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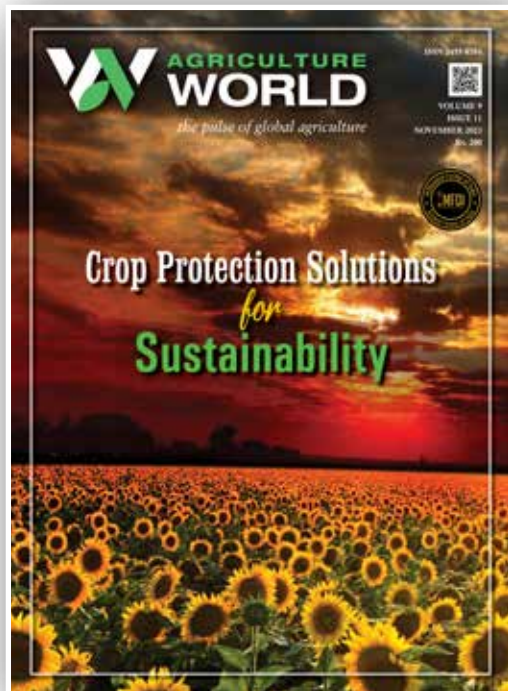


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Printed and Published by :
MC Dominic
60/9, 3rd Floor, Yusuf Sarai Market, Near Green Park Metro Station, New Delhi-110016

Printed at :
Pushpak Press Pvt. Ltd.
Shed No. 203, 204, DSIDC Complex Indl. Area, Okhla Phase-I, New Delhi-110020

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Editor in Chief: MC Dominic

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Krishi Jagran Millionaire Farmers of India (MFOI) Awards

Celebrating The Marvellous Blend Of Stupendous Achievements And Affluence In The Agriculture Sector

India has emerged as a titan in food production globally. We all are aware that we have miles to go. At the same time, we must not lose sight of the miles that we have traversed in reaching this far. Today, India has pride of place on the global high table of agriculture.

The Millionaire Farmers of India (MFOI) Awards are the most cherished endeavour of the Krishi Jagran Group. These awards are the first of their kind internationally. We are celebrating the marvellous blend of stupendous achievements and affluence in the agriculture sector.

Agriculture is an essential part of human life, and it is the foundation of our daily food supply. Celebrating affluence in agriculture is a way of acknowledging the hard work and dedication of farmers who work tirelessly to provide us with food. It is also a way of recognizing the importance of agriculture in our lives and the role it plays in our society and economy.

Another reason why it is important to celebrate the affluence and achievements of farmers is that it helps to motivate them to continue their hard work. Farming is a challenging profession, and farmers often face many obstacles in their work. By celebrating their achievements, we can help to motivate them to continue their hard work and dedication to agriculture.

Celebrating the affluence and achievements of farmers promotes innovation in agriculture. By recognizing the achievements of farmers, we can encourage them to continue experimenting with new techniques and technologies that can help to improve crop yields and reduce waste.

The road towards the MFOI Awards is both exhilarating and exciting. India is celebrating Amrit Kaal, and all stakeholders of agriculture are acknowledging that these awards are the call of the times that we are in.

Let us together celebrate the Millionaire Farmers of India. The journey has begun.

MC Dominic
Founder & Editor-in-Chief



Successful Farmer Welfare Initiatives Should Be Replicated Across The Country

New Delhi Leaders' Declaration - Testament Of GOI's Commitment To Addressing Global Challenges



Farmers are the backbone of India's economy. Agriculture is the primary source of livelihood for more than 50% of the Indian population. The sector has been a significant contributor to India's Gross Domestic Product (GDP). India's farmers have been instrumental in making our nation self-sufficient in food production and in ensuring the country's food security.

With the advent of technology, there has been a significant shift in farming practices across the country. Farmers have started using modern techniques and equipment to increase their yield and improve the quality of their produce. The government has also taken several initiatives to support farmers, such as providing subsidies, crop insurance, and minimum support prices.

It is with gratitude that we acknowledge the contribution of farmers to India's growth story. They have played a crucial role in making India one of the largest producers of agricultural products in the world. The agriculture sector has also been a significant source of employment in rural areas, providing employment opportunities to millions of people.

It is heartening to see the diverse policy initiatives of the government to support our farmers and provide them with the necessary resources to help them grow and prosper. Many states have come up with wonderful initiatives to enable farmers to prosper. These initiatives should be replicated in other states so that our farmers can benefit from them.

As we adopt scientific knowledge and technology, it is also important to retain the best from our traditional knowledge systems. There is much in our tradition which has served us well for centuries. Scientists must evaluate those traditional practices that have stood the test of time, and must advocate the continued use of these practices for the growth of Indian agriculture, and for the prosperity of our farmers.

Shiny Dominic
Managing Director

www.krishijagran.com



The New Delhi Leaders' Declaration is a testament of G20's commitment to addressing the global challenge of eliminating Hunger and Malnutrition. The emphasis on accelerating innovations, investment to escalate agricultural productivity, strengthening the value chain to reduce food loss and waste shall be crucial for sustainability. This Declaration also underscores the importance of improving soil health with a judicious use of quality agri inputs, intensifying the **Pivotal Role of Crop Protection Industry**.

Implicit in this statement is our industry's contribution to the significant achievements in agriculture food production and more significantly exports. From a mere 50 million tonnes of exports at the dawn of independence, our agricultural exports have grown exponentially, reaching a value of over USD 50 billion in 2021-22. The introduction of High Yielding Variety (HYV) seeds, high-quality fertilizer and crop protection products has fueled this momentum.

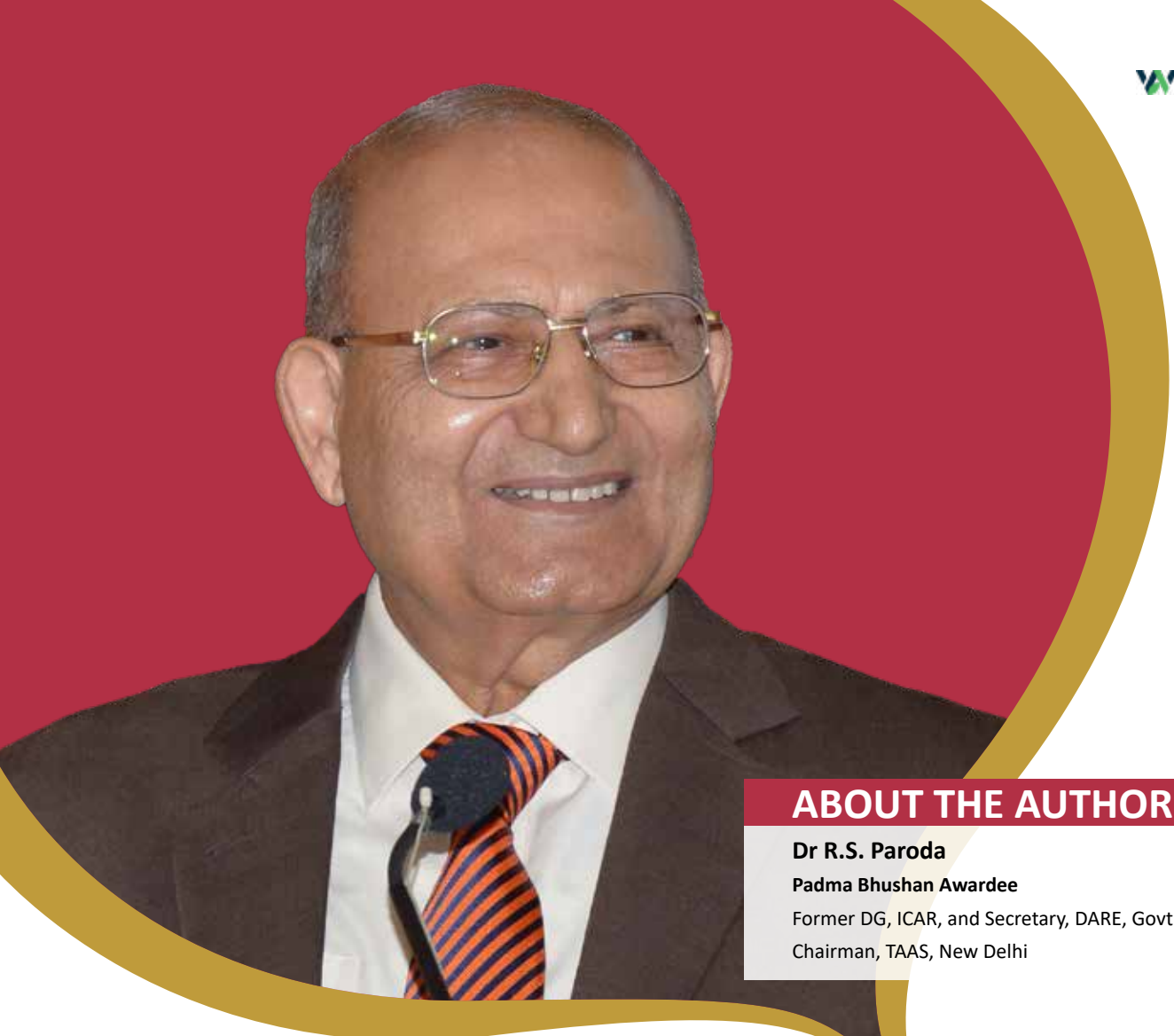
After the Second World War, technological advancements helped to develop agriculture and meet urgent food needs. The green revolution was based on the cultivation of new high-yielding varieties, the adoption of plant protection measures, and synthetic fertilizer use. Today, agriculture is called upon to recover its productivity in environmentally friendly terms and to face challenges such as climate change and international political-military events that threaten global sufficiency in agricultural products.

