the other, pocket of each one filled with peanuts, which served as my food for the journey."

Later in India, the family settled in Jalandhar, Punjab where he continued his education. His career choice as agriculture was his family's decision. "There was an engineering college situated 100 km from my hometown. But my family rejected the idea of me going to such a faraway place for education. Instead we chose an agriculture college located in Ludhiana, hardly 10 km from my home."

Agriculture Education

Krishan Lal soon ended up with a job after completing his bachelor's degree in agriculture. He was appointed as a Fruit Research Assistant at the Regional Fruit



Research Station, Mashobra, Shimla. He was quick to realize that a Bachelor's degree alone was not enough for a productive career in the field of agriculture. His brief stint in the field of horticulture had set his heart on pursuing the same at post graduate level. However, the subject was not offered at M.Sc. level.

Fortunately, the Indian Council of Agricultural Research, in that very year offered a fellowship for a Master's degree in Horticulture for the first time. "Since the required infrastructure for M.Sc. course in Horticulture was not available at the college, I was obliged to approach Dr. K. Kirpal Singh, Fruit Specialist based in Patiala, who could provide necessary facilities and guide me towards this degree." Mr Chadha completed the M.Sc. programme in 1959, from Punjab University, Chandigarh. He was later selected in IARI for a Ph.D. degree in Horticulture under the Chairmanship of Dr. G.S. Randhawa. "This time, my family was not ready for my higher studies. It was my Professor who decided to take things under his control and told me "Banda ban ja" (Be a man). I was certainly amused by the sense of ownership of the Professor on me and I eventually enrolled in my Doctoral programme".



tête-à-tête with *Anjana*



An icon and doyen, Dr Chadha has steered policy, planning, research and development of horticulture in India for almost five decades. For his yeomen's service for bringing Horticulture Revolution in India.

An Illustrious Career Path

After his brief stint at Shimla, he worked as Technical Assistant in ICAR Headquarters followed by Assistant Horticulturist at IARI. A year later, he was selected as Fruit Specialist in Punjab Agricultural University, an important position which encompassed today's Haryana and Himachal Pradesh states as well as covering six regional research centres.

He went on to serve on key national positions in ICAR - Senior Horticulturist



RESEARCH CONTRIBUTIONS

- Establishment of the National Germplasm Repository on Mango
- Causes and management of citrus decline, malformation, black tip and fruit drop in mango
- Mango rootstocks for dwarfing and other economic traits
- Pineapple high density production, techniques, leaf/tissue sampling
- Optimization and quantifying critical limits of nutrients for various fruit crops, resulting in a record three-fold increase in yield and reduction in the use of inorganic fertilizers

and Head, Division of Fruit Crops at Indian Institute of Horticultural Research (IIHR), Bengaluru; Project Co-ordinator (Fruits) and Head, Central Mango Research Station, Lucknow (now Central Institute for Subtropical Horticulture) and Director, IIHR. During the same time, he joined GOI as the first Horticulture Commissioner and concurrently, as Executive Director, National Horticulture Board, to lead the national research and horticultural development programmes in India.

In 1987, he was appointed as the first Deputy Director General (Horticulture) in the ICAR. His last official assignments were the positions of National Professorship 1997-2001, and Adjunct Professor in Horticulture at IARI 2011-2017, which provided him an opportunity to give guidance to 15 postgraduate students in horticulture in different universities.

He also had the opportunities for short term consultancies in several countries of Asia and the Middle East, namely, Afghanistan, Bangladesh, Bhutan, Egypt, Indonesia, Iran, Malaysia, Nepal, Philippines and Thailand. Dr Chadha was elected as Member and Vice Chairman, Board of Trustees of International Potato Centre (CIP), Lima, Peru, for seven years.

He has been President of 9 and Vice-President of 5 national agri-horti societies, besides chairing several important national committees. He has also served as Chairman, Indian Society of Agri-business Professionals and Chief Agriculture Advisor (EUREPGAP), FICCI.

Stellar Contributions to Horticulture

Dr KL Chadha's tenure as Member Secretary of VIII Five Year Plans, Chairman of Working group on Horticulture and Plantation Crops for X and XI Five Year Plans of the Planning Commission, Government of India (now NITI Aayog) was the turning point in the history of horticultural research and development programmes.

He obtained higher funding, built new institutions, and launched several hi-tech programmes. The annual grant for national horticultural development used to be a meagre Rs. 25 crores in VII Five Year



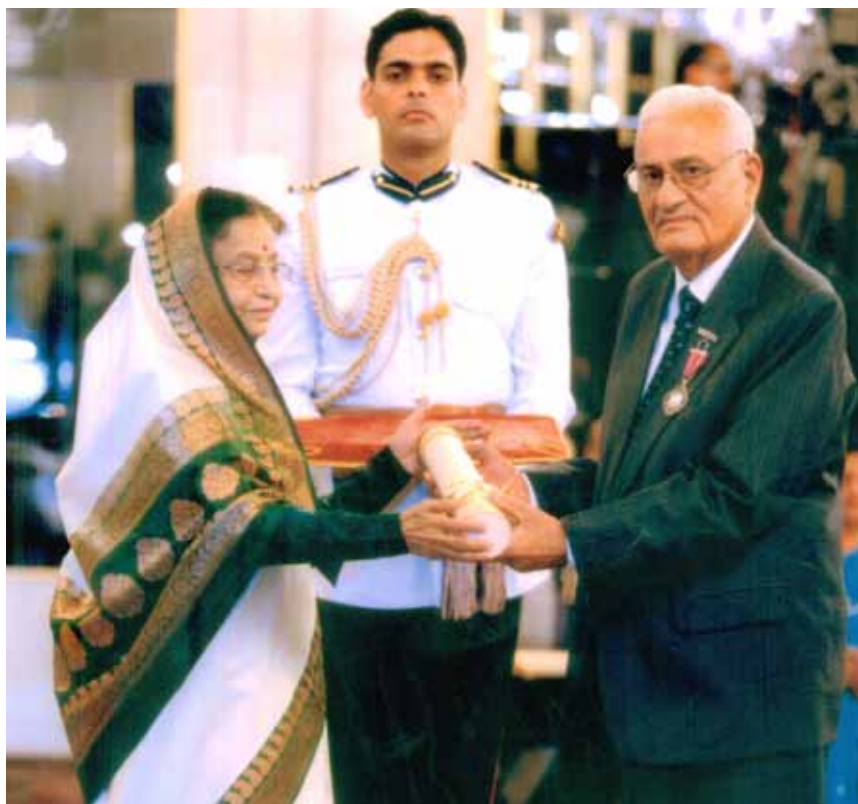
Plan. He managed to raise it to a level of Rs. 20,000 crores by XI Five Year Plan. For the first time the horticultural sector witnessed a glaring impact on nutritional security, employment generation, foreign exchange earnings, improving incomes of small farmers and so on. Micro-irrigation, high-density planting, rootstocks, micro-propagation, and hybrid vegetable seeds

Dr KL Chadha's tenure as Member Secretary of VIII Five Year Plans, Chairman of Working group on Horticulture and Plantation Crops for X and XI Five Year Plans of the Planning Commission, Government of India (now NITI Aayog) was the turning point in the history of horticultural research and development programmes.

became the hi-tech face of horticulture across the country.

He contributed substantially to the formulation of the flagship development programme - National Horticulture Mission. The Mango Research Station that he had established is now upgraded as the Central Institute for Subtropical Horticulture. Another significant contribution of Dr Chadha was the development of IIHR into a world class horticultural facility for research and education.

As a Coordinator, he set up a Centre of Excellence in tropical horticulture at the institute, which provided an opportunity to upgrade research infrastructure and manpower to undertake research and teaching at postgraduate level through exchange of eminent scientists from USA, Italy and Australia with corresponding research workers from the IIHR. The first National Curriculum for Postgraduate education in horticulture was also designed by him. He was also instrumental in setting up



nine National Research Centers (NRCs) on specific crops. He is also credited for the nationwide introduction and promotion of oilpalm plantation. In the capacity of Executive Director, National Horticulture Board, GOI, Dr Chadha launched the first national market information scheme (MIS) on perishable commodities.

A Prolific Writer

Dr K L Chadha has authored/edited 40 books and bulletins, contributed 40 chapters in books, published 135 research papers, and about 200 popular articles. He has compiled and published *Advances in Horticulture*, the milestone compilation of research work in Indian horticulture covering more than 9,410 pages in 13 volumes that continues to be a source of reference to researchers and postgraduate students. His other book *Handbook of Horticulture* is a signature publication that is the unequivocal source for horticulture information in the country for students, young researchers and farmers. 'Agriculture and Environment', authored by Dr Chadha and Dr. M.S. Swaminathan, is another important book.

Now settled in New Delhi, Dr Chadha had a long and fruitful marriage of 50 years. His wife, Mrs. Sunita Chadha, passed away in 2015. His son, Mr. Mohit Chadha is working as the Chief Manager, ICICI Bank and his daughter, Mrs. Mona Chadha is settled in New York, USA.

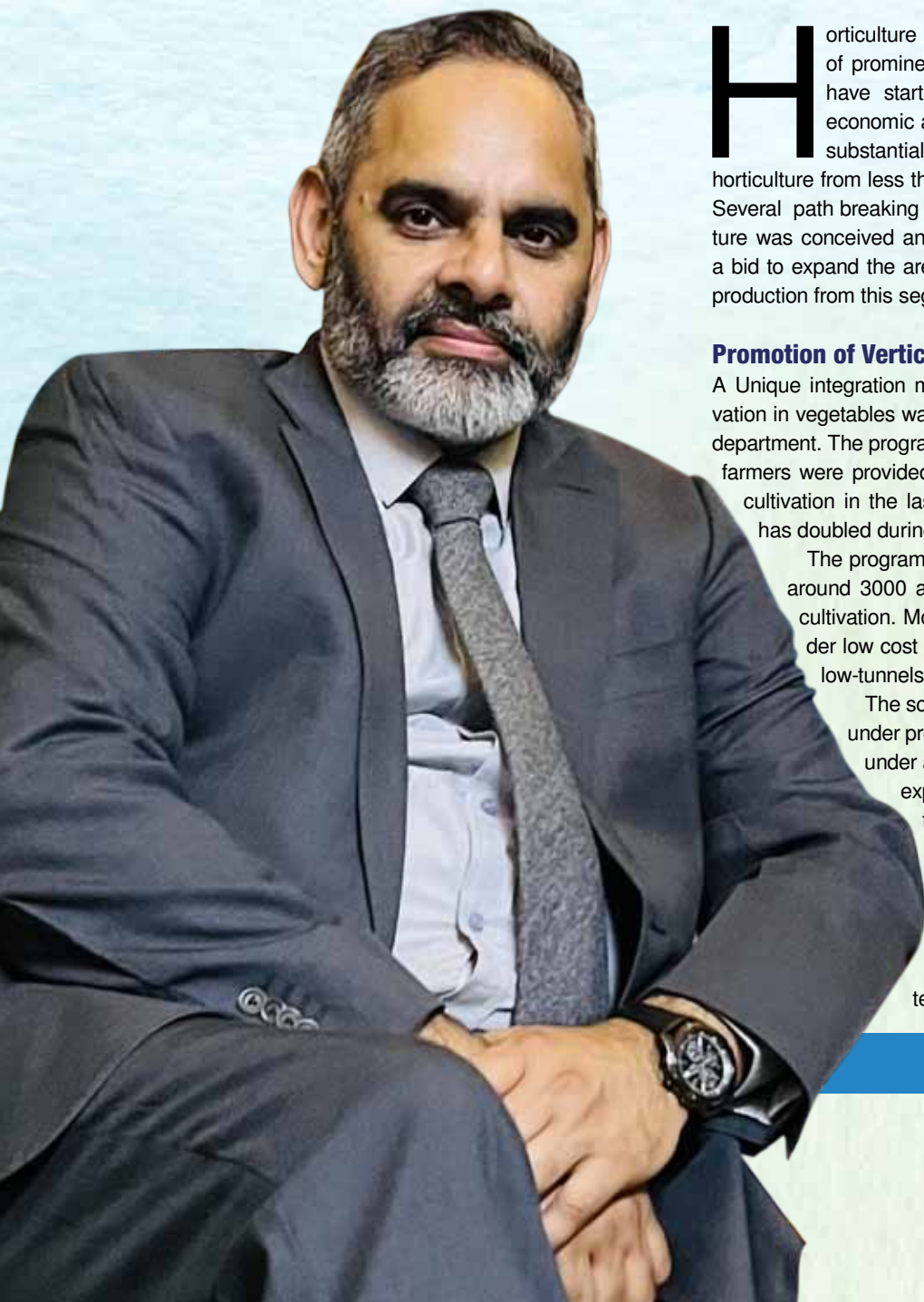
Dr Chadha has aptly utilized the resources and positions to shape policies, build institutions, launch national R&D programmes, disseminate knowledge and energize the system, opening up employment and entrepreneurship avenues in horticulture sector, which has benefited millions of farmer in the country.



AWARDS AND RECOGNITION

- Four fellowships, including those from the International Society for Horticulture Science (ISHS) (2014) and NAAS, New Delhi (1992)
- Three D.Sc. (Agri) Honoris Causa degrees by the State Agricultural Universities, at Kanpur, Uttar Pradesh, Samastipur, Pusa, Bihar and Bhubaneswar, Odisha during 1995, 2008, 2009, respectively
- Krishi Shiromani Samman (Mahindra & Mahindra Pvt. Ltd., 2014)
- National Agriculture Leadership Award (Agri Today, 2008)
- HSI-Sivashakthi Lifetime Achievement Award (2007)
- Dr B.P. Pal Memorial Award (apex award of NAAS for the best agricultural scientist),
- S.K. Mitra Memorial Award (AIFPA, 1998)
- M.H. Marigowda Award (1996)
- Om Prakash Bhasin Award in Life Sciences (1992)
- Borlaugh Award (1984)

HARYANA SURGING AHEAD SUSTAINABLE APPROACH FOR NUTRITIONAL SECURITY



Horticulture development has assumed a status of prominence in Haryana. Farmers in Haryana have started viewing horticulture as a viable economic activity. The state government too has substantially increased the budget allocation for horticulture from less than Rs.1Cr. to Rs. 824Cr. in 17 years. Several path breaking initiatives and programmes in horticulture was conceived and implemented by the government in a bid to expand the area under horticulture and improve the production from this segment.

Promotion of Vertical Farming & Diversification

A Unique integration model for promotion of precision cultivation in vegetables was conceived by Haryana's horticulture department. The programme was allocated Rs. 500 crore and farmers were provided 50-65% assistance under protected cultivation in the last seven years. Vegetable production has doubled during the time period.

The programme has impacted 25,000 farmers and around 3000 acres were brought under poly house cultivation. More than 8000 acres were brought under low cost bamboo cultivation, 3000 acres under low-tunnels and 14,000 acres under mulching.

The scheme has envisioned to bring 1 lakh h under protected cultivation and 10 lakh ha area under all horticulture crops by 2030. It is also expected to enhance productivity 2 times from 15 MT to 28 MT per ha by 2030.