The objective of this **special edition** is to **evaluate the function that crop-protection technologies play** in ensuring the continuity of agricultural output. In order to meet the current environmental, economic, and political challenges, the agriculture sector at the global and local level should improve and further adopt existing technologies, consolidate the use of integrated pest-management strategies, and fully introduce innovations, combined with digital transformation, into agricultural management and production.

The 'Amrit Kaal' is poised to be a transformative phase in Indian agriculture. The consistent focus on the digitization of farming, in line with **Prime Minister Narendra Modi's vision to empower our 'Annadatas,'** will revolutionize Indian agriculture over the next 25 years, easing the toil of our farmers and creating new opportunities for rural youth and farm workers. The Centre's plan to build a digital public infrastructure for the agriculture sector is set to be a game changer.

Mamta Jain
Group Editor & CEO

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Padma Bhushan Awardee

Former DG, ICAR, and Secretary, DARE, Govt of India
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Scaling Innovations for Accelerated Agricultural Growth

“ For transforming our agri-food system to be more resilient, sustainable, productive, and profitable, we have no other option but to scale agricultural innovations aiming at linking science to society

Global population will be around 9.7 billion by 2050 needing additional 60 per cent foodgrains. An additional 167 million people have become food insecure after COVID 19 to the number of 800 million before. More than 67 countries have become food insecure. In India we add almost 11 million people per year needing >5 mt additional foodgrains over and above what we produce (330.0 mt).

Hence, complacency that we have produced enough and have become an important exporting country shall be detrimental to our food security. On the contrary, it is time to accelerate agricultural growth (> 4.0 percent) to achieve Sustainable Development Goals (SDGs) by 2030, especially to reduce poverty (still around 15 percent) and to eliminate hunger (almost 200 million people live below poverty).

To address these, we need to urgently scale the innovations that reduce cost on inputs, conserve natural resources and increase both yield and quality of agricultural produce, while ensuring higher income to the farmers, majority (80%) of whom are smallholders with less than 2 hectares of land. In the past, agricultural growth largely depended on: i) policy support, ii) good institutions and human resource, iii) infrastructure development (seeds, water, fertilizers etc.), iv) efficient transfer of technologies and v) partnership at the global level.

Second-Generation Problems Of Green Revolution

The Green Revolution in the late Sixties was an innovation-led initiative around the use of high-yielding dwarf wheat and rice varieties that responded favorably to higher inputs. As a result, despite a four and half fold increase in population, India has increased foodgrain production by six and half fold ensuring food for all. Despite these, we now face the second-generation problems of Green Revolution such as: factor productivity decline, depleting natural resources (soil, water, biodiversity), increased cost of inputs, higher incidence of diseases and pests, less farm profits and above all the adverse impact of climate change.

To address these, a paradigm shift from agricultural research for development (AR4D) to agricultural research and innovation for development (ARI4D) is urgently needed. Those nations have progressed much faster who accorded greater emphasis to scaling new innovations aiming at genetic resource management, natural resource conservation and value chain.

Regenerative Agriculture

For long term sustainability, we need to improve our soil health, mainly in the green revolution region of north-west where soil organic matter (SOM) has depleted below 0.5 percent. whereas the healthy soils do contain >1.5 to 2.0 percent soil organic matter. In an unsustainable situation like this, greater focus on improving soil health using practices around regenerative agriculture (RA) is urgently needed.

UN Food Systems Summit in 2021 and recently held G 20 meeting in New Delhi also called for reversing the on-going degeneration process in agriculture by adopting innovations that

are sustainable and aim at 'One Health'. Also, the important role of local food systems (like pseudo-cereals and millets) has been recognized to diversify our food baskets for future food security.

We all know that the health of plants, animals and human beings mainly depends on soil health. Any deficiency of nutrients and micronutrients in the soil results in ailments in plants, animals and humans. It is estimated that almost 1.0 billion ha of land is degraded globally, of which India's share is about 10 percent.

Moreover, the efforts to promote soil health also demand effective and safe crop protection measures. Hence, soil and crop protection solutions that deliver agronomic and environmental benefits would require new innovations that can produce from less for more. Accordingly, soil and plant health should now be at the center stage of the development agenda.

Scaling Of Agricultural Innovations

To improve soil health, an aggressive approach to promote no till or conservation agriculture (CA) for sustainable intensification, being adopted in more than 200 million hectares in drylands of Argentina, Australia, Brazil, Canada, USA, Turkey, Central Asia etc. offers good opportunities that we have so far missed. CA can help to make our grey areas (drylands) green.

We also need to promote micro-irrigation to improve water use efficiency, have greater use of biofertilizers and use N,P K and micronutrients (Zn, Fe, Sulphur, Mn etc.) only on soil test basis. Also, we need to create mechanisms of giving incentives in place of subsidies for the adoption of good agronomic practices (GAP) and the ecosystem services by farmers.

Scaling of innovations such as: hybrid technology, genetically modified (GM) crops, conservation agriculture for sustainable intensification (CASI), micro-irrigation, fertigation, integrated nutrient management (INM), integrated pest management (IPM), protected cultivation, vertical farming, besides the use of genome editing, nano-technology, artificial intelligence, drones etc., offer new opportunities to achieve resilience and sustainability in agriculture. For this, enabling policies, public-private partnership, innovative extension systems that are private involving youth (including women), and harnessing the potential of both secondary and specialty agriculture would be desirable.

The scaling of innovations demands greater investment, incentives and rewards, including the provision of IPR. Besides, there is an urgent need to have innovative institutional and policy reforms as well as substantial increase in the investment on ARI4D at the national level (unfortunately the budget of ICAR has remained static around Rs 8500 crores since last one decade).

In addition, the expected progress can be much faster through inter-ministerial and inter-institutional coordination and monitoring of mission-mode programs to achieve defined targets in a time bound manner. To conclude, for transforming our agri-food system to be more resilient, sustainable, productive and profitable, we have no other option but to scale agricultural innovations aiming at linking science to society with the human face.

From The Executive Editor's Desk

Farmers turn to tech as Farmers turn to tech as substitute for bee pollination

Israel's tech firm BloomX has found a way to mechanically pollinate crops in a similar way to bees. Says Founder Mr Thai Sade, "We are not replacing bees... but rather, offering more efficient pollinating methods to farmers, and reducing the dependence on commercial honeybees."

Three out of every four crops grown around the world to produce fruits or seeds for human consumption are reliant, at least in part, on pollinators. And it is bees, be they farmed honeybees, or the more than 20,000 different wild bee species, such as bumble bees, that do the heavy lifting.

In the US, bees of all sorts are said to account for 75% of the pollination of the fruits, nuts and vegetables grown in the country. It is a similar percentage in Europe, with other insects, such as wasps and butterflies, making up the remaining quarter.

Unfortunately for farmers, bee populations are under pressure, due to factors such as climate change, habitat loss and the use of pesticides. The European honeybee is also being badly affected by a parasitic mite called varroa destructor.

BloomX's technology is currently aimed at two crops - blueberries and avocados - and allows them to be pollinated even if local bee numbers are very low.

The firm's main products is called "Robee", which at first glance looks like a large push-along lawnmower. It has two mechanical arms that stick out either side.

These vibrate, and when brushed over blueberry plants, they cause them to release their pollen. The level of vibration is said to have been designed to imitate that of bumble bees - the most effective pollinators of blueberries - which use their wings to agitate the flowers.

BloomX's other product is "Crossbee", a handheld tool for collecting and spreading sticky pollen grains between avocado trees. To date the equipment is being used in South America, South Africa, Spain, the US and Israel, and BloomX says it can increase fruit yields by 30%.

Both products are controlled by an AI-based software system linked to a mobile phone app, and each is fitted with a GPS tool so that farm workers know which areas of a field have been treated.

Sensors can also be put in place so that the pollination takes place on the optimum days.

(bbc.com)

The place where lime supply is escorted by the Police



The price of lime rose more than 58% last year in Mexico, according to the Agricultural Market Consulting Group (GCMA). In Mexico City, the price doubled to almost \$4.5 per kilo (€4,26) in August.

Lime reigns Mexico's gastronomy. Mexico is also the world's largest producer of the fruit. The region's plagued by mafia and cartels. Due to this situation, the police started escorting lime shipments that go to the rest of the country.

(euronews.com)

World Cooperative Economic Forum formed to give voice to over 3 mn cooperatives across globe



Leading cooperative sector experts have come together to form the World Cooperative Economic Forum (WCopEF) to give voice to over three million cooperatives spread across the globe, employing 10 per cent of the total workforce worldwide. The WCopEF will endeavour to promote cooperative thinking and cooperative movement, in addition to raising issues and concerns of the sector with the governments and other stakeholders around the globe.