Water Resource Management Model

Under this programme , farmers are encouraged to adopt Farm water Pond + plantation +Micro-irrigation

About the AUTHOR

**Dr Arjun Singh Saini is Director
General Horticulture, Haryana**

model for farm sustainability. This model has so far benefitted 17000 farmers. As a result of increased water availability around 24,000 acres were brought under catchment area with orchard establishment and micro-irrigation. 3115 farm water ponds were constructed. More than Rs. 300 crore have been allocated.

Risk Mitigation Program

Bhavantar Bharpayee Yojana (BBY)

The scheme was launched for horticulture crops in 2018-19 with protected price for 21 fruits, vegetables and spice crops. Farmers are compensated when wholesale price falls below protected price.

Registration & processing are done through online portal. Rs. 14.12 crore has so far been disbursed to 5403 farmers. This has helped the farmers immensely in diversification.

Mukhayamantri Bagwani Bima Yojana (MBBY)

Launched in 2021-22, the scheme compensates horticulture farmers of 21 fruit, vegetables and spice crops against weather vagaries. It is a 100% State Plan Scheme, and corpus fund of Rs. 10 crore has been created. No firm is empanelled. Verification is done by third party using technologies like drones.

An important feature of this scheme is its very low premium of 2.5% i.e. Rs. 750 for vegetables and Rs. 1000 for fruits per acre. Compensation is fixed at Rs. 30,000 for vegetables and Rs. 40,000 for fruits. Compensation is given at the range of 50% to 100%.

Registration and processing is done through online portal. Risks covered include Hail Storm, Temperature- Frost, Water Perils- Rainfall- Flood-Cloud - Burst-Canal/ Drain Break, Inundation, Wind and Fire.

Crop Cluster Development Program (CCDP)

Development Phase Schematic Model

Through CCDP, establishment of a complete horticulture supply chain for quality, quantity and seamless delivery as per global standards is envisioned. The clusters will be a tool to develop socio

The state has registered tremendous progress in horticulture development. The area under horticultural crops has increased. Haryana's reliance on advanced technologies has improved the productivity of fruits and vegetables. Integrated models, crop diversification and risk mitigation programmes have strengthened our horticulture sector.

economic security for farmers. Delivering safe food to the consumers, generate employment in rural areas and ensuring better returns to the farmers are other objectives of the CCDP.

Technology Promotion Intervention

Demonstration Centers/CoEs Transfer of Technologies

11 Centers of Excellence (CoE) were established for different horticulture commodities with an investment of around Rs. 100 crore for fruits, vegetables, potato, bee-keeping, semi-arid crops, flowers, onion, etc.

CoEs are centres of demonstration for latest technologies such as precision farming, high-density plantations, protected cultivation, vertical farming, new crops, new varieties, organic farming, etc. They also generate more than 2 crore soil less hybrid vegetable seedlings and more than 2 lakh grafted fruit plants for the farmers annually. The Bee Policy-2021 was able to double honey production to 9000 MT in 5 years. The Potato Policy-2022 has been envisioned to cover 15% seed potato business in India in 5 years. A total of 120 Village of Excellence (VoE) linked with CoEs.

The scheme was able to bring 3000

acres under protected cultivation, 8000 acres under vertical farming and 14000 acres under mulching. The scheme was able to distribute 10000 bee-boxes per year. Another significant impact was noticed in terms of crop diversification which has extended up to 2 lakh ha since the establishment of Centers.

Haryana Bee-keeping Policy: 2021

The Economic Advisory Council to the Prime Minister (EAC-PM) in 2018 constituted "Beekeeping Development Committee" (BDC) and based on its recommendation, Haryana launched Bee Policy-2021 and Action Plan 2021-30.

Haryana tops the Madhu Kranti portal launched by GOI. The policy aims to support scientific bee-keeping and develop infrastructure & price mechanism for expanding quality honey production. For marketing activities the state has established Honey Trade Centre at IBDC Ramnagar, Kurukshetra for auction & storage.

To check adulteration of honey and to produce quality honey, Haryana is in the process of establishing Quality Control Lab with INR 20 cr. The policy addresses issues of lack of nectar & pollen in new crop hybrids. Haryana has introduced regulation of sale of prohibited pesticides and promotion of use of green label pesticides. Haryana has also included bee pollen and honey in mid-day meals, and for sports persons. Apiculture has been brought under BBY.

Vision-2030 envisions increasing the number of bee-keepers from 1500 to 5000, honey Production from 4800 MT to 15000 MT, bee wax from 90 MT to 270 MT and produce bee propolis from zero to 50 Qtl, bee venom from zero to 80 KG and royal jelly from zero to 50 Qtl.

The state has registered tremendous progress in horticulture development. The area under horticultural crops has increased. Haryana's reliance on advanced technologies has improved the productivity of fruits and vegetables. Integrated models, crop diversification and risk mitigation programmes have strengthened our horticulture sector.

URBAN HORTICULTURE CREATING HAPPIER CITIES

Green roofs and vertical gardens are viable spaces for urban horticulture. They can provide effective solutions and novel methods for sequestering carbon dioxide.

Green roofs provide effective thermal insulation to building roofs, reducing the heating/cooling load and electrical energy use. During summer, electrical energy consumption is decreased because of evapo-transpiration from the vegetation and soil, which cool the air and improve the microclimate.



Multiple Benefits

The roof contributes to urban environment by supplying recreational and amenity values for residents, improving air quality, sequestering CO₂, enhancing urban biodiversity and reducing storm water runoff, improving water quality and avoiding flood hazards. In addition, when comparing green roofs with normal conventional roofs, studies have shown that green roofs have 20.3% - 25.2% longer life span. This benefit is mostly attributed to its many layers which protect the main roof from

mechanical damage, ultraviolet radiation, extreme temperatures and usage.

Another great benefit of green roofs is its aesthetic value. The vegetation stimulates pleasure in each individual, improving their wellbeing throughout the day. This also influences the economic value, as each city's different green aesthetic can produce tourism, generating income. Additionally, it serves as an informative and education role going into a heavier climate change future, where through its health we are able to analyze the quality or condition of the environment, whether in the air, water or soil. This added benefit can prepare us for unexpected events.

Green roofs also have the potential of an informative value, where the newly installed biodiversity can act as an educational role, rekindling urban city dwellers love for the environment. Through direct contact in day to day, instigating observations and interactions, leading to a great

About the **AUTHOR**

Dr. A. Vishnu Vardhan Reddy is Vice- Chancellor, ANGRAU, Andhra Pradesh



Computer simulations in Germany have proven that adding a mere 7% of green roofs to urban areas can help reduce the temperature in cities by 2oC. This means less heat intake from buildings, which also leads to lower internal building temperatures

construction industry on the environment.

Green Buildings

The advocacy of green buildings could give potential reductions of environmental impacts but the transformation of social structure and economic base necessitates a paradigm shift towards a more holistic approach for sustainability. Green buildings have to work and perform collectively, and therefore neighbourhoods, built environment, public transportations, amenities and services are always the keys for improving sustainability performance.

The preservation and promotion of biodiversity in cities can increase the quality of life of citizens, through the various values that incorporate them. The amount of new green spaces in roofs adds to the cities aesthetic value, where people will appreciate the magnificence of different types of environments. This causes an immense sense of pleasure in each individual and stimulates their wellbeing during the day. Since people spend 90% of their times in doors, office buildings could even benefit by incorporating more windows in their offices, allowing workers to be exposed to the innumerable amounts of green roofs and vertical gardens throughout the city, creating a biophilic reaction which enhances the work produced.

The added greenery can also translate to economic value, as the new found beauty will stimulate tourism, generating more income to cities. The computer simulations in Germany have proven that adding a mere 7% of green roofs to urban areas can help reduce the temperature in cities by 2oC. This means less heat intake from buildings, which also leads to lower internal building temperatures.

There is still insufficient promotion from the government and social communities to implement or incentivize green roof development. Government incentive programs, such as public financial and technical support, should be provided to developers and owners who are willing to retrofit their buildings in adopting a green roof.

er understanding of the systems and the nature of the habitats. Athwart this new connection, the different types of vegetation in each region of the city can be used, through its health, to analyze the quality or condition of the environment, whether in the air, water or soil.

Added greenery can fuel the return of insects such as bees to become more abundant in cities. Increasing bee population is an integral part to humanities survival because 2% of wild bee species contribute to 80% of crop pollination worldwide. Although the impact of interactions is not always apparent, the effect it causes is large. For example, trees and plants that remove small particles like particulate matter (which are averse to health) from the air and decreasing the amount breathed in by citizens.

Benefits Enhanced Through Vertical Gardens

Vertical gardens also benefit from all the already mentioned benefits of green roofs. They serve as an additional working force to enhance the benefits of the new roofs. A great problem cities face in current days is noise pollution. Aside from hearing damage, noise pollution elevates stress levels, which may lead to cardiovascular effects, psychological impacts and cognitive development.

Abundant space is available for vertical gardens. They can lower noise pollution level within cities.

These can also provide respite from urban heat islands, retain humidity, contribute to biodiversity, improve urban landscaping; filter volatile organic compounds from the air, capture particulate matter and enhance a person's wellbeing.

Green building concept is one of trending concept of vertical garden in many developed and developing countries with an aim to promote better earth as similar to butterfly effect through the small changes in construction industry. India being a developing country is well placed to have eco-friendly constructions or green building projects when compared to all other countries with an objective to reduce the significant impact of



Dr Reddy likes to visit villages and spend time with farmers

HOLISTIC APPROACH

FARMING AS A COMPLETE SYSTEM



When we look to increase agricultural productivity in an effort to feed the growing population, researchers and input providers focus on key components of the overall process and seek to solve those individual problems. For example, improving nitrogen absorption has been a consistent focus in the effort to increase fruit and vegetable pro-



aging than carbon dioxide) and the breakdown of soil structure over time.

The overuse of some chemicals has increased the spread of fungi, plant-born diseases and pesticide-resistant insects. By focusing on solving only a small component of the overall system, we inevitably create many other unintended problems. In addition to the direct affects of manipulating some components, there are indirect effects that must be considered.

duction in agriculture.

While this approach has indeed dramatically improved production over the last 50 years, it has led to many other problems, such as reduction of microbial activity in soil, increases in greenhouse gases (especially nitrogen compounds, which are hundreds of times more dam-

Financial Consequences Of Piecemeal Approach

In the case of increasing key nutrients such as nitrogen, phosphorus and potassium, we not only create mineral imbalances in the soil, but we also affect the economic viability of the farmer. As this year has showed us, the reliance on nitrogen and other nutrients to grow our food can cost farmers far more than they earn in production.

What is needed is a holistic approach, wherein we look at all the components of plant health, the environment, human health and the economics of farming as a complete system.

New Technology For Increasing Productivity

It was this approach that led Fulvio



About the **AUTHOR**

Mr Jim Kurtz is Senior Farm Consultant for Harvest Harmonics International. Jim has interviewed over 5000 farmers around the world and assists them in resolving issues relating to sustainable food production.

Balmelli to develop a new technology for increasing productivity and reducing input costs for farmers. The technology is called Kyminasi Plants. It uses groundbreaking advancements in biophysics to make plants more efficient in their energy production through photosynthesis.

Mr Balmelli's goal was to improve the quality of food, so that people could eat healthier and improve their resistance to illness and disease. He realized that he needed to help farmers reduce their pesticide and chemical use, increase productivity and do so in a sustainable way so that they can continue growing healthy food for years to come. He needed to make his solution effective and affordable so that farmers can earn a good living in the process, and so their liveli-

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Mr Kurtz enjoys public speaking, hiking, meditation and studying diverse subjects from physics and engineering to philosophy and world religions

hood is also improved.

24-Year Research Project

With all of these factors under consideration, Mr Balmelli began a 24-year research project that incorporated all of these aspects. Many advancements

were made and tested, and their effects on the entire system were measured. Eventually, Mr Balmelli discovered that the key was to analyze how the various biological processes work together to help the plant generate energy.

It turned out that these processes become very inefficient when plants are exposed to various stresses, such as extreme heat, lack of water, insect damage, nutrient imbalances, etc. This means that when plants are stressed by these problems (which happens constantly in a natural environment), they produce less energy. This in turn means that they can't grow or produce fruit or vegetables nearly as much as they otherwise would.

Farmers try to combat these problems by adding fertilizer, irrigation, using pesticides and other chemicals. It is a constant struggle to continue to solve these problems individually. The answer is much more simple.

Crop Booster By Kyminasi Plants

The result of this research is the Crop Booster by Kyminasi Plants. This system is a simple device that attaches to a farmer's or gardener's irrigation system. Every time the farmer irrigates his crops with this Crop Booster system, it sends these physical signals into the water and to the plants. As the plants absorb this treated water, the Crop Booster signals continually retune the biological processes in the microbes in the soil and in the plant to maintain their ideal metabolism.

The crops become more and more efficient in using the available nutrients, water and sunlight. This in turn increases fruit and vegetable production while reducing the need for expensive fertilizer and pesticides.

The farmer saves money on these inputs, and there is less environmental damage from the overuse of these chemicals. We all get healthier food to eat. The microbes and animal life in the soil help rebuild the soil, making a sustainable growing environment.

The solution of the past is chemistry.
The solution of the future is energy.
Welcome to the Future of Farming!



How The Holistic Approach Helps

Using a holistic approach, Mr Balmelli created a solution that constantly resolves the inefficiencies caused by stress factors as mentioned above. Using a unique system of physical signals, Mr Balmelli proved that we can reduce the inefficiencies in the biological functions of the plant and dramatically increase the energy and resilience of the plant, all without adding chemical inputs or altering the genetic code of the plant.

Using his holistic approach, Mr Balmelli also analyzed the role of microbes and soil structure in making plants more efficient. He then developed physical signals to boost microbial activity, especially cyanobacteria and mycorrhizae, which are the organisms in soil responsible for pulling nitrogen and carbon out of the atmosphere and extending the root structure of the plant to enable them to contact more water and nutrients efficiently.

While the technology behind this is quite complex, the solution itself is very simple. Just make photosynthesis and microbial function more efficient by continually balancing the biological functions in the plant for optimum function.

HORTICULTURE

For Happy Environment, Health, Prosperity

Over 35 per cent of India's population lives in urban/peri-urban areas. The figure is expected to increase by over 40 per cent by 2030 and 65 per cent by 2050. Small to medium size land holders within outskirts of 21 large cities need to be encouraged to adopt peri-urban and urban horticulture.

For which, activities like protected cultivation, plug plant production, terrace and roof top cultivation of vegetables, pot plants, fruit and flower nurseries, mushroom production, bee keeping, flower production etc. need to be

promoted in mission mode manner. The soilless horticulture comprising of lighter solid other than soil and liquid as medium of production are now perfected and can be suitable for large number of vegetables and certain fruits in addition to leafy vegetables and strawberry.