"WCopEF journey is starting at the juncture of ideation of an equitable economy, tempered by pragmatism. We are transitioning to a new engagement with the international cooperative economic order," Mr Dileep Bhai Shanghai, one of the founder members of the Forum, said in a statement.

Mr Shanghai, Chairman of the fertilizer major IFFCO and President of National Cooperative Union of India (NCUI), had also earlier served as a member of parliament and a Minister in the Government of Gujarat.

(Economic Times)

Agriculture's share goes higher in global economy



The structural change in the global economy has reversed since the 2006 financial crisis with the agriculture sector witnessing a growth while manufacturing and non-agricultural sectors have slowed down, Ramesh Chand, member, NITI Aayog and chairman-BoG of the Institute of Economic Growth said.

(Economic Times)

Can tech stop India wasting so much of its harvest?



Getting harvested produce to market in good condition is a problem that farmers all over India struggle with.

According to government figures, in 2022 India lost between 6% and 15% of its fruit, between 5% and 12% of its vegetables, and between 4% and 6% of its cereals.

“Farmers throw away large amounts of fruits and vegetables because of a lack of infrastructure, limited processing capacity... natural disasters like cyclones, and floods that disrupt transportation routes and damage facilities,” says Varun Raheja, founder of Raheja Solar Food Processing.

Mr Raheja points out that most Indian farms are small, without the resources to invest in storage or refrigeration.

(bbc.com)

GOI revises wheat production estimate for 2022-23



The Indian government has revised downward its wheat production estimate for the 2022-23 crop year to 110.55 million tonnes, down by 2.19 million tonnes from the previous estimate. Unseasonal rains during harvesting led to some loss, resulting in the downward revision. However, rice production is estimated to reach a record 135.75 million tonnes, coarse cereals production is higher at 57.31 million tonnes, and oilseeds production has reached a record 41.35 million tonnes. Cash crops like sugarcane and cotton also saw increase in production.

(Economic Times)

Heat waves harm bird reproduction on agricultural lands



The link of agriculture and birds has been known and acknowledged for centuries. With global warming, bird populations are declining.

Researchers analyzed data from more than 150,000 bird nests across the U.S. They found that bird populations are in rapid decline across North America. While climate change is just one of the many factors influencing North American birds, its effects are significant and can interact with other stressors, such as habitat loss.

A team of University of California, Davis, researchers found that the effects of extreme temperatures on avian reproduction can vary depending on the type of environment that birds call home.

The findings, published in the journal Science, shed light on how climate change can combine with habitat loss to affect bird reproduction across the United States.

(sciencedaily.com)

More farmers to get opium production licence in 2023-24



Nearly 112,000 farmers are expected to receive licences for poppy cultivation in the 2023-24 crop year as part of the new licensing policy, the finance ministry said on Thursday.

Poppy cultivation is strictly regulated and licences are granted by the government every year for producing the key raw material for pharmaceuticals.

Nearly 112,000 farmers are expected to receive licences for poppy cultivation in the 2023-24 crop year as part of the new licensing policy, the Finance Ministry has said.

Poppy is grown in Madhya Pradesh, Rajasthan and Uttar Pradesh. The ministry said that 27,000 more farmers are expected to get licenses in the 2023-24 crop year, compared to the year before in these three states.

(livemint.com)

Horticulture output rises to 351.92 million tonne in 2022-23: Government data



India's horticulture production is estimated to have risen annually by 1.37 per cent to 351.92 million tonne in 2022-23 due to better productivity, according to government data. Ministry of Agriculture and Farmers Welfare on Wednesday released the second advance estimates of the area and production of various horticultural crops for the year 2022-23.

According to this estimate, total horticulture production in the country is expected to be a record 351.92 million tonne in 2022-23, with an increase of about 4.74 million tonne (1.37 per cent) as compared to the previous year, an official statement said.

(Economic Times)

Can 800 climate-resilient varieties available help agri sector counter threat?



The Indian Council of Agricultural Research has developed more than 800 climate-resilient varieties to counter the change in climate patterns. But mere availability is not enough as stakeholders need to come together to build more awareness and ensure easy availability.

(livemint.com)

Crop Protection

Challenges And Potential

In view of the New Delhi Leaders' Declaration during recent G20's commitment to global challenge of eliminating hunger and malnutrition the new innovations and investment to escalate agricultural productivity to strengthen the value chain to reduce food loss and waste shall be crucial for sustainability.

The world's population is expected to surge from 6.1 billion in 2000 to 9.2 billion in 2050. A significant increase in predicted human population requires increasing crop yields to meet the requirements of the rising global demand for food. Regardless of major advances in agriculture science over the past 50 years, a considerable number of the world's population suffer from hunger and undernourishment. Lack of balance between crop production and demographic food demand is due to existence of hunger and malnutrition. With this population rise, it is expected that a corresponding food security problem will occur with the probability of losing agricultural land to industrialization and urbanization.

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Increased innovation in basic and applied research can help farmers start closing the production gap by providing them with cutting-edge crop protection techniques

Agriculture practices have incorporated greater part of world's available fertile farmland, which may limit further expansion to low/non fertile land. In addition to existing farmland problems, constrained farmland availability and identification of new plant diseases compound the challenges growers and scientists face globally to meet the nutritional requirements of the growing population. Zero hunger is a complicated task for scientific community considering climate conditions, rapid population growth, and with limited arable land. To match food demand, it is necessary to apply new strategic approaches that can increase crop productivity and yield.

The intensive use of agrochemicals (fertilizers and pesticides) has led to severe consequences, including the deterioration of soil and the environment. Increasing soil pollution and adverse effects of agrochemicals on human and animals put pressure on agricultural scientists to find alternate eco-friendly approaches. In this context, application of agriculturally important microorganisms (Bio-agri inputs/PGPR/biostimulants/microbiome) to colonize crop roots and enhance plant growth by direct and indirect mechanisms. Modification of root system architecture by Bio-agri inputs implicates the production of phytohormones and other signals that lead, mostly, to enhanced lateral root branching and development of root hairs. The Bio-agri inputs also modify root functioning, improve plant nutrition, and influence the physiology of the whole plant.

Bio-Agri Inputs

The novel knowledge and gaps on microbiome modes of action and signals and highlight recent progress on

the links between plant morphological and physiological effects induced by them. They will show the importance of considering the size, diversity, and gene expression patterns of Bio-agri inputs assemblages in the rhizosphere to better understand their impact on plant growth and functioning.

Integrating mechanistic and ecological knowledge on Bio Agri inputs populations in soil will be a prerequisite to develop novel management strategies for sustainable agriculture. During the past couple of decades, Bio-agri inputs have emerged as a potent alternative to chemical fertilizer in an eco-friendly manner.

Globally, countries are impacted by salinity, and crop productivity is severely affected. Anthropogenic activities leading to the degradation of agricultural land have also accelerated the rate of salinization in arid and semi-arid regions.

Effective Use Of Crop Protection Products

Effective use of crop protection products is one of the contributing factors to fill the gap between theoretical and actual crop yields. Shortage in the discovery of new active ingredients and the steady build-up of chemical pesticide, fungicide, insecticide and herbicide resistance, increased pressure is now being brought to bear on crop protection products adopting an increasingly hazard, risk-based approach of their use.

There is a widespread concern among the agricultural communities to withdraw from the use of chemicals that play key roles in crop protection. As these chemicals are subject to the new requirements during this decade, there needs to be joined-up thinking across the public and private sectors of the agricultural community to determine how crops might best be protected within the regulatory framework. New innovative approaches for crop





New innovative approaches for crop protection including the exploitation of novel cultural practices, natural plant defence mechanisms and bio inputs is the need of hour in the context of integrated pest management

Utilisation of ongoing supply of new chemicals to tackle crop protection issues traditionally by the farmers followed by the elimination of several pesticides and prevented to a standstill in the introduction of new ones by a combination of new laws and higher expenses for complying with those laws. The application of sophisticated breeding methods, such as using agricultural biotechnology, important crops will gain disease and insect resistance.

Research priority to understand how interactions with beneficial microbes, their modes of action and active metabolites; increase the efficacy of conventional crop protection, and/or help delay/prevent the development of resistance, when used as part of an IPM programme. Policies and resistance issues are the biggest threats to sustainable crop production. Better informed policy, based on scientific evidence and risk rather than hazard, would improve the maintenance and development of safe and effective crop protection methods.

Centralised Research Collaborative Centres

At present, there are few alternative solutions to minimise the impact of resistance apart from crop rotation, the use of fallow and to some extent varietal choice/delayed drilling. In the future, there are exciting technologies that need much more investment to bring about applied developments.

Development of a centrally collated, independent monitoring system for resistance to crop protection and establishment of centralised research collaborative centres is a need of the hour.

The changes in the economy and society that acknowledge the numerous outputs needed from land managers, farmers, and food producers; and a refocusing of research to address a more comprehensive set of objectives than just yield enhancement. The necessity of creating several “good practise” case studies for efficient knowledge transfer and evaluating common features, as well as the significance of encouraging the development, adoption, and use of sustainable, resilient, and profitable agricultural practises, to be highlighted. This will allow for the commissioning of future research with requirements that have the highest likelihood of being conducted successfully. It is common to overlook how difficult it is to do information transfer that affects the industry. Hence forth Farmers will be educated to become innovative individuals.