Multi-storey vertical farming under protected cultivation in peri-urban areas is now catching up to meet the requirement of fresh vegetables. For aesthetics it can be seen in public places, airports, metro pillars, bridges, elevated roads in many metro cities. However, several issues such as economics of production, regulations, lack of expertise, etc. are major constraints in promoting successful vertical farming. Compatible crops for vertical gardens are broccoli, lettuce, spinach, coriander, mint, and herbs, which are also recommended for micro-greens. Other crops such as rosemary, thyme, fennel, strawberry, ornamental foliage, and ornamental greens are used for growing under vertical gardening.

The novel crop production and

improvement technologies are listed below.

Innovative/Novel Production Systems for Horticultural Crops

- **High Density Planting:** Mainly in fruit orchard high density plantings are yielding better.

- **Protected cultivation** It is modification of micro-climate around the plant to express its potential with least abiotic stress. Modification of microclimates is low as well as high tech.

Low technology protected horticulture: --using plastic & other claddings: These technologies are listed below.

1. Mulch
2. Low Tunnel
3. Walk-in tunnel
4. Insect Proof Net houses
5. Shade Houses
6. Rain Shelter
7. Naturally Ventilated Polyhouse (NVPH)
8. Soil Trench/underground greenhouse
9. Ladakhi Greenhouse

High Tech. Protected Cultivation

- a. Climate Controlled Green House- Environment in Green house is controlled as per crop requirement.

- b. Retractable Roof Green House- Roof and some cases sides of greenhouse are auto-retractable to take advantage of natural environment.

Both types of greenhouses use modern horticulture technologies for production and propagation.

Precision horticulture

Precision horticulture is an information-based management strategy that relies on collecting site-specific or plant-specific data. These data can be converted to useful information that helps growers make informed management decisions. Precision horticulture means about do-



About the AUTHOR

Dr Brahma Singh, Padma Shri Awardee, disciple of Dr APJ Abdul Kalam is Founder Chairman of Prof Brahma Singh Horticulture Foundation (BSHF), Delhi/ Thane. He is known for his contribution in the greening of Leh valley, protected horticulture in the country and usage of natural growth of Sea buckthorn/Brahmaphal in Ladakh, UT



Green Environment Rashtrapati Bhawan



ing the right thing, at the right place and in the right time and in the right way. Technologies like GPS, GIS are used to assess and analyze variations in production. Precision Farming is application of technologies and principles to manage spatial and temporal variability associated with all aspects of horticulture production

Organic Farming/Natural farming

It is getting momentum of late though huge acreage in Indian tribal and Himalayan belt by default is organic/natural horticulture. A mix of modern and natural horticulture technologies, in my opinion, would boost horticulture production with desired quality in the country.

It is theoretically possible to grow any plant completely indoors. Economic factors limit the realistic set of crops having dwarf canopy, prolific producers with

Soilless Production – Ponics

It is the most basic and popular model of soil free farming in soilless growbag or container filled with various artificial media like cocopeat, perlite, vermiculite etc.

Long back it has been proved that soil is not essential for production of several crops. In certain horticultural crops soilless cultivation is picking up using following technologies: Hydroponics, Aeroponics, Aquaponics

high market value such as:

Micro-greens, sprouts, plant nurseries and several following crops are being produced in sizeable quantity using soilless technologies

Leafy Vegetables - lettuce, broccoli, spinach, chard, chive, palak, mustard greens, amaranths, parsley, chard, coriander, mint, chive, kale

Herbs - rosemary, fennel, thyme, oregano, basil, Oregano, Sage, Savory, Stevia, Thyme, Wheat Grass, Beebalm (Bergamot), Borage, Chervil, Cilantro, Cumin

Medicinal and Aromatic Plants - Calendula, Catmint, Chamomile, Echinacea, Goldenseal, Hyssop, Lavender, Patchouli, Scented Geranium, Sweet Woodruff, Yarrow.

Fruit – Strawberries Fodder (oat, maize, barley and others), Mushrooms

Other Vegetables - summer squash, peppers, eggplants, tomatoes, cucumbers, onion, garlic, muskmelon, algae

Ornamental foliage and flower plants and tobacco for monoclonal antibody farming



Innovative/Novel techniques for Horticultural Crops Improvement

Without crop improvement it is not possible to appreciably enhance crop productivity. Hence horticulture crops improvement (development of suitable varieties, hybrids, grafts etc) using following technologies is essential.

- Gene Editing
- Omics,
- CRISPR systems,
- Reverse breeding,
- Marker assisted breeding
- De-novo domestication and vegetable breeding
- Quality Seeds & Planting Materials- grafts etc

TECH-DRIVEN HORTICULTURE FOR GREEN ENVIRONMENT, NUTRITIONAL SECURITY



Waste management is another aspect of horticultural activities in urban areas. Inorganic waste like plastic bottle, plastic water tank, basket and polythene bag can be used as container for growing horticultural plants. Household organic waste such as fruit peels, vegetable peels, plant bi-products, waste food, etc. can be recycled into compost. Composting is an encouraging initiative to keep the environment clean and it can be used as a natural soil amendment for fresh food production. Such composting materials are eco-friendly and reduce demand for chemical fertilizer that promotes sustainable production.

Scope of Horticulture Sector

Horticulture sector manages a complex set of natural resource and environmental issues including soil fertility, irrigation-induced soil salinity, soil acidity, conservation of native vegetation, emission of greenhouse gases, water quality, etc. The goal of environmental horticulture is to preserve and enhance the environment through planting and proper cultural practices for green plants, including shade trees, shrubs and turf grass, etc.

In India, the degraded and wastelands can be judiciously utilized by growing various horticultural crops with standard land management practices. For instance, rainfed areas with good soil fertility can be

Green environment is important for environment protection and reduction in air & water pollution. Clean and green environment supported by abundance presence of trees and greenery is very much essential for maintaining quality of healthy life. Trees are instrumental in purifying air by absorbing the harmful gases and providing adequate quantity of oxygen to immediate environment. Clean environment reduces pollution, preserves biosphere and upholds earth's natural resources.

The significance of green environment includes reduction of environmental pollution, minimizing greenhouse gas emission, ensuring resource conservation, helping wildlife preservation, etc. Cultivation of horticultural crops can effectively alleviate environment pollution. Similarly, profitability of land can be increased by integrating horticultural plants into the landscape.



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used for plantation of fruit trees like mango, cashew, anola, ber, jamun, custard apple, bael, tamarind, jack fruit, etc. Rainfed areas can also be utilized for dryland horticultural activities and inclusion of high value low water requiring crops.

Agri-horticulture based farming system having better yield potential can be recommended to harness the potentiality from such type of land. Intensive avenue plantations with ashoka, neem, jamun, delonix, arjun, etc. can be taken up near the road sides in order to beautify the landscape and make the environment more soothing. Horticultural crops can be a boon for the farmers in peri-urban areas to make agriculture profitable. Promotion of rooftop gardening and urban horticultural activities will beautify the urban ecosystem and ensure availability of quality food for the urban households.

Fruit and vegetable crops are rich source of carbohydrates, proteins, etc. Besides, those are good source of naturally available vitamins, minerals, dietary fibre, phyto-nutrients, antioxidants, etc. Hence, regular consumption of fruits and vegetables can prevent malnutrition thereby ensuring nutritional security. Several diseases including diabetes, anemia, gastrointestinal malfunction and other chronic diseases can be effectively managed by consumption of coloured fruits and vegetables on daily basis. Several bioactive components of horticultural crops can be used for production of processed products, nutraceuticals, pharmaceuticals, cosmetics, pigments, essential oils, natural colorants, etc. Food and nutritional secu-



Dr Roul loves to travel and enjoy beautiful destinations

rity can be ensured by promoting backyard farming, establishment of nutritional garden, rooftop gardening, etc.

Major Area of Growth

With constant effort, horticulture sector can meet the challenge of under nutrition through abundant availability of safe fruits and vegetables. However, the sustainability of horticulture sector depends on appropriate utilization of available land, community area, rooftops and area adjacent to commercial complex.

The potentiality of technology driven horticulture sector can be harnessed to address various issues faced in the prospective of green environment, nutritional security, health care management and the economic growth of the country

Vertical farming, an emerging system of growing plants in houses, apartments, offices, commercial establishments, etc. can improve the aesthetic value of a place, reduce heat stress of the buildings, minimize pollution and make the environment favourable. Similarly, the system of soilless cultivation including hydroponics, aeroponics and aquaponics are utilized in vertical gardening system. Recently, the multi-story vertical farming under protected cultivation is catching up in peri-urban areas to meet the requirement of fresh vegetables. It is accommodated in the areas of public place, airport, bridges, elevated road, etc. in the cities. However, several issues relating to production and post production should be standardized for large scale adaptation.

Horticulture sector contributes significantly to the Indian economy. Apart from ensuring nutritional security, it creates alternate employment opportunities in rural areas, helps in diversification of farm activities and enhances income of farmers. There is immense scope of horticulture sector to strengthen rural economy, supporting agro-based industry and generation of employment. India is earning foreign exchange through export of various fruits, vegetables, processed products of fruits & vegetables, cut & dried flowers, medicinal & aromatic plants, seeds, spices, cashew kernels, etc. Therefore, promotion of horticultural crops will improve the financial status of the farmer and ultimately contribute to the economy of the country.

Horticulture has positive effects on social, economic and ecological aspects. It increases community livelihood, sustains the environment and improves human health through supply of fresh food and recreational & aesthetic value of landscape. In addition, floriculture can help people to get better mental health, which is a key component for promoting good health. Therefore, the potentiality of technology driven horticulture sector can be harnessed to address various issues faced in the prospective of green environment, nutritional security, health care management and ultimately economic growth of the country.





Feeding the Future of Agriculture with **VERTICAL FARMING**

The technology-driven model of agriculture may offer a means to address farm output and food security in the years to come. The global food supply cannot keep up with the growing global population. According to the Food and Agriculture Organization of the United Nations, food production must increase by 70 percent before the year 2050 in order to meet global food needs. This growth must happen against a storm-force urbanization is taking over arable

land while simultaneously pushing people away from farming as a profession.

Food Price Inequalities

In addition to the longstanding problems of lack of proper nutrition and widespread poverty in developing countries, food price inequalities have also emerged in industrialized countries. In places like the U.S., the cost of fresh food has led vulnerable populations to choose processed foods high in fat and sugar with low nutritional value. The consequence of these dietary

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"choices" is an epidemic of obesity nationally as well as an increase in diet-related diseases such as diabetes. At the other end of the spectrum, high-income households stimulate demand for more health-conscious 'super foods', such as antioxidant-rich kale and protein-rich quinoa. As global food needs and the costs of agriculture continue to increase, the prospects for improved health are greater and nutritional conditions are disastrous for low-income families in both developed and developing nations leading to toxic food environment.

The social, ecological and economic promise of vertical farming was accepted, but not yet brought to scale. Due to a number of factors related to geographical location, cultural differences, political support, investor dynamics, and local agricultural market conditions, what works for the businesses outlined above may not work for other people involved in Vertical Farming. As well, there are limitations on the amount of plant species that can be grown indoors.

For example, fruits and vegetables that are heavy non-edible weights, such as leaves, stems and roots, would not make good use of vertical farming space or resources.

For commercial farmers interested in expanding to vertical farming and social entrepreneurs who see a potential for using vertical farming to address local food and hunger issues there are ways to minimize the costly learning curve and increase their chances of succeeding:

Changing The Vision Of Agriculture

Traditional agriculture has been characterized as labour intensive and remote from a modern, urbanized lifestyle. There are places where agricultural work is associated with poverty and isolation, but on vertical farms, farmers need to be data analyst biological scientists and system monitors in addition to working with crops. If urban farms continue to grow, this could result in the displacement of existing unskilled labour. Such a

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Dr Dharmendra loves to pursue his interest in growing plants and doing terraced gardening

change is typical of any major industrial transformation—economists call it the rebound effect (take-back effect). The rebound is driven by the fact that efficiency is improved, often resulting in cost reductions that can buy more improved produce. The understanding of this transformation in agriculture provides professionals who enter or are already in the Vertical Farming industry to leverage when communicating the necessity of adopting vertical farming with various stakeholders.

Educate Consumers

Vertical farming is not just the first creation to use scientific experiment as a method. Businesses may use promotion campaigns to clarify the value of non-agricultural crops and increasing consumer awareness of the nutritional and environmental benefits of vertical agriculture. The tastings can also offer consumers the possibility to taste hydroponic products and to judge their own taste.

Support Regional Food Economies

Governments and industrial groups can be valued allies who see local food production as economic development. In Canada, for instance, Ontario's Ministry of Agriculture, Food and Rural Affairs (OMAFRA) actively supports a regional food strategy with project support ranging from promotional campaigns to creating agricultural markets and financing agricultural businesses to purchase new equipment. Supported by OMAFRA, the sector added \$1.3 billion to GDP and created over 34,000 jobs between 2013 and 2015. Such

government support is a sign that local food flows are a credible source of economic development without any signs of slowing down. Cloud kitchen will be an activity growth for the future in the food industry.

Encourage Ongoing Investment

Investors are vital in assisting the scale of vertical farming. Significant investments in Vertical Farming are already under way. Startup Plenty recently received \$200 million to support its global, expansion. Others may have to develop strategies to succeed similarly, since some vertical farm startups have failed in that same timeframe. AeroFarms, for instance, secured equity funding of \$95.8 million by positioning itself as a non-traditional farm, but rather as a "clean-tech urban agriculture company." Other investment attraction trends include the use of vertical farming technology to grow nutrient-specific crops such as Fujitsu's low potassium lettuce.

The National Horticulture Board (NHB) in India through the "Development of Commercial Horticulture through Production and Post-Harvest Management". Central and state governments in India have cut capital costs for farmers that are ready to invest in Vertical Farming. Retrospective loan subsidy of 20% of total project cost is limited to Rs 25 lakh per project in general and Rs 30 lakh in NE and hilly, scheduled region. For crops with high value under protected cultivation, the alternative Central Sector Scheme of the Agricultural Infrastructure Fund Facility may be useful.

Improving The Future Of Farming

Although vertical farms may never be expected to replace conventional farms, they will likely need to complement each other if we are to meet the food requirements of tomorrow. It is economically sound, environmentally friendly, state-of-the-art and, above all, sensitive to health. Vertical farming is not a fairy tale. It's what is going on right now.

HYDROPONIC AND AEROPONIC FARMS

QUALIPLAST MAKES THE JUMP TO THE ASIAN MARKET!

About the **AUTHOR**

Mr Samuel Pagé-Morin is the President and Development Director of Plastiques Qualiplast. The company wants to prove itself in Asia

Agriculture occupies a major place in India's economy. To a large extent, the subsistence of its population depends on production in this key sector which brings together a very large part of the working class.

The food security scenario calls for resilience. The challenge is tough: soil depletion and drying, climatic changes, pollution, high production costs and inadequate infrastructure, small size or lack of cultivable land for many farmers and inhabitants, indebtedness, etc. Nationally and internationally, the door is open to solutions adapted to the Indian context. It is on this path that we come to take part in the 3rd Global Vertical Farming Show in New Delhi, on November 29 and 30, 2022.