Increased innovation in basic and applied research can help farmers start closing the production gap by providing them with cutting-edge crop protection techniques. You influence your environment, and your environment influences you. It is an interdependent cycle. Perhaps you motivate your colleagues to adopt new methodologies, or conversely, you learn from them about new research integrated approaches.

protection including the exploitation of novel cultural practices, natural plant defence mechanisms and bio inputs is the need of hour in the context of integrated pest management.

Driving Innovation In Crop Protection

Decline in the discovery of new actives using conventional methods, ‘omics’ technologies linked to systems approaches are now being increasingly used to identify new potential ‘druggable’ in the field of life sciences. The development of non-targeted analytical methods for everything from metabolites to genomes has revolutionized biological research and been a major driver for the adoption of systems-based approaches to biological research.

The potential for ‘omics’-based technologies to drive innovation in crop protection is powerful when applied to understanding plant pathogen interactions and genetic variation among crop genotypes and populations of target organisms (weeds, invertebrates, and pathogens).

To optimize the integrated use of agrochemicals with crop varieties of differing genetic background (e.g., matching fungicide mode of action with host resistance) using molecular approaches. Identification of new crop protection targets for intervention in pathogens, pests and weeds which may provide the basis for screening chemical and biological agents.

Understanding how beneficial microbes and resistance elicitors enhance crop protection and thereby improve their efficacy. Knowledge and exploitation of ‘natural’ plant protection strategies including pest and disease resistance, as well as embracing less studied interactions such as allelopathy along with many resistance mechanisms that reduce ability to deploy existing toxophore and its interaction.

Development of synergistic mixes and formulations of pesticides; and identifying novel bioactive natural products directly through bio prospecting are some of the novel ideas paved for crop protection using ‘omics’.

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For India to sustain its food security and compete globally, it must leverage advanced technologies, ensure use high-quality seeds, fertilizers and agrochemicals



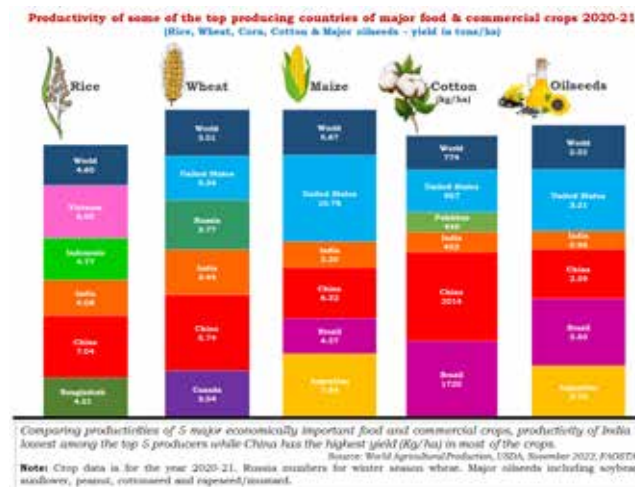
Agriculture in India is at a crossroads, with both enormous challenges and incredible opportunities. Despite being one of the world's largest producers of food and horticultural crops, India has low production per unit area. The problem, coupled with shrinking arable land, has made it critical for India to boost output through increased productivity. A comparison with agriculturally advanced nations such as China reveals a stark disparity. China has significantly higher productivity, which can be attributed to its adept use of advanced agricultural technologies including fertilisers and agrochemicals.

Unlocking the potential of India's agriculture- key to unleash a thriving economy.

India is one of the world's largest producers of food and horticulture crops by volume, but it has one of the lowest per unit area production rates among the world's major agriculturally rich nations. Despite being the world's second largest producer of agricultural commodities (FAO, 2023), our per hectare yield is among the lowest when compared to agriculturally developed countries.

As arable land shrinks, the only option for India to achieve agricultural growth is to increase productivity (Farm Economist, NITI Aayog - Mint). When comparing the productivities of five major economically important food and commercial crops (Rice, Wheat, Maize, Oilseeds, and Cotton) of the world's highest producing countries,

India has the lowest yield (Kg/ha) in most of the major food and commercial crops, while China has the highest yield (Kg/ha) in most of the major food and commercial crops (FAOSTAT, 2022).



Factors Affecting Crop Production And Productivity

Despite 30% more arable land and 67% more rainfall, India's agricultural GDP is merely half of China. Nonetheless, there is a considerable disparity between the two countries in the usage of fertilizers and pesticides, two crucial components for optimum production and protection. India uses only 209.4 kg/ha fertilizer compared to 383.3 kg/ha by China. Besides, while India uses only 330 pesticides, including bio-pesticides (CIBRC, 2023), more than 1060 pesticides are registered for use in agriculture in China. In addition, the dosage of pesticides used in India is one of the lowest in the world (360g/ha) compared to China (13.07kg/ha). The significant disparity in usage of two essential inputs underline the importance of optimizing fertilizer and agrochemical usage to enhance crop production.

The Challenges On Way To Increased Crop Productivity

One of the major factors limiting crop production and productivity globally is the losses caused by pests, and pathogens. FAO estimates that annually up to 40% of global crop production is lost due to biotic stresses caused by pests and diseases. Pests cost the global economy by over \$220 billion, and invasive insects at least \$70 billion. In India, the crop losses due to pest, diseases and weeds are approximately assessed to be ranging between 10-30% of crop production (Sanjeev Kumar, 2014).

On this analogy, computing 20% losses in crop yields, at present rate of production [Food Grain - 323.55 Mt 2022-2023 & Horticultural produce - 342.33 Mt 2021-2022], more than 64 million tons of food grains and 68 million tons of horticultural produce are lost due to pests and diseases at pre- and post-harvest stages of crops. This whopping annual crop losses in monetary terms have been pegged at INR 2.25-2.50 lakh crores, worth each of food grains and horticultural produce. The avoidable loss if prevented, can fulfil the food requirement for more than 25 crore additional population, the highest that India is expected to attain by 2050, even without any further rise in productivity.

Genetic engineering, genome editing, transgenic crops, the use of creative solutions like biostimulants, clever formulations for plant protection, both chemical and biological, crop intensification, encouraging improved nutrient and water use efficiency and developing climate resilient crops, etc. are some of the options available to increase the productivity of any crop.

Nevertheless, none of the afore-mentioned modern techniques can match the enormous productivity boost that results from protecting against the avoidable crop losses. As the proverb goes, "Crop loss protected is crop yield gained," there is a great opportunity to boost crop productivity by promoting innovative agrochemical solutions to prevent crop losses caused by pests, including insects, diseases, weeds, etc.

Challenges In Protecting Crops From Biotic Stresses

India presently uses only 330 pesticides, including bio-pesticides (CIBRC, 2023), most of which are generic and are in use for 3-4 decades. In contrast, there are more than 1000 pesticides registered for use in agriculture in some of the other developed nations. These include the newly discovered and novel technologies covered under the IPR. The introduction of new technologies in India is impeded due to the lack provision of data exclusivity under Indian law. Data protection and fast-tracking the registration of novel agrochemicals in India simultaneously, as they are approved for use in the nation of discovery can serve to provide solution to this problem.

Data Protection & Harmonization Of Indian Regulation- A Need For Introduction Of Advanced Technology

How to save farmers' crops without new agrochemicals is a concern. Lack of regulatory data protection for agrochemicals and their formulations in India may be one of several factors why the new technologies are not able to be introduced in the country. Development of new pesticide costs more than ₹2,000 Crore equivalent of USD by MNCs which a developing country cannot afford to incur. However, the 1st time introduction of any new molecule needs additional costs of ₹30-50 Cr for India-centric data generation, popularisation, and registration. Thus, the data

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With acceleration in growth of agriculture and increased global awareness about competitiveness, India can realize the PM's vision to generate USD 5 trillion economy by 2027, with contribution of at least USD 1 trillion from agriculture sector

protection is essential to attract new technologies in various sectors. Since India is a signatory to TRIPS, it must comply with IPR requirements, including data protection under article 39.3. Various countries including USA, EU, Canada, Japan, China etc., have provision to protect data for 6-10 years for the 1st time introduction of new molecules in their country. Despite recommendations from several committees from 2007 to 2020 for the adoption of a data protection provision, they have yet to be adopted. As a result, data protection is critical in attracting MNCs to invest in India. However, the government must ensure that local regulatory rules are in tune with global regulatory norms. This, in turn, will aid in the introduction of new and advanced technology into the country before the pest/pathogen strains have undergone enough selection pressure against the pesticide to acquire resistance.

Pesticides resistance and resurgence management:

Resistance to pesticides results in failure of management of pests and diseases causing economic loss of over US\$2 billion. The evolution of resistance in pathogens and pests against pesticides is a rule rather than an exception unless adequate measures are taken to prolong the life of pesticides. Pests and pathogens often develop antibiotic and pesticide resistance. In the last 80 years, more than 500 insect species developed resistance to 300 insecticide compounds, 1700 bacterial species to 200 antibiotics, 389 fungal species/strains to 64 target sites in Fungi, and 250 weed species to eight herbicide target sites worldwide.

The pesticide resistance in the USA cost \$1.5 billion, mostly due to increased pesticide use to control pests resistant to previously effective chemicals (Pimentel, 2005; Corkley et al., 2021). Pesticide resistance is so common that we are losing effective pest control, faster than new pesticides are being developed (Gaines et al., 2021). Due to poor IPM, repeated use of same-mode pesticides, sub-lethal or overuse of same-group pesticides, single site-specific pesticides against high-risk pests and pathogens, etc., resistance can develop. All these practices serve to mount selection pressure on specific pesticides or group of pesticides with same mode of action thereby resulting in buildup of resistance.

The CIB should approve printing of mode of action (MOA) groups numbers on the label to prevent farmers from using the same group-numbered pesticide consecutively marketed by different manufacturers by different trade names. Farmers often recognised pesticides with different trade name unmindful of whether they are chemically same or have the same mode of action.

Off-label Use Of Pesticides Ignore Biosafety & Impede International Trade - Need Resolution

Present shifts from traditionally grown, less remunerative crops to more nutritionally rich ones have occurred due to favourable government policies. Besides, the availability of varied agro climates has also led to crop diversification and the consequent evolution of regional niches. In general minor or speciality crops that constitute a group of high value low volume crops, like spices, vegetables, exotic & under-utilised fruits, flowers, medicinal and aromatic plants.

These minor crops are cultivated in relatively smaller geographies. Several of these minor crops on which a particular plant protection chemical finds its use, the overall market potential does not justify the expenses for bio-efficacy and residue data generation and fixation of MRLs. This results in off-label use of pesticides by farmers for their protection. Many of the high value low-volume crops serve as sole source of livelihood for farmers. For example, India exports >80% of spices worth more than USD 4,000 million in the global market.

The spices suffer badly from diseases and thus often experience heavy loads of unregistered pesticides on them, rendering them liable to rejection by the importing country. Out of 330 pesticides registered in India, labelled use is limited to less than 100 out of a total of 554 crops (<15%), mostly high-volume, low-value crops that occupy large acreages, with a high market potential for pesticides. The remaining 454 crops that include the minor and speciality commodities, due to lack of label claims, leave farmers with fewer pest management options experience off-label use of pesticides. The residue laden commodities bear the risk of rejection in the international trade in the absence of MRLs.

Off-label use of chemicals is a global phenomenon and concern too. The development of crop-specific labelling of any pesticide costs a whopping INR 4.0 - 4.5 million, coupled with the substantial time taken to register them. Despite existence of scientific rationale for biosafety and mandatory requirements of crop-specific registration of individual pesticides where they are found effective and intended for use, it is impractical and unaffordable for any industry to bear with the whopping cost of registration of a chemical across all the crops (Approx INR 4.5 million/ pesticide X approx. 554 crops). This necessitates a need to legitimise the use of pesticide on minor crops yet uncompromising with the biosafety to human, animal, and environment.

The Codex committee on pesticides residues have grouped all crop in 29 groups with further subgroups under each group. Representative crop(s) specific to each group and subgroup, were identified based on several criteria on the principle that the representative crops are the ones that are expected to accumulate and retain highest residues, among all the members in a group. The MRL (and label expansion) of a pesticide on a member crop within a crop group can be extrapolated across all members in the group, when the residue of pesticides tested on the representative crop, following same GAP, remains within 1.25 X of the MRL.

Developed countries like USA, Canada, EU are developing label expansion of pesticides based on the crop groups and development of group MRL. Towing the same rationale, India grouped its crop in sync with codex crop groups and developed guidelines for bioefficacy and residue data as per international regulations with exemption from redundant data generation (408 RC meeting on 15-06-202). Despite approval of the guidelines for crop group-based label-expansion and group labelling, the same couldn't be implemented by the CIBRC, for lack of faith in the Indian guidelines.

The stalemate in label-expansion to legitimise use of pesticides on minor crops should be solved immediately and compassionately in national interest by removing the constraints on way to minor use of pesticides. Wherever FSSAI MRLs are more stringent, there is wisdom in adopting Codex MRLs at higher level to minimise trade barriers.

Abrupt Imposition Of Regulatory Decisions Without Alternatives

The unilateral pesticide regulations, such as the ban on pesticides without proper alternatives (gazette notification S.O. 1512(E) dated 14 May 2020), the mandatory use of pesticides through PCOs (S.O. 2268(E) dated 6 July 2020), enabling nationwide use of the same strain of biopesticide (DPPQS no. 24-01/2019-CIR.1 dated 28 April 2020), at the cost of ignoring the agro-eco specific, diverse microflora of the country, will prove counter-productive, in the long run.

Lack of Awareness regarding New Technologies- a need for effective dissemination among farmers:

The benefits of new technologies like recently notified biostimulants, novel chemicals, smart formulations, availability of climate resilient varieties, crop advisories, IoT, AI, remote sensing, and precision agriculture, etc remain confined to a fraction of Indian farmers, while most remain unaware of them. Reaching 14 crore farmers in 6.5 lakh villages in the country is a Herculean task for government extension machinery. MOSPI, 2021, found that less than 3% of rural households received technical advice from government extension agencies (ATMA-1.5%, Kisan Call Centers-0.7%, ICAR-KVKs-0.5%, SAUs-0.2%).

Most households got technical advice from progressive farmers (20.3%) and input dealers (19.1%), electronic media (8.2%), etc. Advanced technology like Smart Phone Apps served up to only 0.8% as a source of technical advice as reported by the report. It is enigmatic that farmers need aggressive awareness regarding the smartphones, in the age of digital India and the ICT revolution. The policy makers in the public sector should strengthen public-private-partnership to leverage the resources and proficiencies with private sector stake holders. This would help establish a robust and functional linkage between the technology provider and the end user, i.e., farmer for dissemination of the advanced technologies. Collaboration of private sector with public sector agricultural enterprises, like State Agricultural departments, SAUs, ICAR, KVKs, IARI research stations, etc can facilitate dissemination of advanced technologies, more effectively and aggressively.

Ensuring Sustainable Food Security

For India to sustain its food security and compete globally, it must leverage advanced technologies, ensure use high-quality seeds, fertilizers, and agrochemicals. Marker assisted breeding, adoption of genetically modified (GM) and genome edited crops can hasten the process of development of climate resilient crops with enhanced crop yields. Transforming India's agriculture into a global food hub requires a collaborative effort between the government, industry, and farmers. With the right policies and technologies, India can not only meet the food requirements of its growing population but also become a global food hub.

The transformation of challenges into opportunity requires agriculture development with proactive will and support of the government. Enabling farmer friendly regulatory policies for introduction of advanced and novel technologies proactively, their implementation in right spirit, facilitation to adopt precision tools, incentivization of innovative technologies, and so on. With the resultant acceleration in growth of agriculture and increased global awareness about competitiveness, India can realize the vision of Hon'ble Prime Minister to generate USD 5 trillion economy by 2027, with contribution of at least USD 1 trillion from agriculture sector.

Prathista's 5-G Nanotechnology Agri-Inputs Revolutionizing Agriculture

Nanoparticles in today's times are significantly useful as these are used in different fields of agriculture, medical and pharmaceutical sciences. Thus the studies are going on to prepare nano-particles or their formulations for their versatility in different practices and applications.

The technology for preparation of such nanoparticles is utilized as chemical or biological. The chemical technology is somewhat toxic, expensive and is not environment friendly. The biological synthesis on other hand is safe, least expensive and eco-friendly. Different nanoparticles are in use commercially utilizing inorganic metallic ions.

Nanoparticles are the particles that have one or more sizes on the order of 100 nm or less—has attracted much attention because of their unusual and exciting properties and when necessary cations are more affordable than bulk goods. There are a large number of physical, chemical, biological, and hybrid methods to synthesize different types of nanoparticles.

Development Of Reliable, Non-Toxic And Environmentally Friendly Methods

Although physical and chemical methods are more popular in the synthesis of nanoparticles, the use of toxic chemicals significantly limits their bio environmental applications, especially in clinical areas. Because development of reliable, non-toxic and environmentally friendly methods is extremely important for nanoparticle synthesis to expand its biomedical applications.

One of the options to achieve this goal is to use microorganisms for synthesizing nanoparticles. Nanoparticles produced by a biogenic enzymatic process are in many ways better than manufactured particles by chemical methods.

Despite the fact that the latter methods are capable of producing large quantities of nanoparticles of a defined size and shape in a relatively short time, they are complex, outdated, expensive and inefficient and produce hazardous toxic waste, which is harmful, not only to the environment, but also human health.

With an enzymatic agent process, the use of expensive chemicals is eliminated and a more acceptable "green" route is less energy intensive as a chemical method and is also environmentally friendly. The "biogenic" approach is further supported by the fact that most bacteria live in environmental conditions with changing temperature, pH and pressure. The catalytic reactivity generated during these processes is higher, greater specific surface area and

better contact between the enzyme and the relevant metal salt bacterial carrier matrix.

Prathista's Milestones

Prathista Industries Limited, an Indian MNC, is continuously making remarkable efforts in the preparation and production of nano-particles utilizing inorganic metallic ions and natural molecules/polymers/ plant extracts/microbial metabolites (extracts); biological synthesis performed by plant growth promoting rhizospheric microbial strains (PGPRs) which can be utilized as solubilizers.