Nationally and internationally, the door is open to solutions adapted to the Indian context. It is on this path that we come to take part in the 3rd Global Vertical Farming Show in New Delhi, on November 29 and 30, 2022

At the dawn of its 26th year of existence, our Quebec company Les Plastiques Qualiplast is making the jump to the Asian market, convinced that our know-how in the field of manufacturing thermoformed plastic products stands out in the field of cultivation.

Listening to markets and customers, we have come to develop excellent products with the best plastics. North American leader in the manufacture of large and small culture tables, we have evolved according to research and orders adapted to customers.

Our entry into other markets is accompanied by the creation of partnerships with companies for networking, strategic positioning and business opportunities. For example, we have created links with a Turkish company to better serve certain Asian countries.

Vertical Farms On Our Roadmap

We already have a good track record with the manufacture of our tables, floats and basins, whether for hydroponic, aquaponic, aeroponic,

drip system, tide table or deep culture processes. Our team is betting on remaining on the lookout for needs and taking part in solutions to deal with current issues. One of our strengths is having developed more than a hundred products that meet specific criteria with the best materials, at very competitive costs and with recycled plastic. Our commitment to sustainable development is also reflected in our production.

Vertical farms have been appealing to us for some time and they have the advantage of displaying a yield that can exceed that of traditional agriculture for less water consumption. Indeed, free from dependence on natural light, growing on vertical walls can be done anywhere and in tight spaces. Productivity is greatly increased while costs and environmental impacts are reduced.

This type of cultivation creates the perfect environment for the plants by reducing the constraints linked to the climate. Our robust, non-corrosive products line for this market is approved by the Canadian Food and Drug Administration (FDA). We recently introduced the products for vertical farms in Dubaï, in the Arab Emirates and also serve customers in the United States and Canada.

It is with great pride that we claim to be part of one of the first links in the supply chain of hydroponic and aeroponic farms, by manufacturing equipment for hydro-agriculture. Our services are personalized and adapted. I am fortunate to rely on the skills and teachings of my father, Jean-Pierre Morin, who founded the company relying on his skills and perseverance.

Our Recognized Sectors Of Activity

We are also arousing growing interest in our products intended for cultivation in a controlled environment. This



hydroponic or aeroponic culture simply involves growing plants outside the soil. Vegetables take all the nutrients they need for their growth from the water where their roots are bathed (known as hydroponics) or from the mist sprayed directly on their roots (aeroponics).

This way of doing things eliminates weeding and reduces the use of insecticides. Our plastic tables and trays are manufactured to optimize shoots, reduce the risk of flammability and increase resistance to chemicals and UV rays.

Over the years, we have become a recognized and active company in other

sectors of activity where we have also pushed research and production thanks to our team of engineers, designers, moulders, electricians, mechanics, operators and directors. Each time a serious customer contacts us, we can offer them five-star service: product design, if necessary - prototyping, thermoforming, machining-assembly and recycling.

Whether in vertical farms and in a controlled environment, water treatment, drainage systems and civil engineering, merchandising or other services to individuals, we demonstrate the same concern for quality at a lower cost. In this stimulating challenge, we remain aware of the major challenges posed by climate change and the responsible use of different types of energy.

Underpinning our leap into the Asian markets is the audacity to take on entrepreneurial challenges with other companies and the willingness to engage with all stakeholders and levels of government in improved agriculture for betterment collective.

Looking forward to meeting you in New Delhi at a conference or at our booth.

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FACT**



I like to escape to the mountains for snowboarding or hiking. In summer, I love jet ski rides. I also like to cook. For some time, Asian cuisine has been on the menu. Japanese Ramen is divine and easy to prepare

SUNRISE SECTOR RAPID GROWTH OF URBAN HORTICULTURE



Among several challenges that India is facing viz., increase in population, food scarcity, climate change, industrialization, urbanization, migration of people from rural to urban areas for employment; food and nutritional security is also one of the key challenge. Horticulture provides a wider choice for farmers, in recent years a new

paradigm shift in farming has been observed towards horticulture based farming systems. This diversification of cropping system will ensure nutritious food, greening, and environmental protection.

At present, horticulture is considered to be a sun-rise sector of the Indian economy. It is growing rapidly and offers good options for agricultural diversification. Horticulture is not merely a means

of diversification but has become an integral part of food, nutritional security and poverty alleviation. This sector alone provides livelihood for 30–40% of India's population.

Horticulture also contributes to the quality of life, beauty, sustainability and rehabilitation of our environment. Plants, crops and green spaces sustain and enrich our lives by providing nutritious food, enhancing the beauty of our homes and communities and reducing the carbon footprints.

Urban Horticulture

The new concept in Horticulture is 'Urban Horticulture' which has emerged as a viable concept with the aim to provide sufficient fresh and safe food to city dwellers, supports sustainable food supply and food security. Urban Horticulture is the cultivation of mostly vegetables, mushrooms,



About the AUTHOR

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herbs, and aromatic, ornamental plants and few fruits, that can be grown easily in open spaces, balconies, terraces of buildings in cities.

The pandemic and lockdowns attracted many people living in apartments and individual homes to grow their own vegetables, herbs, etc at homes for domestic needs. The pandemic has provided an opportunity to enhance urban horticulture. People, planners, private and government institutes all are rethinking ways to encourage public to best utilize vacant open areas in cities for food production under this dynamic condition. Many horticultural crops are considered ideal in urban farming as they occupy less space, produce more per unit area, have high nutritional value, and short production cycles. Growing horticultural food crops in urban landscapes and open spaces will improve the sustainability of food and the environment.

Diverse Farming Techniques

As a part of Green environment, several modern cropping systems such as indoor farming, vertical gardens, rooftop gardens, edible green walls, aeroponics, hydroponics and aquaponics are being used in several countries under urban horticulture production which are considered to be environmentally-friendly and thereby supply consistent food throughout the year to ensure food security.

Vertical Gardening is a special kind of urban gardening suitable to small spaces, particularly for decorating the walls and roofs in various styles. This is an alternative method for gardening by expanding the scope of growing plants in a vertical space. Intensive urbanization has left hardly any horizontal space for outdoor gardens. Green walls are not only spectacularly beautiful, but also helpful in enlivening the ambiance. Green walls can absorb solar radiation, thus lower both indoor and outdoor temperature, providing a healthier indoor air quality as well as a more beautiful space.

Plants suitable for vertical garden:

Peperomia, Syngoniums, Philodendron,

Many horticultural crops are considered ideal in urban farming as they occupy less space, produce more per unit area, have high nutritional value, and short production cycles. Growing horticultural food crops in urban landscapes and open spaces will improve the sustainability of food and environment

Epipremnum, Begonia, Anthuriums, Nephrolepis, Chlorophytum, Lantana, Pilea, Rheo discolor, Cuphea, Fittonia, Spathiphyllum.

Indoor Green walls/ Shaded areas:

Herbaceous perennials Pepromia, Syngoniums, Philodendron, Epipremnum, Pepromia, Begonia, Anthuriums, Chlorophytum, Pilea, Rheo discolor, Fittonia, Spathiphyllum, Schefflera

Shrubs: Schefflera, Ficus spp succulents, Rheo discolor, Zebrina pendula, Setcreasea purpurea

Ferns: Nephrolepis

Outdoors/Exterior Green Walls:

Herbaceous perennials Asparagus spp., Pilea microphylla, Alternanthera, Mentha spp.

Succulents: Jade plant, Sedums, Portulaca

Shrubs: Dusty Miller, Cuphea

Ground Covers: Baby's tear, Calisia repens

Grass Like Foliage Forms: Ophiopogon, Dianella tasmanica

Mitigating Environment Pollution

Urban horticulture can help mitigate ever-increasing environmental pollution because of the ability of plants to absorb air and soil pollutants. Cities are becoming denser due to rapid urbanization, the increase in the numbers of structures, and the addition of

dust. Heavy transportation pressure on roads results in vehicles that emit harmful gases, such as CO₂, CO, SO₂, etc., which are harmful to urban inhabitants and contribute to global warming.

National Aeronautics and Space Administration (NASA) suggested that certain common indoor plants like Areca palm, Bamboo palm, Rubber plant, English Ivy, Dwarf Date Palm, Boston Fern, Pothos, Syngonium, Diffenbachia, Philodendron, Sansevieria etc., provide a natural way of removing toxic agents such as benzene, formaldehyde and trichloroethylene from the air, helping to neutralize the effects of sick building syndrome thereby acting as air purifiers.

Trees and shrubs can be planted along roadsides, highways, and even the center of wide streets. Vegetation assists in decreasing solar radiation and dust particles, and increasing atmospheric humidity, which will modify the microclimate of a place. Moreover, the strategy of planting aromatic plants can help in mitigating bad odors from polluted cities. Urban horticultural plants have played an important role in making cities more natural, greener, and beautiful.

Thus cultivation of horticultural crops plays a vital role in national prosperity and is directly linked to health and well-being thereby attaining nutritional security and sustainable income. The current trend shows that dietary habits are changing with increasing income, from cereal-based diets to cereal plus vegetables/fruit-based diets. Resultantly, there is a growing demand for fruit and vegetables. It has been recognized that the horticulture sector is the best option for agricultural diversification to ensure nutrition and healthcare.

fun FACT



Dr Neeraja loves doing yoga, meditation, having fun with grandchildren and listening to music



HORTICULTURE ON A FAST GROWTH TRAJECTORY

India's plantation crops have started fetching a higher value in the international markets. Exotic fruits shall emulate the trend of sky rocketing investor expectations and perhaps the returns. The exotic fruits market has seen a strong tailwind of investments especially from Agri-commerce players across the globe.

The three prime factors for further penetration and attracting foreign and domestic investments into the sector may center around the following:

Sustainable Practices and Climate Resilience

For a country so diverse both geographi-

cally and demographically, aligning the Agricultural practices with Sustainable Development Goals (SDGs) of UN for achieving gold standards in green production becomes indispensable.

As India transitions into a food-surplus and trade-oriented nation, SDGs assume even greater significance in an agricultural economy like ours. Almost all SDGs from No Poverty (SDG1), Zero Hunger (SDG 2), Good Health (SDG 3) to Decent Work and Economic Growth (SDG 8) and Reduced Inequalities (SDG10), could effectively be influenced and brought to fruition through agriculture. Traditionally, crucial linkages have been witnessed while developing strategies to achieving them. Agriculture could, thus, be a key enabler in achieving these resilient practices and even ensure better health and hygiene of the

farmers.

Several field production activities like half strength fertilizers and mulching with coconut leaves have shown promising results. A few key elements that could re-orient farming systems while ensuring ecological security could be efficient resource utilisation, proportionate decrease in Agro-chemicals and improved seed varieties. The nation is gradually transitioning towards a focussed policy development for converting trade-offs between Climate Smart Agriculture (CSA) and SDG into synergies for the two to be able to complement each other. Simultaneously, efforts are being made to channelise capital across practices (from circular economy to cellular agriculture) and to attract global players that have built technologies with a potential to address environmental impact of agriculture practices.

About the AUTHORS

Mr Gaurav Sishodia is Sr. AVP, Invest India

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AGRI ECOSYSTEMS

Investment in Farm Gate Infrastructure, Technology

Infrastructural development such as post-harvest treatment facilities, cold chain, storage and pack house facilities could be complemented with two growth accelerating factors:

Technological breakthroughs such as cold frames, greenhouses, robotic scouting devices and other controlled environment and precision farming techniques

Exchange of knowledge and replicating the findings of advanced research and development of countries like Israel, China and Germany who have been global leaders in attracting the lion's share of investments in Agritech models

Export Strategy and Quality Standards:

After the introduction of National Horticulture Mission, the horticulture exports increased rapidly. The government is opening up the economy by signing more Foreign Trade Agreements and establishing Joint working Groups with international partners so that the farmers have greater access to high potential markets.

While APEDA has designed Export focused financial assistance scheme (Agriculture and Processed Foods Export Promotion Scheme), export market could further be strengthened by a commodity specific export strategy as more partners and international counterparts are onboarded to capitalize on the increasing demand for Exotic fruits and Vegetables.

Currently, a larger share of Indian horticulture crops' export goes to UAE, Saudi Arabia, Nepal, Kuwait and Bahrain (in decreasing order of quantities).

Post pandemic, though, the Exotic fruit market has largely driven a positive investor sentiment and has outshined other commodities amongst the global investors (New Zealand, Singapore, etc.) who want to monetize through diverse Agro-Climatic conditions in India.

International Standards, Testing, Labelling and Certification requirements need to be strengthened and direct linkages with international importers must be established to build a robust market abroad, to onboard global partners and to emerge as a global horticulture export leader.

The government's intent of leveraging its agricultural super-power and emerging as a global agricultural leader is mirrored through its multi-faceted approach of greater Accessibility, Availability and Affordability. It has only been compounding its efforts to achieve the mission of doubling farmers' income.

The sincerity of purpose and an intuitive policy making has enabled a paradigm shift from an isolated sub sector development to value chain empowerment. The government is focused on strengthening the sector through groundbreaking initiatives towards building sturdy supply chains that are

devoid of traditional challenges.

To augment producer influence and de-complexify the supply chains, cluster level aggregation (input and output) at the farm gate itself came as a god-sent solution across crops and commodities.

Government Initiatives

This can well be witnessed through the government's initiative to promote FPOs and cluster based horticulture schemes simultaneously. On one end, the clusters are strengthened by increasing the farmer member base of FPOs - incentivizing them to trade through the FPOs by extending value added services, providing them a sense of leadership through capacity building activities, enhancing business acumen and helping farmers access quality inputs and market. On the other end of the spectrum, cluster oriented schemes (Mission for Integrated Development of Horticulture) are developed to enhance the scale and scope of these horticulture crops by incentivizing volume-production.

This impetus is duly reflected with enhanced financial support through interest subvention schemes across agriculture and allied departments such as Agriculture Infrastructure Fund, Animal Husbandry Infrastructure Development, Fisheries and Aquaculture Infrastructure Development Fund, etc. which are furthered through capital subsidies for food processing and building infrastructure.

The opportunities for a country like India, which is an investment hotspot with a huge potential to emerge as a global leader in Horticulture, are humongous largely due to affordable labour, economical inputs, and supportive government schemes.



Ms Malhotra is a passionate reader, a health enthusiast and a firm believer that physical fitness is the key to mental fitness.

NDMC STRIDES

TRANSFORMATION OF URBAN HORTICULTURE

In our Country, Landscape is generally thought of cosmetic and affordable by only affluent and corporate since many decades. This barrier was started broken while real estate, township, gated society concept gained momentum. People loving plants around their living surroundings, and more green and beauty in outdoor and indoor of their homes; business places and institutional campus etc. today potted ornamental indoor plants got recognition in the kitchen too. In urban area growing pollution, over competition, stressful life, machine like everyday life, hurdles and energy loss in transport, traffic mess etc forcing people make them living environment green and remain touch with plants to evolve from all health issues.

Though we have enough to say about Urban Horticulture, here restrict to certain examples as follows

- **Vertical Garden:** This was developed at Palika parking, Charkha Museum Connaught Place. etc This was gone viral and public got more confident to grow green wall on their homes etc.
- **Green waste Management:** Transportation to landfill site and availability of landfill site are emerging challenges for each city hence local composting, in situ composting, zero waste garden/park concepts have been evolved.
- **Tree Pruning:** Pruning Machines has been introduced to do the pruning work smartly.
- **Mechanization:** Various smart machines like Ride On Lawn Mowers,



Hedge Trimmers, Tree Pruner, Chain Saw, Earth Augur, Wind Blower etc. are being used in the horticultural operations.

- **Hi-tech nursery:** Many herbaceous, rooted semi hardwood shrubs, seedlings of many winter annuals have been prepared to meet our requirement considerable level.
- **Tulips introduced in public spaces:** We got pre-programmed and pre-treated bulbous from Holland to grow tulips here.
- **Flower bed:** The Horticulture Department has changed the winter annual display pattern in Delhi.
- **Flower boards:** The Department introduced Flower Boards 10 years ago, and these became hugely popular.

- **Pollution mitigation:** Open soil surfaces have been covered with suitable ground covers, so that the barren patches may not be visible in NDMC area.

- **Tree surgery:** To save the very old and heritage trees, the department care intensively through a dedicated team called Plant Project Cell.

About the AUTHOR

Dr S Chellaiah is Director (Horticulture), Municipal Council, New Delhi





Metros present challenges in maintaining green spaces due to shortage of water, high cost of irrigation, lack of sustainable landscape, non availability of common duct system, lack of availability of skilled labour on gardening etc. We have to overcome all these challenges to create beautiful urban landscapes

- **Butterfly Garden:** This has become a favourite spot in Lodi Garden.
- **Herbal Garden:** This is at NDMC Lodi Garden. There are more than 100 herbs.
- **Garden amenities:** These enable people to enjoy the morning and evening walk as well as the open gym.
- **Tree plantation:** The department has planted large numbers of trees saplings in NDMC area by organizing Van Mahotsav.

• **NDMC-IUGM (Innovative Concept):** I have proposed this unique concept to cater to the growing demand of skilled gardeners. We give them complete hands on practice and also internship opportunity.

Challenges

Cosmopolitan and metropolitan cities present challenges in maintaining green spaces like shortage of water, high costing on network of irrigation, lack of sustainable landscape conscious, non availability of common duct system, lack of civic sense of public, lack of forethought, visualization, ego issues between technocrats and bureaucrats, lack of availability of skilled labour on gardening, lack of fund in maintenance, stereotypic, cryptic tender procedures and rules, non availability of professional, committed contract agencies in greening, delayed payments system, lack of political will etc. We have to overcome all these challenges to create beautiful urban landscapes.

• **Tree census:** NDMC has conceptualized and executed the Tree Census with geo tagging and QR Code.

• **Shade Landscape:** In NDMC area, parks and gardens, large area has been brought under shade.

• **School of Gardening:** To cater to the demand for skilled gardeners, the school of gardening was started in NDMC. So far more than 10000 people got trained by us.

• **Participation in flower shows:** NDMC is one of the tough competitor and is a regular prize winner.

Development of Commemorative parks: Indo African Friendship Rose garden, BRICS Friendship rose Garden, Bharat ASEAN Maitri park, Kautilya Park, Ambedkar Vatika, Jelebi Chowk etc

• **Blooming “Magic on Concrete verge” of BaraKhamba Road:** Last year in the paved concrete central verge a novel idea started displaying flowers in pre-fabricated frame beds and went viral across the world. Petunia with

different colours attracted many corporate, ULBs, visits, public comments, appreciation etc.

• **Development of new Nurseries and improvement:** Every nursery of NDMC was upgraded to labour friendly and efficient nursery in diverse ways.

• **Introductions of hedge plants:** Delhi faces acute shortage of water for greening. Hedge plants suit our needs well.



I love to interact with friends, listen to music, sing songs and crack jokes, making my surroundings warm, friendly, positive and happy

NEEDED

SPECIAL PRODUCTION HUBS FOR HORTICULTURE DEVELOPMENT

India is evolving in a manner that has ne'er been seen before. Sizable numbers of the population have climbed the economic ladder as a result of the economic boom that the country has seen. The very fact that per capita income has up within the past 10 years has raised demand for consumption and choices, which was any driven by the communication boom. The market is positioned to make the most the opportunity given by the new demand driven by India consumerism, India has seen a shift in product segmentation, and food is one in all many premium products that are slowly entering the market all told segments.

In particular, the bourgeois section of India, which has been driving consumption in India, the segmentation of food and beverages is changing quickly for the better and newer food is on the way. In order to switch from staples (rice and wheat) to healthier items, consumers are

The shift in demand for healthier foods provides an opportunity to de-intensify the food system from rice-wheat to a greener food system that is more resilient than the traditional rice-wheat system

looking for healthy diets. Fruits will play a vital role in this process of switching diets that will create a demand of more fruits in market. According to data on horticultural production, fruit consumption has increased in India over the past ten years and is now rising proportionately to the country's rising per capita income.

Higher Demand For Fruits, Vegetables

According to economic projections, India's economy would expand steadily over the next couple of decades, which will lead to an increase in demand for fruits in particular, according to some estimations. It provides a great opportunity to change the food system to one that is more nutritious and greener, even helping to create more carbon pool in order to increase the prosperity of the nation.

The shift in demand for healthier foods provides an opportunity to de-intensify the food system from rice-wheat to a greener food system that is more resilient than the traditional rice-wheat system. To create a better food system, disruptive changes in the way food is cur-



About the AUTHOR

Mr Murli Dhar is a director of an international organization that leads environmental work. He has worked extensively to advancing sustainability throughout the agricultural supply chain





**fun
FACT**



I enjoy travelling, watching English comedy serials, and walking

rently produced and transported are required. India requires newer approaches to overcome the issues that are linked to the way better food is currently produced.

Reducing Food Loss In Horticulture Supply Chain

GOI should make it a priority to build reliable infrastructure to plug leaks within food supply chain, especially in horticulture, as many studies indicate that because of a shorter shelf life and a lack of infrastructure, fruits and vegetables are lost before being consumed. The intricate details of every commodity supply chain must be understood in order to build a bespoke and bankable infrastructure that ensures returns may be obtained from each investment. To do this, a data inventory for each commodity in terms of production and commodity flow must be created. Even if India produces more in future, there would still be food loss in the supply chain if the necessary infrastructure is not built. By building the necessary infrastructure, the production system will transition smoothly to produce greener and nutritious food.

Creation Of Backup Infrastructure

Today, growers struggle to get appropriate planting material even in the areas wherever horticulture uptake is high in India. The necessity to develop a up-to-date infrastructure which will provide

growers viable planting material even in locations wherever horticulture adoption is high has been a serious obstacle to the transition to a sustainable food system. Like, cereal crops, horticulture crops have a range of choices and might thrive in regions with very little to high rainfall, so the provision of planting material ought to be localized to make sure that it fits with the area's resources.

Creation Of New Production Hub In Peri-Urban Area

Urban food choice changes offer new



opportunities to grow food that is healthy for people and also the environment. They also highlight the necessity to find "Special Production Hubs for Horticulture Development" close to urban areas. Government can initiate and establish special production hubs with the assistance of the private sector, where both retailers and food processors can imitate the transition to make the hubs viable and build a supply chain closer to the consumption centre. This alone would lower the logistical price of horticulture products that can be grown nearby.

Price Discovery and Risk Management

Due to restrictions and the limited amount of price discovery that is guaranteed for growers, horticulture commodities are constantly subject to market instability. Crop insurance's coverage area needs to be expanded so that risk exposure can be carefully managed.

There are still concerns with horticulture that must be rectified immediately due to a lot of the changes involved; if these issues are not resolved, horticulture's adoption within the country will not be consistent. To make Indians healthier and more environmentally friendly than ever before, bold approaches to addressing the issues associated with a more greener and resilient food system are required.

TERRACE TO TABLE

FARMING IN THE URBAN JUNGLE



Arranging your plants

Companion planting can also be practiced and provides many benefits. One plant can help another to stay pest free such as planting nasturtium near squash (zucchini, pumpkin) will keep the squash bug away. Some plants act as a pest trap and thereby protect their companion, for example, aphids love nasturtiums and will flock to them instead of their companion plant. By planting these with a crop such as tomatoes, our tomatoes will be protected. Certain varieties of marigold can control the nematodes that attack the roots of melon. Aromatic herbs act as natural insect repellents. They confuse insects with their strong odor that mask the scent of the intended host.

Some plants help release valuable nutrients for their companion plant; crops such as beans and peas help to make nitrogen available. Similarly, plants with long taproots bring up nutrients from deep in the soil, thereby enriching the top soil for plants with shallow roots. Below is a table of plants that can be planted with or alongside each other to mutually benefit each other.

Starting a farm on your terrace is easy and rewarding. Before beginning this project ensure your place is waterproofed to prevent your building getting damaged by seepage. Here are some tips to get you started.

Sunlight

Ideally, there should be at least six hours of sunlight on the terrace to grow fruits and vegetables successfully.

Plants such as brinjal, okra, peppers, tomatoes, beans, cucurbits, amaranth and cucumbers require sunlight the most and therefore should be placed in sunny spots of your garden.



About the AUTHOR

Mr Raminder Singh is a die hard urban gardener who strives in the promotion and knowledge dissemination about non-traditional and alternate means of farming. He believes that today technology and AI can play a very important role in the urban farming sector



Carrots, celery, garlic, radish and most herbs can grow in areas that have partial shade, at least four hours of sunlight.

Areas of your terrace that receive less than four hours of sunlight can be planted with leafy vegetables such as spinach, lettuce, kale, mustard, chives and some herbs.

Containers

There are a wide variety of containers available, from clay and concrete pots to lighter plastic ones and grow bags. These all come on a range of sizes to suit the needs of the individual plant and the size of your terrace.

Raised beds are an ideal way to grow vegetables on your terrace.

Trees, tuberous vegetables, gourds and squashes (cucurbits) require larger pots of at least 20inch diameter to grow well and give good yields.

Soil

A rich fertile, loamy soil is best for farming. Best results are attained by mixing equal amounts of soil and compost (well rotten cow dung manure, vermicompost or home compost) together. If your soil is too heavy then add cocopeat, washed coarse part of sand or perlite to make it porous and light.

Watering

Container grown crops require frequent watering, and those grown on the terrace even more. The plants are exposed to more wind and sun and therefore the soil dries out more quickly. They will need watering at least once a day and more frequently during the hot summer months. Irrigation systems are

**fun
FACT**



**Mr Raminder Singh
loves playing golf**

widely available and may suit your needs

Fertilizing

Plants grown in containers on your terrace will need more frequent fertilization than those grown in the ground. The roots have a smaller area of soil in which to grow and also loss of nutrients also occurs due to watering. For successful crop growing, fertilize your plants every 7 to 10 days with a good liquid fertilizer. Intersperse this with tilling and addition of a handful of well rotten cow dung manure and other best options locally available.

Pest Control

The best way to safeguard your plants against pest and disease is to keep them at bay by following a weekly regime of spraying them with a dilute soap solution, followed the next day by a spray of a solution made by adding 5ml vinegar and 5 ml lemon juice to 1l of water.

A neem oil spray is a good general organic pesticide for plants that get infected.

Mulching

Mulching with dried leaves, hay, straw or cocopeat helps soil retain moisture, cools it during the hot months and warms it during

the cold months. Leaves, hay and straw will decompose over a period of time and provide nutrients to your plants.

Home composting

A shady protected area of your terrace is an ideal place to have your composting containers. All your kitchen waste (peels, food scraps, tea leaves, coffee grounds, leftover food etc.) along with plant waste from your urban farm can be composted to provide a rich source of nutrients for your plants.

There is a huge variety of bins and containers to choose from in the market. It is also fairly easy to make your own bin by using empty large paint containers or used oil barrels.

Communing with nature

The flowers and fruits in our urban gardens attract a wealth of small wildlife. They become a haven for birds, butterflies, bees and other insects coming to get food and thereby pollinating our plants.

Cooling our cities

The concrete structures in our cities are heat traps. This heat is then released into the atmosphere causing 'the heat island effect'. Rooftop farms and gardens help dispel this effect by cooling the buildings.

Reducing waste production

By incorporating a compost area in our farm/garden we can utilize all plant and food waste. Plastic bottles and containers can be recycled into unique planters, hanging and otherwise, which are ideal for growing herbs and leafy vegetables.

CONTROLLED ENVIRONMENT AGRICULTURE BRINGING HOPE FOR FOOD PRODUCTION AND DRIVING SUSTAINABILITY

Mankind is facing unprecedented challenges in the effort to produce enough food for future generations. To meet the needs of a burgeoning global population—expected to reach nearly 10 billion by 2050—food production will need to double. And that will need to happen in a more sustainable manner, which is a significant barrier, given the resource-intensive, high carbon-emission nature of traditional agriculture.

These challenges will be compounded by disruptions to the food supply chain due to pandemics, severe weather and geopolitical crises, which have already led to food security being a prime concern for many nations.

But there is hope. Controlled Environment Agriculture (CEA)—that is, technology-driven indoor farming—has the potential to fill important production gaps in traditional agriculture to help feed tomorrow's population. Certainly, there are some challenges that must be overcome first—but the industry is already working on those problems, and CEA shows promise to overcome them by as early as 2027.

How can CEA help?

CEA systems use data and technology to attain crop yields up to 390 times larger than conventional farming, while using up to 95% less water and zero pesticides. Being free of seasonal changes, these indoor farms can have 12 to 20 crop turns a year, whereas outdoor farms are lucky

CEA adoption has been growing over the last few years, and many see it as a way to help address issues such as increased demand for food, water scarcity, consumer interest in sustainability and the need to tackle climate change

to see three. In addition, CEA production sites can be set up close to urban populations, reducing transport emissions and minimizing supply chain risks. And only 5% to 10% of produce is lost or wasted with CEA, compared to nearly 40% in traditional agriculture.

Currently, CEA production is limited primarily to leafy greens, microgreens and herbs. But many companies are now exploring a next wave of CEA crops. In a survey of 336 CEA growers, 30% were considering growing berries (strawberries, raspberries, etc.), which topped the list of

potential new crops. These were followed by vine vegetables and mushrooms (26% and 22% respectively).

In addition to food crops, some indoor farms are producing seeds and seedlings for traditional agriculture, a practice known as “hybridization of agriculture.” CEA farms are also exploring the use of plants to produce inputs for pharmaceuticals, nutraceuticals and cosmeceuticals.