The revolutionary technology of Prathista has created milestones, after adopting the technology from Indian Council of Agricultural Research (ICAR), GOI. Its continuously research driven R&D team have led Prathista to flagship 5 G technology based Nanoproducts which are exemplary, effective and are a unique replacement of all the conventional chemical based fertilizers in the market.

The synthesized nanoparticles have effective results in phyto-pathogenic activities in terms of fungicidal activities, insecticidal -pesticidal activities and plant growth regulatory activities. The way of synthesis of such fused nanoparticles is found to be efficient because of ease of processing, least expensive, solubility, biocompatibility, less toxicity and also for stabilization. The studies determined significant fungicidal action of the above said nanoparticles against fungal pathogens invading the crops.

These nanoparticles were found to be efficient against insects and pests attacking the crops. The results also revealed prominent growth regulatory activities of these nanoparticles on a wide variety of crops. There has been tremendous development in the field of nanoparticles produced by microorganisms and their use over the past decade.

With commercialization, the company is continuously working on the technology to optimize the sizes of nanoparticles produced to have significant potential for a wide variety of population of crops with minimum dosages. It is known that the synthesis and the processing of nanoparticles by microorganisms is a rather slow process (a few hours and even a few days) compared to physical and chemical approaches. Shortening the synthesis time makes this biosynthetic pathway much more attractive. A particle size and monodispersity are two important issues in the evaluation of nanoparticle synthesis.

“The revolutionary technology of Prathista has created milestones, after adopting the technology from Indian Council of Agricultural Research (ICAR), GOI. Its nanoproducts are exemplary, effective and are a unique replacement of all the conventional chemical based fertilizers in the market

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Dr KVSS Sairam is instrumental in conceptualizing Indigenously developed technologies and establishing state of the art fermentation facilities to manufacture various biotechnology products which find applications in several sectors. The Prathista Group is producing multi-segment Innovative formulations with eco-friendly technology and is serving the pharma, food, veterinary, poultry and other agriculture sectors

Crop Protection Industry

Key Partner for Sustainable Agriculture

The recent G20 meeting in New Delhi, presided over by India's Prime Minister Shri Narendra Modi Ji, showcased India's rising global influence and commitment to addressing critical global challenges, especially those related to food and nutrition security. India, under the leadership of Prime Minister Modi, has been on a transformative journey, striving to become a world-leading economy while recognizing the importance of leveraging technology and digitalization, particularly in the agricultural sector.

Why Crop Protection Matters in Agriculture

Plant protection is paramount to sustain food and nutritional security of people of India besides enhancing their yields and ensuring remunerative income for farmers. Panel on the Science and Technology to European Parliamentary Research services claims that without crop protection 50% of the crops will be lost in Europe.

The said maxim "crop loss protected is crop yield gained" holds true for increasing productivity. Protection of avoidable crop losses from pests and diseases is expected to increase crop yields many folds compared to a quantum jump in the increment that can be expected from advanced technologies including genetic improvement through conventional and non-conventional approaches.

Several publications from ICAR-IARI cited 8% - 90% of crops are lost depending upon the insect infestation and climatic conditions. Hon'ble Minister of Agriculture, while replying to the questions in the parliament, endorsed 10-30% crop loss due to pests including diseases (Parliament Question 2928 dated on 13.03.2018). The FAO (FAO STAT, 2022) and Commonwealth Agricultural Bureaux International (CABI, 2019), however, report a global loss of 10-40%.

In India, the crop losses due to pest, diseases and weeds are approximately assessed to be ranging between 10-30% of crop production (Sanjeev Kumar, 2014). On an average with 20% losses at 'present rate of production, more than 64 million tons of food grains and 68 million tons of horticultural produce are lost due to pests and diseases at pre- and post-harvest stages of crops. The protection of the food grains & horticultural crops to this extent can feed an additional population of more than 25 crore people in India, the highest that is expected to reach by 2050.

Indian Agriculture: A Paradigm for Resilience and Prosperity

During the COVID-19 pandemic, India's agriculture sector demonstrated remarkable resilience when other sectors were facing downturns. This resilience and growth serve as a testament to the significance of agriculture in India's economy, and the need for continued support and innovation to this vital sector. The government's initiatives, such as Direct Benefit Transfer (DBT) and subsidies on drones, have encouraged the adoption of advanced & improvised technology in agriculture, empowering farmers with tools like Information Technology (IT), Artificial Intelligence (AI), Internet of Things (IoT), and precision farming.

The G20 Agriculture Working Group (AWG) meeting held during the New Delhi Leaders' Declaration emphasized the importance of sustainable agriculture to ensure food and nutritional security for citizens worldwide. It addressed pressing global issues, including food and fertilizer price volatility, supply chain disruptions, and geopolitical tensions, highlighting the critical need for resilient supply chains. This is a golden opportunity for India to meet the world's food needs in difficult times and qualify as a global food hub to sustain and support the world's increasing population.

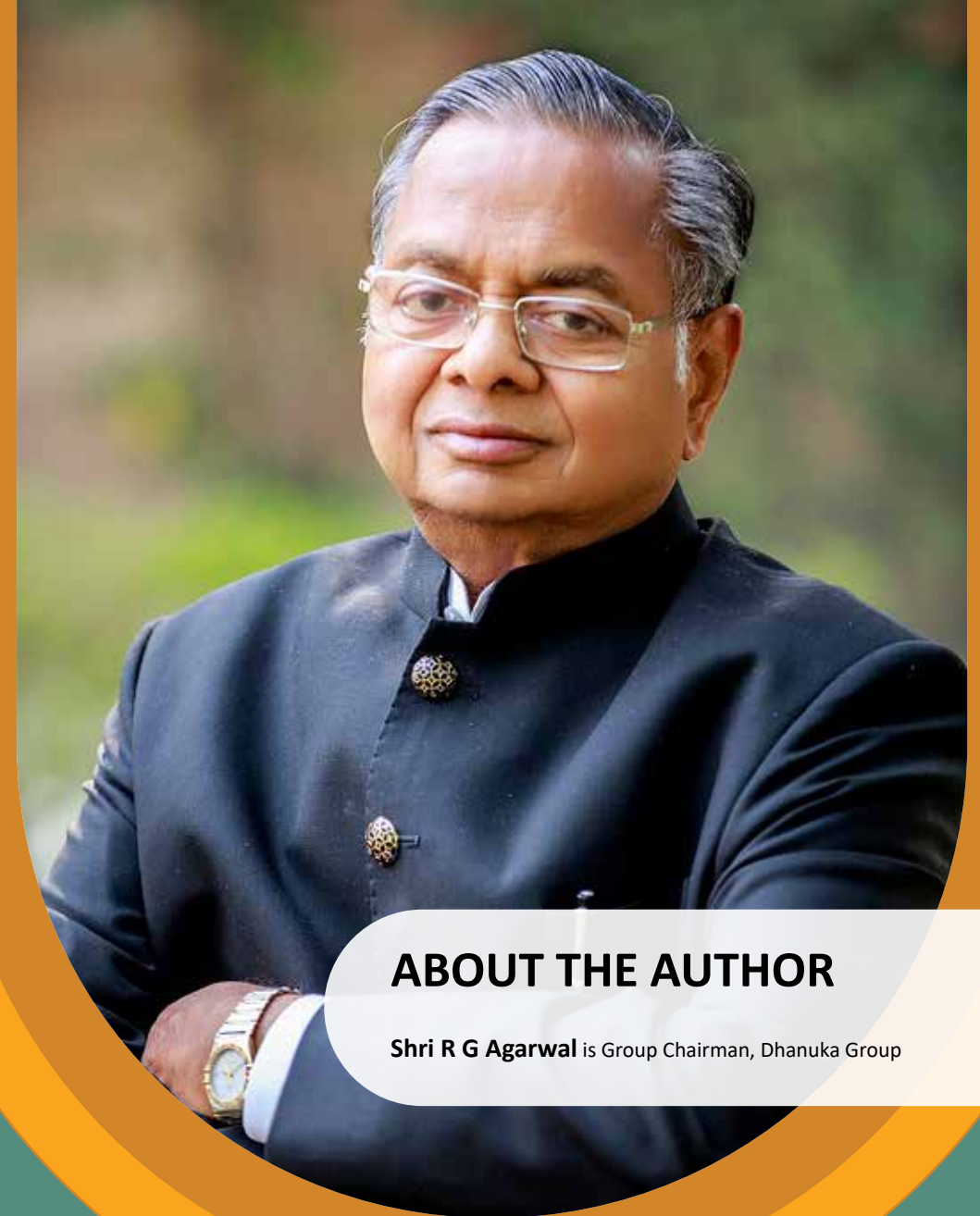
G20 Meetings under the Presidency of India during 1st December 2022 to 30th November 2023, dealt with important role in shaping and strengthening global architecture and governance on all major international economic fronts including agriculture. The meeting effectively tackled pressing global issues such as food and fertilizer price volatility, supply chain disruptions, and geopolitical tensions, emphasizing the importance of resilient supply chains.

Promoting Diverse and Sustainable Food

A significant emphasis was placed on the promotion of nutritious, diverse, and sustainably produced food. Ministers endorsed innovative approaches to crop development, emphasizing the necessity for climate-resilient, promotion of diverse grains locally adapted to the respective States.