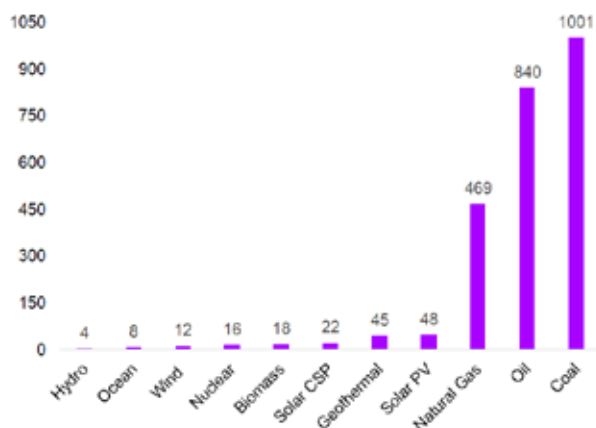
Cost And Carbon Challenges

While CEA has huge growth potential, challenges face the industry. These include high operational costs, 70% to 80% of which are due to high labor and energy costs. Thus, automation is a vital factor in costs. So too is location, because it affects both labor and energy costs, as well as the type of energy that's available, with

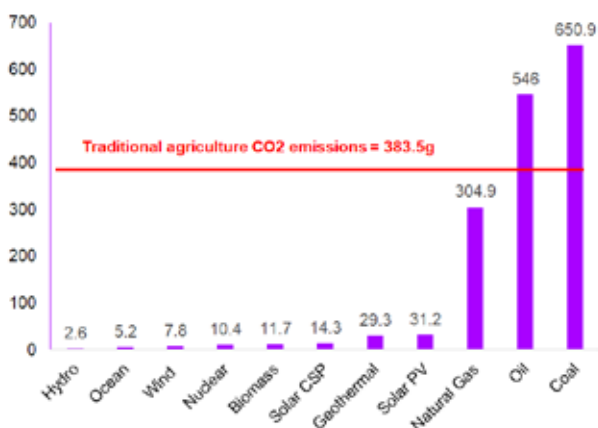
About the AUTHOR

Gaurav heads agribusiness research at Accenture. With almost two decades of experience as a business strategist and thought leader, he shapes perspectives about the future of the agribusiness industry.



Carbon Intensity of Electricity Generation (g CO₂eq/kWh)

Source: Adapted from IPCC special report on Renewable Energy Sources and Climate Change Mitigation

CO₂ Emissions per Lettuce Head (g)

Source: Paul Gauthier, CEA Expert

traditional electricity generation being a key contributor to emissions.

The use of electricity from renewable sources has the potential to change the carbon-footprint equation significantly. Figures 1 and 2 show how carbon intensity compares for various types of electricity generation, and how this translates into significantly lower CO₂ emissions for renewable electricity-powered vertical farms, compared to traditional agriculture.

The Coming Inflection Point

There are many innovative ways to incrementally reduce energy costs and carbon footprints. But it is likely that the CEA industry is approaching a significant inflection point that will accelerate growth. This will primarily be driven by three developments:

- **Falling cost of renewable energy.**

By 2030, solar will become the cheapest source of new power across the United States, Canada, China, India and 13 other nations. Access to competitive renewable energy will significantly reduce energy costs and carbon footprints at CEA farms.

- **Higher LED energy efficiency.** LED lighting accounts for 50% to 60% of energy usage in a typical vertical farm. Currently, a well-designed horticultural LED system is typically 55% to 60% efficient, but that is expected to reach 70% in the next few years—again, reducing energy usage and CO₂ emissions.

- **Innovations in plant sciences.** The development of vertical farming-specific cultivars and practices should enable companies to improve productiv-

>
accenture

CEA will be a viable option to help combat food production challenges and drive sustainability by as early as 2027

ity and crop quality while growing crops more quickly. According to Paul Gauthier, CEA expert and former head of R&D for a leading vertical farm startup, "This could increase productivity by at least 25% to 30% over the next 5 to 10 years."

The CEA opportunity

Companies across the agribusiness value chain have an opportunity to be front runners in tapping the massive opportunity created by CEA.

Plant genetics will play a big role in making the broader use of CEA viable, as

indoor farms focus on traits that enhance flavors, aromas, textures and nutritional qualities. To that end, Unfold, a startup that provides an integrated offering of superior seeds, digital services and agronomic insight, is leveraging AI, machine learning and plant biology to develop new varieties of fruits and vegetables suited for vertical farming.

Last few years have also witnessed the supply chain issues as one of the biggest challenges faced by agribusiness companies. CEA is being seen as a likely solution here, enabling more resilient and sustainable supply chains.

The use of CEA is expected to expand soon. "We are continuing to witness development in renewable power, LED energy efficiency and farm automation," says Jaime Guerrero, global CEA practice lead at Accenture. "As a result, we feel bullish that CEA will be a viable option to help combat food production challenges and drive sustainability by as early as 2027."

CEA adoption has been growing over the last few years, and many see it as a way to help address issues such as increased demand for food, water scarcity, consumer interest in sustainability and the need to tackle climate change. In the near future, CEA is likely to become more competitive compared to traditional agriculture, and to encompass a widening variety of crops. Capturing that growth will require innovation, investment, research, partnerships, and collaborative strategies centered on end-to-end solutions that prioritize the best of technology and human ingenuity.





HORTICULTURE

HOLISTIC APPROACH TOWARDS GREEN ENVIRONMENT, HEALTH & PROSPERITY



If you have a garden and a library, you have everything you need!

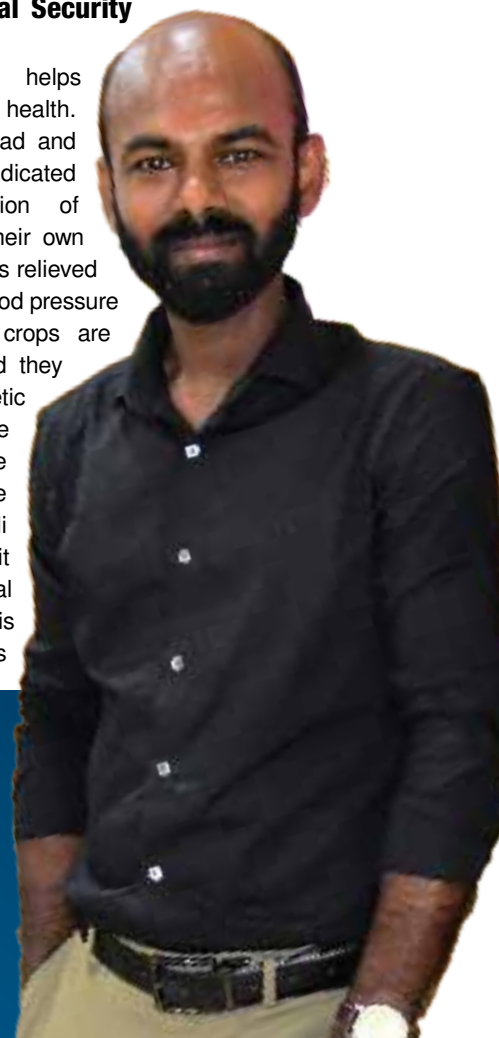
-Marcus Tullius Cicero

Urban gardening is gaining tremendous importance. Most important vegetable and leafy vegetable crops cultivated by urbanites in Hyderabad include tomato, brinjal, bhendi, chilli, all type of gourds, cluster bean, palak, hibiscus (Gongura), coriander, mint, lettuce, etc. In addition to this, mango,

custard apple, sapota, coconut and pomegranate among others are grown by them. On the one hand, growing their own food is safe for their health and on the other hand, it minimises the climate change risks such as increasing temperature, the effect of urban heat islands, humidity and other environmental perils caused by burgeoning vehicles, polluting industries, and other anthropogenic centred economic activities. Considering the importance of urban gardening, the Horticulture Department at Nampally, Hyderabad has established Urban Farming Division to conduct training, seminars, exhibitions and expos, as well as provide subsidized vegetable kits to urbanites to grow their own foods.

Ensuring Nutritional Security And Health

Urban gardening helps improve and stabilise health. Urbanites in Hyderabad and Secunderabad indicated that the consumption of fresh produce from their own terrace/rooftop gardens relieved them from asthma, blood pressure and thyroid as the crops are grown organically and they did not use synthetic pesticides. Most of the urbanites also cultivate cole vegetables like cabbage, broccoli etc., as a result, it serves as the natural medicines for arthritis and diabetes. It is



About the AUTHOR

Mr Vincent A is working as a Consultant at Centre for Climate Change and Adaptation (CCA) at MANAGE, Hyderabad. He is presently conducting research on Climate Smart Agriculture and documenting Climate Smart Extension Models across the country

also evident from research that the cole vegetables such as broccoli and cruciferous vegetables cut the risks of arthritis and heart disease (Hubbard et al, 2017). Besides, they stated that the vegetables, leafy vegetables, fruits etc., grown organically have better taste, flavour, savour as well as have more digestibility and are cooked more easily than those brought from markets or supermarkets.

Revitalising Environment Through Urban Gardening

Urban gardening is capable of restoring the running environment and optimising the use of scarce urban natural resources. Urban gardening hinges on the framework of cultivation by conservation. Most of the urban agriculture practices are done close to nature, thereby establishing harmony between humans and the environment. As urban farms are located mostly on rooftops, backyards, terraces, balconies and exclusive vacant and unused land areas, it transforms the concrete jungles into green scape.

Rooftop and terrace gardens encompass multiple benefits such as it can prevent the penetration of scorching sunlight into the house directly, vegetables and other crops on the rooftops/terrace can absorb and use the sunlight effectively for their metabolism. The use of wastewater/rainwater in urban gardening helps restore urban ecosystem that has been polluted by mushrooming industries, chemical plants, etc. Interestingly, urbanites who grow vegetables and other fruit crops use their own growing media such as waste buckets, containers, mud pots, waste tyres and torn aluminium vessels to name just a few.

Concerning manure management, many urban practitioners use organic manures and fertilisers, which are prepared by them. For example, compost/vermicompost generated from household waste such as kitchen waste, peels of fruits, rotten vegetables and fruits, leaf litter fallen on the grounds,



I am fond of social and wildlife photography and maintain a page on Instagram for posting. I own a Canon 200d II to freeze the moments

waste papers etc., also use coco peat, fish manure, cow dung, sheep pellet and other organic manures source from goshala.

Therefore, almost all of the household's waste is converted into manure or otherwise into a useful growth media for crop production. As a result, urban gardening is an effective way of reusing the plastic and other petrochemical materials used in the households which are otherwise dumped in municipality waste bins or thrown away in the lanes of the city.

Prosperity for all – Not far away

Considering the increase in urban poverty which is linked to many factors such as a lack of access to quality

education, job opportunities, health, sanitation, food etc., there is a need for wide-scale promotion of "growing your own foods initiative" for self-consumption, especially among urban poor.

Capacity development programmes have to be organised by the urban extension division for city dwellers to practice gardening, involve the interested urbanites in the community kitchen garden on a wasteland or common land, network all the urban food growers to one platform, create micro-level market facilities at an important cluster, ensure supply of essential nutritive foods to all urban poor by linking them to practitioners and tap the potential of social media for sharing the knowledge on urban food system.

Practising gardening in cities or growing own food in the available spaces may not be a single-fit model to achieve prosperity among all urbanites. However, it will certainly pave a way for a better environment, and better health, thereby playing an important role in bringing prosperity to all, including the urban poor.

This article is the outcome of the research study "Urban Farming-Good Practices and Knowledge Management" conducted by me in the twin cities of Hyderabad and Secunderabad.





DEVELOPING HORTICULTURE OPPORTUNITY AMIDST ADVERSITY

of us living in these cities may feel helpless as we watch large garbage dumping sites growing ever larger. It is observed that domestic wet waste is generated at about 1 kg/day/home. For these 25 cities, when aggregated this will result in thousands of tonnes of waste per day. Of this, between 50% and 80% is wet (food/kitchen) waste.

Let us look at the need for sourcing our daily requirement of fresh, naturally grown vegetables devoid of chemicals. If we live in the heart of a large city, then it may be difficult to procure directly from a farmers'

market and we have no choice but to go to many stores or vegetable markets. Not all of these may promise the chemical-free produce which we seek.

The Beginner

Being a real novice, I was quite tentative about the whole exercise. Even before I

This may sound a bit philosophical, but I have observed that sometimes what seems like two different "problems," in reality, turns out to be a problem-solution pair – each resolving the other! In the present context, I am referring to the dual problems: of urban waste management on the one hand and the difficulty in procuring fresh, chemical-free vegetables on the other.

Vast Potential For Urban Horticulture

There are over 25 cities in India with a population of over two million. Those

About the AUTHOR

After more than thirty years as an Electronics Engineer, Mr Ravindra Karnad switched over to building composters for urban homes and communities



Problem And Solution: It's Right Here

So, we have these two daily domestic needs: disposal of wet waste and procurement of fresh vegetables. Could these two possibly form a problem-solution pair? As with the example of domestic waste being needlessly transported away from the city, would it not be great if fresh chemical-free vegetables too do not need transportation and are available right in our garden?

Like many people who love to support the environment, I too learnt how to process wet waste by composting in a hygienic and efficient manner. I came across a variety of methods of composting to choose from but what appealed to me the most was the technique of aerobic composting described in great detail by the Food & Agriculture Organisation (FAO) and I began practising it. This meant that at least my house-hold wet waste was not carted away dozens of kilometres for processing. Instead, the waste was converted to organic fertiliser right at home. It took a few iterations to achieve the fine texture and deep black colour. The next step was more difficult – to utilise the compost and grow green vegetables at home.



This early success further encouraged me to try fruiting vegetables like okra, purple brinjal and ridge gourd –which are now just about giving me some samples to take to the table.

For the terrace garden to keep the trays light in weight, I have avoided garden soil. But in my back yard, I have added to the soil: compost, cocopeat and neem cake powder. One of the easiest for me to grow was turmeric. Frankly, there was almost nil intervention on my part and just watering it when needed was enough to give me a good crop – a harvest of about 2 buckets of turmeric bulbs. After the customary washing, boiling, and drying it was milled at the local chakki (flour mill) to yield truly fragrant turmeric powder. This indeed was a real aha moment because until then, I never had sniffed the real fragrance in packaged and branded turmeric powder! It made me realise the true value of having home-grown produce.

Good Going

I have had my failures too with very poor yield of coriander and inadequately sized tomatoes. There will be many like me who live in cities and may have just a little time but do still want the benefits of home-grown vegetables. The challenge for city dwellers is not just space but time and energy too. As an engineer, my impulse is to put to work some form of technology which will make it easier for city dwellers to see sustainable pickings from the garden. This could be using wall space for small baskets of greens watered by timer-controlled drippers and sprayers, all this built with the bare minimum of plastic (or PVC).

began using the compost in the garden, I learned that a simple but effective test for compost maturity is to check how well seeds sprout when sown in compost. Having passed this first essential qualifying test with methi (fenugreek), the real proof was to successfully grow greens for the dinner table. I began with a mix of cocopeat and compost as a potting mix for the trays on my terrace. Such a potting mix was very light in weight as compared to garden soil and made it definitely easier to move around and carry my growing trays on the terrace.

A multi-level planter with a rain shade helped me to grow amaranth, methi, palak and mustard. For beginners like me such greens are much faster and gratifying. It helps to understand the cycle from waste, to compost and back to fresh greens.

This also offered an opportunity to try out electrically operated drips and micro sprayers – a much needed accessory for

those who may find it bit tedious to climb up to the terrace to water the trays.

Early Success

It was not always a smooth journey and I was often disappointed to lose plants to root rot. Fortunately, I had access to some professionals in agriculture. I was advised to add a fist-full of neem-cake powder into the potting mix. Till date, I find this an effective combination and have stayed with it.