Nutrition and Biofortification

The ministers championed an evidence-based approach to nutrition, highlighting the significance of a varied food base and the potential of biofortification to enhance crop nutritional content.



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India's presidency of the G20 meeting in 2023 not only demonstrated the country's rising global prominence but also set a compelling agenda for addressing critical global challenges in agriculture, food security, and nutrition

Alignment with Sustainable Development Goals (SDGs)

The meeting recognized the interconnectedness of sustainable agriculture, food production, international trade, and the achievement of SDGs, particularly SDG2 (zero hunger). The meeting underscored the importance of capacity building in developing countries for sustainable food production.

Transparency and Data-Driven Decision-Making

Initiatives like the Agricultural Market Information System (AMIS) and the Group on Earth Observations Global Agricultural Monitoring (GEOGLAM) were hailed as pivotal for enhancing transparency in agricultural markets. The meeting recognized that food insecurity encompasses not only food availability but also equitable access to food.

The Path Forward

While the New Delhi Leaders' Declaration laid the foundation for international initiatives to combat acute food insecurity and persistent hunger, the real challenge now is the implementation of these principles into action. As nations collaborate, share best practices, and learn from one another, the vision of a world with strong food security and improved nutrition comes closer to realization.

India's presidency of the G20 meeting in 2023 not only demonstrated the country's rising global prominence but also set a compelling agenda for addressing critical global challenges in agriculture, food security, and nutrition. India's commitment to leveraging digital technology, fostering innovation, and embracing sustainability will be pivotal in achieving the vision of climate resilient food systems, improved nutrition, and global food security for future generations.

The Role of the Crop Protection Industry – Dhanuka Agritech Limited

As India embarks on its journey to enhance food and nutrition security, it is imperative to recognize the pivotal role of the crop protection industry one of the major stakeholders of agriculture in this endeavour. The recent declaration by the Indian Council of Agricultural Research (ICAR) has opened new avenues for private sector collaboration with public organisations/institutions can yield potentially revolutionizing research and development in agriculture.

Dhanuka Agritech Limited, a leading Indian agrochemical chemicals company, is taking proactive steps to address global challenges in agriculture for food and nutritional security beside alleviating farmers livelihood woes. It is striving hard to make agriculture more profitable by employing novel crop protection chemicals and productivity measures. The establishment of the Dhanuka Agricultural Research and Technology (DART) lab in Palwal, Haryana, and technical alliances with 6 international companies



According to a study in Germany (SAGE, 2019), if the total area in Europe is brought under organic cultivation, production may dip by 35%, and to make up this loss, 50% more arable land must be brought under agriculture

showcases its commitment to innovative crop protection.

Dhanuka is eager to harness the potential of new technologies including Machine Learning, IT, IoT, precision agriculture, and drone-based spray applications to produce and protect crops from pests, improve their quality and enhance crop yield thereby increasing farm returns.

Dhanuka has always been a pioneer in educating farmers regarding water conservation. The company itself is actively involved in promoting efficient irrigation technologies, contributing to conservation of water for sustainable agriculture. Dhanuka has built check dams at the village level and launched "Save Water" campaign with the tagline "Khet Ka Pani Khet Mein Aur Gaon Ka Pani Gaon Mein". Dhanuka is creating awareness among the farmers with "Kheti Ki Nai Takneek" in coordination with ICAR-IARI-Water Technology Centre through aggressive extension activities, distributing flyers among the farmers and authorities. The Dhanuka Group had been the first to join hands with the Government of Madhya Pradesh in 2001 for Agricultural Extension Management in the Hoshangabad district under a Public-Private Partnership mode.

The path to enhanced crop production, protection, and food security can be achieved only through enabling agriculture policy recommendations:

Abrupt Unilateral Discontinuation Of Pesticides

India has one of the lowest number of registered pesticides including biopesticides (330) in the world, however hardly 80-100



are in wide use. Policies of abrupt ban of registered pesticides without a suitable alternative and unilaterally without consultation of all relevant stakeholders, deprive the farmers of potential tools for pest management.

Accelerate the pace of Pesticide Registration

Hastening the registration process for new and existing agrochemicals maintain their efficacy post-discovery over a longtime. Excessive delay would result in pest developing resistance due to prolong selection pressure exerted on pests in countries where they are registered. Further delay in registration lowers efficacy levels and loss of novelty. There should be a provision of fast-track registration of new and novel agrochemicals.

Need For Improved Governance

The failure in adherence to requirements of Insecticide Act, 1968 for trade and manufacture of agrochemicals by illicit companies as well as discriminatory practices followed by relevant authorities for sampling, with most samples drawn from reputed brands, ignores the preponderance of the fake products in the country. They not only fail to control pests but also overlook the biosafety of human & environment.

Resistance Management

Implementing the pest resistance management strategies and labelling pesticides based on their mode of action group can contribute to promote effective pest control, over long period of time.

Supporting R&D

Encouraging research and development efforts by domestic manufacturers with data incentivisation can lead to the creation of new, effective crop protection solutions.

Public Awareness

Educating consumers about counterfeit products to ensure the

safety and effectiveness of agrochemicals will foster trust in the industry, besides ensuring the GAP.

GST Reduction

Agrochemicals are indispensable pest management tools to protect their crops and thus serve to act as insurance for the farmers. Lowering the Goods and Services Tax (GST) on agricultural implements is a necessity including agrochemicals, from 18% to 5% will act as an incentive for farmers to invest in crop protection.

Cropping System Diversification

The Maize-Mustard-Mung (3M) cropping system is an efficient solution for diversification in the Indo-Gangetic plains. It can address problems related to soil fertility, crop residue burning, and groundwater depletion. Implementing this system in suitable regions can maximize productivity and farm returns while contributing to sustainable agriculture.

Challenge of Organic Cultivation

Organic farming is gaining traction in India, with a growing market for organic products. However, transitioning to organic agriculture comes with its challenges. Organic farming is often associated with lower yields due to the lack of organic management tools and practices compared to conventional agriculture. The world has witnessed the food crisis in Sri Lanka, that had gone organic from April 2021. Within six months of its promulgation, realising that the decision risked the famine in the country, it was forced to reverse the ban on chemical fertilizers.

According to a study in Germany (SAGE, 2019), if the total area in Europe is brought under organic cultivation, production may dip by 35%, and to make up this loss, 50% more arable land must be brought under agriculture. This can be made possible only through massive deforestation. India's food security is a hard-earned, and any shift to entirely organic agriculture may jeopardize food security. It is thus crucial to strike a balance between organic and conventional farming to ensure food production and security.

India Global Food Hub

Role of Crop Protection Solutions



Indian farmers need more molecules to fight the battle against pests, diseases, weeds and other attacks

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India's stature as a global food hub is growing steadily with the impressive strides on the agriculture front. Foodgrain production is at a record 330 million tonnes and agricultural exports are scaling new heights crossing USD 50 billion. Our farmers are feeding our 1.4 billion population and can support the world in times of crisis.

Many of us don't fully comprehend the immense hardships and challenges that our farmers face to ensure that we have enough food on our plate. There are 30,000 species of weeds, 3,000 species of worms and 10,000 species of plant-eating insects that threaten a farmer's crop. Adding to the complexity is the ever increasing newer and more complex pests like Fall Army Worm (FAW), locusts and black thrips in recent times that have caused immense losses to the farmers.

Climate change is also becoming a worldwide emergency and is threatening the very existence of farming. But if this was not all, post-harvest crops have to be protected from bugs, molds and rodents.

Agrochemicals in the form of Crop Protection solutions have been equipping the farmers to prolong the life of crops and prevent post-harvest losses. 'Crop medicines' have been playing a monumental role in several crop emergencies that threatened Indian agriculture from time to time like phalaris minor weeds in wheat, heliothis armigera bollworms in cotton or the brown plant hopper insect pest in rice.

India has become the fourth largest producer and second largest exporter of agrochemicals. The exports valued at \$5.5 billion has surpassed USA and is only second to China valued at \$11.1 billion. This impressive feat has led to a trade surplus of ₹28,908 crore in FY 2022-23. Coupled with the expansion in the production capability, the sector can play an even more important role for the future challenges.

By 2050, India's population is expected to increase to 1.7 billion from 1.4 billion at present. For feeding the population, India needs to not only increase further its agriculture production but also improve the overall productivity to ensure food and nutritional security of the nation and for making our millions of small holder farmers and Indian agriculture sustainable.

Vital Input

The arable land would further reduce, the small land holdings also are not likely to see any dramatic changes. Climate change will continue to create huge disruptions in agriculture across landscapes with unprecedented droughts, floods and record high temperatures.

All these point towards only one direction of increasing productivity of farming in a sustainable way through optimum usage of farm productivity enhancing inputs and tools.

Crop Protection products have been playing a pivotal role in protecting the produce of the farmers across the globe from diseases and pests at various stages of the crop. According to Indian Council of Agricultural Research (ICAR) study, the estimated loss in value terms of India's agriculture produce due to weeds alone would be to the tune of over INR 80,000 crores, without the use of crop protection products.

The contribution of crop protection chemicals in India's agriculture growth is often overlooked and are subject to intense scrutiny, reviews and criticism. Reviews are indeed needed like every other sector to ensure that better products with the least environmental impact are available to the farming communities. But there is a need for enough scientific basis to the reviews.