URBAN GARDENING

GREEN ENVIRONMENT, GOOD HEALTH



Urban gardening involves lots of modern technologies mainly for efficient control and management of costly inputs like energy, water, seed, fertilizer and other chemicals. Value chain based efficient marketing system is the important component of urban gardening.

This type of farming helps in growing safe food with one's own involvement in relatively small space sometimes within home itself. It also helps in pollution control and facilitates supply of abundant oxygen and control of many harmful gases by growing specialized plants. This is the main reason for massive adoption of Smart Urban Farming technology in the post Covid era.

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

common citizen through holistic approach by adopting latest technologies and involving individuals and communities based participation.

Modern Technologies

Following Modern technologies are important components of urban gardening.

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

About the AUTHORS

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

Major Advantages Of Smart Urban



DR MURTAZA HASAN

Farming

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

Protected Cultivation Technology

Protected cultivation based smart urban farming offers several advantages to produce horticultural crops and their planting material of high quality and yields, through efficient land and resource utilization. Fruits, vegetable and flower crops normally accrue 4 to 8 times higher profits than other crops. This margin of profit can increase manifolds if some of these high value crops are grown under protected conditions, like greenhouses, net houses, tunnels, shade net etc.

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

- Naturally Ventilated Greenhouse
- Climate Controlled Greenhouse
- Insect Proof Net House
- Shade Net House
- Tunnel type Greenhouse
- Rain Shelter

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

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



crops round the year.

Protected cultivation has very high entrepreneurial value and profit maximization leading to local employment, social empowerment and respectability of the growers. Environmentally safe methodologies involving GAP and IPM tactics reduce the hazards facing the high value products.

ML, AI, IoT for Sustainable Management of Urban Gardening

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

Protected cultivation has very high entrepreneurial value and profit maximization leading to local employment, social empowerment and respectability of the growers. Environmentally safe methodologies involving GAP and IPM tactics reduce the hazards facing the high value products

mainly based on automation linked with IoT and AI.

Following sensors are commonly used for Smart Urban Farming

- Climatic Sensors
- Fertigation Sensors
- Water Quality Sensors
- Disease monitoring sensors
- Plant Sensors
- Leaf Sensors

Center for Protected Cultivation Technology

ICAR-IARI Pusa Delhi is one of the lead institutes carrying research, education and training on different aspects of Smart Urban farming Technology including Soilless Vertical Hydroponics based Farming at Center for Protected Cultivation Technology. Indigenous infrastructures for Soilless, Hydroponics, Aeroponic, Multi layered vertical farming have been developed, installed and evaluated with significant achievements in Automation with sensors including IoT development.

Collaborative Research projects funded by prestigious government agencies have been going on at ICAR IARI Pusa related to Smart Urban farming. Technical Bulletins titled "Hydroponics Technology for Horticultural Crops" (TB-ICN:188/2018), Smart Urban Farming Technology (TB-ICN:270/2022- English) and (TB-ICN:H-195/2022-Hindi) have been published by ICAR-IARI for Technology dissemination related to Smart Urban farming.

It is high time that common citizen of the country should go ahead and adopt urban gardening at the suitable scale and space available to them. Technology is available in vast range of affordable price as per the actual requirement and there is urgent requirement of genuine interest and some time devotion.

Smart gardening has the potential for sustainable development in terms of environmental & personal health and efficient utilization of precious inputs including water, nutrients and energy. Smart gardening is the futuristic sustainable, precision and smart agricultural technology for India.

BRINGING THE FARM AND FORK CLOSER GREENING THE PLANET!

Lockdowns may become a part of our regular lives and they have taught us a bitter lesson... 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.

We live in an age where despite opportunities and opulence, irony stares right into our faces. Despite working so hard to earn so much, even the richest are forced to eat vegetables grown in drainage water (containing harmful industrial effluents) or laced with harmful systemic pesticides (which get absorbed into the skin of the veg) that cannot be washed away. We have landed in this situation because of our inability to answer a simple question – “How can we grow vegetables inside a city?” Ironically, the answer is as simple as the question – “On rooftops!”

A new category of local growers shall rise.....The Urban Growers!

The Urban Growers shall turn the clock back, by converting the rooftops of the concrete jungles into lush green rooftop organic farms.

HYPERLOCAL COMMUNITY OF GROWERS, CONSUMERS

Rooftop Organic Farms shall spawn organic consumers around them leading to

Besides offering skill development and employment opportunities to unemployed rural youth, rooftop organic farms can offer revenue generation opportunities for poor and needy individuals

the creation of a hyper-local community consisting of growers and consumers. Not only will the consumers consume the fresh organic vegetables from rooftop organic farms but would also sell composted vegetable-waste, which is a nutrient-rich organic fertilizer, back to the rooftop organic farms. This creates a closed-loop hyper-local organic community which not only grows and consumes fresh vegetables, it recycles 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 would grow almost 2000 metric tonnes of fresh vegetables in a year and would uti-

lise 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 not only grow fresh and safe organic vegetables (using a fraction of the water as compared to conventional agriculture) but they shall also create a natural green cover on large buildings who guzzle electricity (for cooling).

Besides offering a natural green cover to product the rooftop from direct exposure to the sweltering sun, the vegetable plants will also do photosynthesis and thus sequester many metric tonnes of CO₂. Thus, rooftop organic farms will also act as carbon sequestraion sinks.

A rooftop organic farm of 1000 sqr ft can sequester 3-5 metric tonnes of CO₂ 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



About the AUTHOR

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generation opportunities for women of the weaker section of the society.

SAVE GOVERNMENT MONEY ON FRESH 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's time to convert our rooftops into organic farms and bring the farm closer to the fork by developing rooftop organic farms.

The world now awaits, with a bated breath, for the next big revolution – the urban farming revolution when roofs shall become organic farms and our cities shall become food self-sustainable.

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!

Besides offering skill development and employment opportunities to unem-

ployed rural youth, rooftop organic farms (with the financial support from government or NGOs) can also offer revenue



fun FACT

Mr Tiwari is an avid reader and has keen interest in Vedic Sciences. He is also passionate about Vedic methods of farming

HORTICULTURE SUNRISE SECTOR, HIGHER FARMER PROSPERITY

The word horticulture is derived from two Latin words (hortus[garden]+cultura [culture]). It is defined as “the art and science of growing fruits, vegetables, herbs, nuts and ornamental plants (trees, shrubs, flowering plants and turf).” Human civilization always works to keep their family happy.

Financial security, social security and health security are the enablers for a happy family. Health is always governed by the environment around us and a healthy environment is an outcome of efficient management of the plants. Even Medical science, for ensuring health



security is advising to enhance the consumption of fresh fruits and vegetables in daily diet, having green and healthy ornamental plants and creating a green and healthy environment. Our society, especially the urban society, is adopting the concept of healthy eating by adopting the migration from “Grain to Greens”.

Fast Growing Sector

Horticulture is one of the fastest growing sectors in India. This sector is significantly contributing in poverty eradication and nutritional security. The sector is contributing in increasing farmer's

income and generating employment for the population and also helping in sustaining good number of industries. Most of the horticulture crop cultivation is a labour-intensive job and it helps in employment generation for the rural population.

Some of the statistics in horticulture indicate the strength of this sector. We Indians are the second largest producer of fruits and vegetables in the world after China. We are contributing 10 and 13.4 per cent of fruits and vegetables in the world. We are the largest producer of mango and banana in the world and pro-

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ducing significant share of global production. Indian climatic variability makes our country suitable to cultivate more than 30 fruit trees and 40 vegetables.

Employment Generator

The unit area production and return are higher in horticulture, it covers only 6.1 % of gross cropped area and contributes 18.8 % of gross value of agricultural output. Horticulture plays an important role in creating employment, enhancing the profits and providing nutritional and economic security to the farmers and community.

Horticulture is focusing on growing fruits and vegetables, which ensures supply of critical nutrients to ensure balanced diet. The population living in areas having limited horticulture crop production i.e. fresh fruit and vegetables are forced to eat a diet with a limited or no inclusion of fruits and vegetables. Low intake of fruit and vegetables contributes significantly to some of the world's most widespread and devastating nutrient-related disorders.

Higher Farmer Prosperity

Adopting horticulture crops helps in increasing farm incomes. The farmers who are growing high-value horticulture crops, such as fruits, vegetables, flowers or herbs, consistently are earning more than farmers growing other agriculture crops i.e. cereal, pulses and oilseeds.

Higher return from horticulture may become an engine for agricultural and economic diversification.

Horticulture is a sector contributing to ensuring gender equality in agriculture. Most of the vegetables, fruits and cut flowers are often grown and marketed by women, but women often have less access to markets, land, inputs and education. Addressing these constraints places women growers on the path to increasing productivity and expanding horticultural markets.

Horticulture can benefit individuals and families by supporting health and well-being. It provides the option of doing physical exercise by managing the plants. Having a kitchen garden supports the family with supply of quality nutritive vegetables. A happy flowering plant at the available space is becoming a stress relief and restoration. Gardening keeps us active and healthy so that we

minimize our risk for chronic diseases.

Urban Landscaping

Gardens developed under horticulture are becoming a source for therapeutic relief resulting from the emotional processing that comes while tending gardens and plants. Gardeners get mental peace from gardening. These mental benefits include a sense of purpose, relaxing, and forgetting worries. Research has validated the fact that patients exposed to flowering plants while recovering from surgery or being in the hospital has improved recovery.

Gardening in horticulture can develop ability of personal choice, mastery and competence, and a sense of relationship to others. Designing a garden space, selecting which plants to grow or even their flower colour are examples of personal choice. Selecting a preferred garden tool may meet that need for a child in the garden. Growing edible plants or those that are purely ornamental is entirely up to the gardener.

The benefits from horticulture are such that every section of our society is either directly or indirectly getting a healthy and prosperous life. One hand, the growers are getting better return and other hand it is helping to improve the environment. All these facts give a clear indication that horticulture may become an enabler in achieving holistic and sustainable development of our society.



**fun
FACT**

**I love to play with new
technologies, read books**

HORTICULTURE AND URBAN GARDENING

One can easily create a gorgeous garden and also grow food in the city through different kinds of urban gardening methods.

Some of these are as follows.

- Roof top gardening
- Balcony gardening
- Container gardening
- Hydroponic farming
- Vertical gardening

People are increasingly recognizing the need for local community gardens and green spaces and cities are being built with market gardens and farms as their trading centres. Urban horticulture is a fledgling field of study and proposes

Presently, agriculture is passing through a fourth revolution facilitated mainly by the advances in information and communication technologies

the concept of utilizing limited available space for maximum yield/output. Whether it is growing produce for the table or having a dazzling display of flowers in the garden, as we continue to live in cities and grow plants, we will keep learning more about them in the home environment itself. Here are some ways in which urban horticulture is establishing its place in the modern society and urban spaces.

Addressing Food Insecurity

A major aspect of urban horticulture is addressing food insecurity, which is a growing global issue. About 88% of the population lives in urban areas. With food prices rising and the increasing incidence of extreme climatic events, the FAO has

identified urban and peri urban agriculture as a farming system that can contribute to domestic food and nutritional security and jobs.

Modern Community Gardening

Community gardens and nearby green space in cities are an important response to the need for nutritious and affordable food, psychological and physiological health, social cohesion, recreation, and life satisfaction. The main goals of this community garden movement include cleaning up neighbourhoods, pushing out drug dealing that occurs at empty lots, growing and preserving food for consumption, restoring nature in industrial areas, and bringing the concept of farming to the urban areas. Essentially, community gardening is seen as way of creating a relationship between people and a place through social and physical engagement.

Standard Home Décor

Plants have become a part of standard home décor over the last many years. Millennials have been the biggest buyers of plants since 2013, and show no sign of stopping. Plants have several benefits. They purify the air and are also great for recreational purposes.

Gardens Around Victory Monuments

The government has been making a lot of effort to integrate different infrastructure and monuments into the urban spaces – Central Vista and the Statue of Unity are two recent examples. Victory gardens are prominent everywhere, including in the city. However, most of the

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Street landscaping reduces urban storm-water runoff and creates fresh produce closer to where it is ultimately consumed. Areas with community gardens and urban farms are also high on property value

economically stable people have moved out into the suburbs, leaving public authorities to engage in gardening. Urban horticulture holds the potential to change this scenario.

Therapy

Plants have scientifically proven benefits for mental health and wellness. According to a study, plants at home or in the office can help reduce stress. Another study indicates that “the visual stimulation of green foliage plants tended to improve attention and feelings of comfort.” Indoor plants are known to purify air and improve its quality. They are also great at mitigating the effects of depression and anxiety. In fact, clinics in Manchester prescribe potted plants to patients based on research done by Cambridgeshire and Peterborough NHS Foundation Trust. According to this research, horticultural therapy can help improve feelings of well-being for those with depression, anxiety, dementia, and other conditions

Forest gardening

This refers to the practice of having different crops, vegetables, and fruits grown within the urban settings. Forests usually create a favourable environment for plant development. Forest gardening can also

be part of afforestation efforts in the fight against global warming in urban areas.

Street Landscaping

Tended to by people in the neighbourhood, street landscaping has different uses such as making of community gardens. It makes the streets look tidy and beautiful and creates a clean environment by purifying the air. The added advantage of street landscaping is that it reduces urban stormwater runoff and creates fresh produce closer to where it is ultimately consumed. Areas with community gardens and urban farms are also high on property value.

Biodiversity

Yards, parks, and rivers in urban areas can all benefit from conservation practices. Urban conservation practices are aimed at reducing pollution and encouraging the population of native plant and animal species (including preservation of almost extinct ones).

Challenges

While urban horticulture has varied benefits, it also comes with its own set of challenges. For instance, many large cities are already under water stress and urban agriculture would only increase the demand on this already stressed resource base. Hence, there is a need to find new sources of water. Then there are the challenges around the availability of space to expand and sustainably integrating it into the existing urban fabric.

There is more than enough urban land available to meet the fruit and vegetable requirements of its population. The need of the hour is a conceptual framework that identifies and provides a solution to key scientific, engineering and socio-economic challenges and opportunities. This solution must be proposed at the polity level for proper implementation for accruing larger benefits.



Playing the guitar, developing a tropical forest in my balcony with my kids, watching soccer and a good workout are my favourite leisure activities



GIVING AGRICULTURAL WASTE AND RESIDUE A SECOND LIFE

Manufacturing disposable tableware which is backyard biodegradable in nature fights the pollution pandemic and also the plastic and paper pandemic. An individual snacking in a qudrat plate indirectly contributes to reducing carbon emissions, land and air pollution and last but not the least - marine litter

Progress is undeniably a double-edged sword.

With the increasing population on the planet, more resources are being continuously used and consumed by human beings. This is essential for the survival of the human race on the planet. In this period of time, we have also progressed scientifically and on the technology front by milestones which is a remarkable achievement by man on the planet. However, all of these glories have come at a cost. Well, let us take a guess? It is none other than the environmental cost.

But how exactly do we tackle a situation like this? Does human progress come first or the preservation of the very planet that cultivated and nurtured the same? The missing piece of this jigsaw puzzle lies in Sustainability. Being sustainable

is to endure the capacity in a relatively ongoing way across various domains of life. In the 21st century, it refers generally to the capacity for the Earth's biosphere and human civilization to co-exist.

Pursuing Sustainable Ways Of Life

At qudrat, an early stage start-up based in Kerala, we answer questions to all of these.

Our business model is further proof to the fact that you can preserve the planet and also get paid for it and contribute wholistically to a green environment, health and prosperity (Even in case of a manufacturing enterprise)

Paddy cultivation comes with its own challenges. There is agricultural waste and residue that is generated while cultivating it and has few uses post the harvest. This leaves farmers in North India with no choice

About the **AUTHOR**

Mr Rishabh Suri, a third generation entrepreneur, was 20 when he dropped out of the ICAI to sell cars and bikes, increasing the carbon footprint. At the age of 24, he embarked on a completely different journey of propagating sustainability, one plate at a time with qudrat.



but to get rid of it in the fastest and most frugal way which is burning it.

This does come with a cost not to the farmer but to the environment around. It is also one of the integral reasons for all the smog around New Delhi during the onset of winter which leads to AQI Indexes turning red and rings the bells for a calamity of its making in the national Capital.

However, qudrat with its Technological Partner CSIR-NIIST in Trivandrum is giving such agricultural waste and residue a second life. Manufacturing disposable tableware which is backyard biodegradable in nature not only fights the pollution pandemic but also the plastic & paper pandemic. An Individual snacking in a qudrat plate indirectly contributes to reducing carbon emissions, land & air pollution and last but not the least - marine litter which is undeniably the single largest global cause of the 100 million marine creatures dying every year.

Problems Posed By Plastic Waste

While plastic and paper happen to be far cheaper goods in the disposable tableware category, they come with their own set of problems which include health implications

for human beings. The PE lining inside a paper cup tends to dissolve above a certain temperature and enters the human body on consumption of a hot beverage (For example - A hot cup of tea in a disposable cup).

This once again causes implications in the longer run for our health as this microplastic is there to stay in our blood and keeps accumulating over time leading to oxidative stress, DNA damage and Inflammation in human beings. This is



On a train journey across Kerala, I read Elon Musk's biography by Ashlee Vance, and his quest to save the planet while getting paid for it. A light bulb lit up, and my brother and I decided to create viable alternatives for plastic tableware

one of the key factors that we kept in mind while engineering qudrat products at their inception in the CSIR-NIIST laboratory at Trivandrum .

We wanted our products to repel water, but we wanted to do that naturally. After intense zeal and efforts put in by the team, we were able to do that which once again reassured us of our strong belief in making our products safe to use for everyone and improvise on the existing options available in the market.

Saving Environment, Creating Employment

Other things kept aside, we also wanted to make impact directly proportional to our business. Talking of social and environmental impact, each qudrat disposable helps generate incremental income for farmers, prevents the burning of agricultural waste and creates employment for people of the community. Not only that, we also help preserve the planet by eliminating single use plastic/paper with Agricultural residue, provide safer oceans for marine creatures and significantly reduce carbon emissions. This is enough to ensure, prosperity for all and business for qudrat which become complementary to one another.

As human beings, in this race towards urbanization and development we must remember the one most important rule of the playbook – We do not inherit the earth from our ancestors. We borrow it from our children. Let us respect it and protect it.

VERTICAL FARMING

ON A HIGH GROWTH TRAJECTORY GLOBALLY

As per the UN development index, India is set to overtake China as the most populous country by 2040. Feeding such a vast population is such a daunting task.

Also, rapid industrialization has increased, destroying arable lands. Growing population and destruction of arable lands is creating a major havoc for sustainable farming practices.

Vertical farming in India might be one of the solutions to all these worries. It is a creative way of maintaining our agricultural practices in urban spaces in a controlled environment which helps in saving the planet from the environmental crisis.

Why We Need Vertical Farming

Owing to urbanization and industrialization, the cultivable land ratio seems to be reducing. Implementing vertical farming might help in growing crops with less arable land. As the retail food chains also been increasing, to address the continuous demand and uninterrupted supply in the urban & sub urban areas, implementing vertical farming might help in growing crops with less arable land to cater the needs.

The vertical farming business model could be operated anywhere globally as the farms are indoors and do not rely on soil or weather conditions to produce goods.

According to planetrenewed.com, vertical farming might help reduce 80% of the water resources in agriculture.

The 2022 edition of the State of Food Security and Nutrition



in the World report warns that “the world is moving in the wrong direction” on the SDG targets to end hunger, food insecurity, and all forms of malnutrition. Rising food costs reflect the loopholes in traditional agriculture.

Vertical farming is protected from nature’s uncertainty and disease without

About the **AUTHOR**

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requiring harmful chemicals which enhances the sustainable way of living and prosperity of the nation.

Global Growth Of Vertical Farming

Vertical farming is not a new thing. France and some other European countries use vertical farming for growing aromatic herbs, fresh flowers, and tiny green vegetables. According to topnewswire.com, The US vertical farming market is projected reach around \$3 billion by 2024, with CAGR of more than 24% during 2018-2024.

Dubai has its largest vertical farm, growing 900 tonnes of vegetables through vertical farming, despite arid land in the Middle East not being suitable for agriculture.

Saudi Arabia's futuristic line city, NEOM, which is set to be completed by 2030, employs vertical farming, which will be integrated into the buildings for growing the crops.

Vertical farming might be helpful in reducing the supply chain logistics problem, since the farm produce can be produced very next to the supermarket retail chain problems. Australian startup

Invertigo is proud to have partnered with Woolworths, Australia's leading grocery retailer, to deliver Australia's first in-supermarket vertical farm. Incorporating the inhouse vertical farming in the supermarkets will help in reducing the supply chain and logistics problems in the urban environments.

According to insight from The Japan News, the number of vegetable vertical farms or "factories" in Japan has grown from 93 in 2011 to 390 in February 2021 due to advancements in technology and support from the local government.

In developing countries like China, India, and Brazil, vertical farming is slowly getting adopted in a phased manner to feed the massive population.

How Is Vertical Farming Done?

The core of vertical farming lies in preparing a controlled environment with the help of intelligent sensors. In vertical farming, Plants are often isolated from the outside environment.

Challenges of Vertical Farming

Even though vertical farming has a lot of advantages, there are few challenges in implementing them. A few of them are as follows.

- **High initial investment cost:** Upfront investment cost is very high for vertical farming, making vertical farming unattractive.
- **Hardships with Pollination:** Vertical farming takes place in a controlled environment. Pollination of fruits happens manually without the help of insects. This increases the indirect cost of the fertilization of fruits/ vegetables.
- **Shortage of trained professionals:** Vertical farming needs to be handled by a trained professional. Proper campaigns and seminars are required to educate the farmers about the vertical farming need to be done by the Indian horticulture Department.



Vertical farming uses intelligent sensors to monitor technical variables like temperature, carbon dioxide, humidity, nutrient concentration, oxygen, lighting, pH, pest control, irrigation, and harvesting. The controlled farming methodology uses advanced sensing and imaging technologies to measure plant growth accurately. Vertical farming with the help of coir substrates is effective in growing herbs, microgreens, leafy greens, and vegetables such as peppers, melons, and sweet corn, tomatoes.

seeds are grown in and planted with the assistance of coir substrates in the nursery rooms, equipped with LED grow lights. Its controlled environment helps to be doctored to match the seedlings' needs.

Seedlings will be shifted from the farms and planted in the vertical racks once the seedling matures.

Does Vertical Farming Achieve A Sustainable Way Of Living?

Vertical farming might be one of the solutions to achieve sustainable farming solutions. It helps create all-weather, all-round farming which helps in overcoming the vagaries of nature. This could help predict crop production, which might help eliminate hunger in a sustainable manner.

Urban farming via vertical farming will create employment opportunities, especially in urban areas where agricultural opportunities are not naturally available. Growing food in cities helps to reduce the reliance on imports and reduce the carbon footprint due to transportation.

Vertical farming with renewable energy sources could help in utilizing terraces and urban spaces for agriculture, resulting in a sustainable way of living

Growing Seedlings For Vertical Farming

Vertical farms often use plant nurseries to start seeds as well. T h e



Mr Palanisamy loves cycling and swimming

REVOPONICS

VERTICAL AEROPONICS FARMING

SUSTAINABLE, PROFITABLE, FUTURE OF FARMING



The objective of vertical farming is to enhance the productivity from the given unit of land. This is made possible by accommodating a greater number of plants by adding third dimension. Hence the production area in Vertical Farming is not defined as per acre or per sq.m., but this is defined as per cu.m. The important factor is the production per cubic meter of the growing space.

The most important challenge in vertical farming is to ensure each plant gets homogeneous treatment, in terms of light, temperature, humidity, and growing space.

Utilize vertical spaces and have higher plant population per square meter. Following are various growing techniques with their merits in terms of productivity.

Soil Based Greenhouse Cultivation: The soil based cultivation has simple crop planting on typical raised beds, and has plant population of 12-15 plants per sqm. The entire volume of Greenhouse which is approximately 20000 cubic meters is not fully utilized.

Horizontal NFT Grow System: This is advanced Nutrient Film Technique Grow System, which involves 15 to 18 plants per square meter. The growth is done in protected cultivation with climate controlled greenhouses. The Fan and Pad Cooling system is used 24 hrs to maintain climate for 15 plants per square meter, the pumps are run 24 hours.

A- Frame: This is a form of vertical farming being used for growing NFT gullies in A Frame. The Plant Population in this case increases to as high as 25 Plants per square meter in a greenhouse

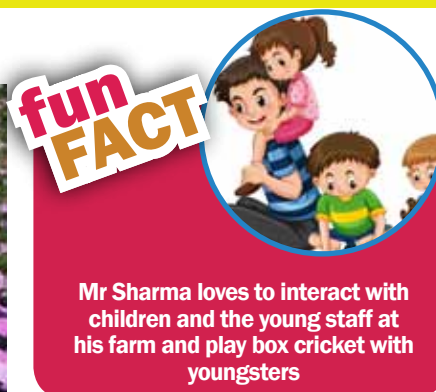
Vertical NFT Towers: This is great innovation, which has vertical growing, with NFT System. The Roots are always submerged in flowing nutrients water. The plants population can be even higher as high as 44 plants per square meter. This technique too has potential to reach higher plant population. Flora Consult offers projects on Vertical NFT Models.

Vertical Aeroponics Grow System: This system is one of the most efficient grow system, having most modern technology of Aeroponics, the plants population under greenhouses can be as high as 75 plants, same can be higher to 114



About the **AUTHOR**

Mr Praveen Sharma is the Founder of Flora Consult. He has over three decades of international experience in setting up large scale hydroponics projects



Mr Sharma loves to interact with children and the young staff at his farm and play box cricket with youngsters

plants if a 7.6 m high Polycarbonate Sheet Greenhouse is considered. Flora Consult is the first company in India to have successfully implemented many commercial projects.

Indoor Vertical Aeroponics Grow System: This is future of farming. In this system one can grow above 500 Tons of Veggies just from an acre of land. The growing is done under full control of various standard crop parameters, like Light, Temperature, Humidity, Co2 etc. Below is a typical view of a similar grow facility

Advantages Of Vertical Farming

The vertical farming shows that one can derive exponential production against the normal open field cultivation. The productivity under vertical Aeroponics Grow System increases by 5 times in a greenhouse based vertical project and 20 to 30 times in case of Indoor Vertical Aeroponics Grow System.

There is wide spread knowledge about fundamental growing techniques like NFT, Raft DWC and A-Frames.

Looking at the growing pressure on Energy Cost, Operations Cost and Productivity, there is urgent need to introduce more advance systems.

Vertical Aeroponics Grow Systems Advantages

- Low Energy Consumption
- The AGT (Aeroponics Grow Towers) offers high production per sq m of greenhouse/warehouse area
- The plant population can be increased to ten times+ as compared to prevalent horizontal hydroponics
- The cost per plant of climate control of greenhouse reduces due to high plant

Vertical Farming Types

- Vertical Farming -Open Land Vertical farming
- Vertical Farming- Naturally Ventilated Greenhouses
- Vertical Farming- Climate Controlled Greenhouses
- Vertical Farming- Totally Climate Controlled Warehouses

Vertical Farming Techniques

- Vertical Aeroponics Grow System
- Revoponics Grow System
- Horizontal Stacked NFT Grow System
- A-Frame Grow Systems

population.

- Due to vertically spaced grow towers, there is very good ventilation around the crop. Unlike in horizontal layered vertical grow system.
- The AGT offers a cooling tower effect, due to showers falling repeatedly from as high as 10 feet. This reduces the temperature of the Nutrigation water.
- Based on our experience and results obtained by various international agencies, we can say Aeroponics is most cost efficient in terms of quality, quantity and ease of growing.
- NASA has shortlisted this method of growing for their Mission on Mars
- The product grown under this system command premium in the market.

Compared to hydroponics, Aeroponics offers even more control over the root system, because you don't even need to immerse the roots in any liquid. Aeropon-

ics uses a small internal micro jet spray that sprays the roots containing nutrient rich solutions or a shower from top based on the temperature. Because the roots are exposed to more oxygen, the plant tends to grow faster. It is also easier to administer all sorts of nutrients to the plant, via the root system.

Variety of Crops: Unlike in Orthodox NFT Grow System, only leafy greens grow well. In Vertical Aeroponics, one can grow various fruity vegetables, like, Cucumbers, Cherry Tomatoes, Strawberries, Jalapeno Chilies, Okra, the list is endless.

The nutrient application via thermal sensed controllers is the key, which monitors the cycles of nutrification, based on meticulously calibrated thermal sensors. This enables perfect root conditioning, followed by lowest consumption of energy and nutrients, with highest productivity.

Aeration is critical to plant root health, without it plants respire anaerobically and generate ethylene, leading to cell death and root rot.

This systems allows us to grow various vegetables even on Warehouses, Greenhouses, Roof Tops Terraces, and uncultivable lands

The project capital costs are high as compared to the existing horizontal growing systems, but the ROI is very satisfactory.

Apartment Farming Models: The growing system is also best suited to apartment farming. The portable automated units, offer very good user friendly grow system, for various crops, specially greens and vegetables. The crops can be grown well are all types of leafy, chilies, cherry tomatoes, strawberries, okra, etc.



India Ka Pranam Har Kisan Ke Naam



The dedicated hardworking farmers of India deserve recognition. Year after year our farmers who battle great odds and adversities to make India self-sufficient deserve our salute.

For the last 4 decades, Dhanuka Agritech Limited is working with farmers and moving forward together. During this journey, Dhanuka took a pledge to bring prosperity in the lives of these farmers using advanced tools and technology. Dhanuka's trained field force is empowering farmers with new age ways of increasing farm yields and crop production.

Dhanuka is committed to bringing a positive transformation to the lives of farmers. At Dhanuka, we believe every citizen of India will salute the farmers for their dedication, determination and grit.



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