The scientific data on the efficacy as well as safety aspects of the various molecules and most importantly the importance to the farming community in protecting their crops need to be properly evaluated. The reviews often result in bans that cause immense hardship to not only the R & D based companies but also to the farmers.

The R&D based crop sciences industry has been launching cutting edge technologies that has over time led to reduced application rates. The dosages were as high as 1,000-3,000 grams of active ingredient per hectare during the 1960s and 1970s. By the eighties, they had come down to 50-500 grams per hectare. From the nineties to the early 2000s, with further advancement dosages have come down to 25-200 grams per hectare.

Since the mid-2000s, the active ingredient application has fallen to less than 100 grams and in some cases to even as low as 4 grams per hectare. The pursuit towards greener chemistry continues and industry is aware of its responsibility towards the need to reduce the environmental footprint. They are not only investing time, energy, and resources in making products that are safe by design to the environment but also train farmers on the 3 R principles of using the 'Right Product at the Right Time and in the Right Dose'.

The industry needs to spend almost INR 2000 crores over a 11-year period to bring a new technology from discovery to commercialization.

That pursuit needs encouragement to make our agriculture both economically viable and more sustainable. It calls for the creation of a policy environment that incentivizes a steady flow of the latest and safer products.

There is also unfounded criticism by the NGOs that India already uses large amounts of crop protection products. According to available data per hectare consumption of pesticides in India is a mere 0.29 kg/ha compared to other countries like China at 13.06 kg/ha, Japan 11.85 kg/ha and Brazil 4.57 kg/ha. This perception

needs to change, and focus must shift to balanced use of chemicals to optimize the yields of farmers in a sustainable manner.

Immediate Concerns

There is another facet that needs to be understood. At present 1175 molecules are available globally but only around 310 are registered in India.

In contrast, much smaller countries like Vietnam, Pakistan have over 500 registered molecules. USA, EU and Brazil have around 650/750 approved molecules for their farmers. It is therefore necessary that Indian farmers need far greater range of newer molecules to fight the battle against pests, diseases, weeds and other attacks. We need more molecules to protect India's 140 million hectare of diverse agricultural crops.

There is a need for a predictable science based policy regime for the proper growth of the crop protection sector. Any hasty decision to ban or a policy environment restricting use and introduction of new molecules will not only affect the growth of this important industry but also deprive the farmers access to the latest technologies.

The industry is committed to work towards ensuring that the farmers are equipped with the best technologies to produce more from less in an environmentally sustainable manner.

What does the future look like? What if plants could talk to us! With the AI revolution that is taking place in Agriculture, crops can today tell us to what they feel and what they require through this wonderful tool called sensors and transmitters. In the age of Internet of Things (IoT), agriculture is at the cusp of becoming 'smart' with the seamless integration of the latest, interconnected technologies. The sensors and transmitters can monitor everything from soil and plant health to greenhouse humidity levels and the data generated can help in improving growing conditions and overall efficiency.

Technology is in a way helping effectively remove the speculation from the way crops are grown. This is an opportunity to leapfrog agriculture practices to the levels of Industry 4.0. There is immense opportunity for public-private partnerships (PPP) in leveraging the benefit of emerging technologies as the private sector is also introducing cutting edge innovation in the areas of digitization and AI.

Similarly, the immense amount of data generated can be analyzed to enable huge breakthroughs with respect to efficiency of practices and yields. Ultimately, it benefits the farmers to have more money in their pocket and improve their return on investment. The data can also help to predict the outcomes before you undertake them, minimizing risk and waste. In fact, today the various digital tools are tremendously helping in discovery of new

molecules leading to the latest crop protection products which takes close to 11 years at a cost close to USD 300 from discovery to commercialization. It also simulates the weather, soil and other conditions and tests the crops accordingly in the lab.

In addition to the cost savings and efficiency jumps, there are pressing global reasons for farmers adopting smart agricultural practices. By the year 2050, the world's population is anticipated to be around 9.6 billion. This means that farmers will have to increase their yields by 50 per cent to cope with rocketing demand. The Indian agriculture sector, which has witnessed robust growth with an average annual growth rate of 4.6 per cent over the last six years, is all poised to rise to the occasion.

The year 2023 has been momentous as we've made significant strides during India's Presidency of the G20. "India's G20 Presidency, themed One Earth, One Family, One Future," draws inspiration from our ancient Sanskrit text of the Maha Upanishad "Vasudhaiva Kutumbakam" meaning "The Whole World is One Family". The New Delhi Leaders' Declaration is also a testament to India's diplomatic prowess and the G20's commitment to addressing global issues collectively and with zeal, prominently recognizes the future path for agriculture.

The Declaration committing to eliminate Hunger and Malnutrition stresses on accelerating innovations and investment focused on increasing agricultural productivity, reducing food loss and waste across the value chain, and improving marketing and storage, to build more sustainable and climate-resilient agriculture and food systems. Equally critical and essential for our industry is the acknowledgment of agriculture inputs. The Declaration, while committing to enhance global food security and nutrition for all underscores "the importance of increasing access to, availability, and efficient use of fertilizer and agricultural inputs, including strengthening local fertilizer production, and improving soil health." Implicit in this statement is the pivotal role of the crop protection industry.

The Tasks Ahead

First, a predictable, science based policy and regulatory regime for the proper growth of the crop protection sector to make our farmers and Indian agriculture sustainable.

Second, forward looking progressive regulations which promote innovation and new product introduction to address the current and future challenges of the farmers.

Third, encouragement to introduction of cutting-edge technologies like Artificial Intelligence, Drones and digitization in service of the farmers.

Fourth, Public Private Partnership – Industry would like to be "Partners in Progress".

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INDIAN AGRICULTURE

A SUSTAINABILITY MODEL GLOBALLY?

The world's population is expected to increase to 9.6 billion by 2050, and by that time global food production will need to increase by 70% to prevent massive famine. India, with a population of 1.39 billion (17.5% of the current world population) occupying only 2.5% of the total landmass, has now overtaken China as the most populous country. Indian agricultural productivity seems to have outpaced the population growth, but India will need to continue to increase its agricultural productivity and work even harder to protect what it produces.

While there has been remarkable growth in domestic food production, the progress in post-harvest management remained subdued, resulting in supply chain inefficiencies and substantial loss and wastage of food.

Challenges

Indian agriculture faces several challenges including factors such as the small, fragmented landholdings, inadequate access to markets, unavailability of key inputs and newer technologies such as seeds, fertilizers, etc, and their associated high costs. The relatively high dependency on weather and the issues related to climate change which have become more frequent in recent years along with the continued soil degradation without any improvement in sight, are even bigger challenges that must be addressed.

These are going to be hard especially if not accompanied by improvement in other sectors as well as increased R&D funding, improving research infrastructure, better management of agricultural resources, rural empowerment, and creating more income generation opportunities. India needs to make agriculture more attractive to the younger generation.

A potential water crisis has been ranked as the highest concern for the next decade by the UN and after water, the destruction of soil could be considered as the biggest threat to global agriculture. According to the FAO, about a third of the world's soil has already been degraded due primarily to chemicals and heavy farming techniques, deforestation causing increased erosion, and global warming.

IPCC states that half a billion people already inhabit places turning to deserts, and soil is being lost between 10 and 100 times

faster than it is forming. In addition to increasing salinity in its coastal regions and severe drought facing several regions, India is clearly facing a crisis with at least 30% of the arable land completely degraded and approximately 2-3% of land being lost annually due to poor soil management and rapid urbanization.

Climate change will make those threats even worse, as floods, drought, storms, and other types of extreme weather threaten to disrupt, and over time shrink, the global food supply. The rapid expansion of unsustainable management of croplands and grazing lands is the main driver of land degradation, causing significant biodiversity loss and impacting food security, water purification, and the provision of energy.

Soil Health

Soil health is a concept that deals with the integration and optimization of the chemical, physical, and biological processes of soil that are important for sustained productivity and environmental quality. A modern consensus definition of soil health is "the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals and humans" (Natural Resources Conservation Service – USDA-NRCS, 20122; Soil Renaissance, 2014).

The soil-health framework (initially under the term soil quality) is the addition of an urgently needed biological perspective to soil management to address longer-term sustainability challenges for crop production and needs to address this urgently.

On the input side, the use of chemical fertilizers has reached its peak, increasing from about 2 kg per hectare in the early 1960s to around 159 kg per hectare in 2019-20, mostly due to the continued government subsidies. Recent studies suggest that the crop yield responsiveness to fertilizer use has declined significantly from more than 10 kg to less than 5 kg of grain output per kg of chemical fertilizer. The unrestricted use of chemical fertilizers and pesticides has also led to long-term adverse effects such as contamination of soil and water, the killing of beneficial bacteria and microorganisms in the ecosystem, loss of biodiversity, and a harmful impact on human and animal health.

Need To Promote Sustainable Cultivation Practices

This calls for urgent measures to promote sustainable



The private sector has the demonstrated ability to innovate and introduce newer technologies in agriculture

ABOUT THE AUTHOR

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Adoption of new technologies remains a major issue since many of these do not address what the farmer really needs or can afford

needs or can afford. Education, effective communication, and judicious integration of multiple solutions at the farm are key to creating a sustainable agricultural system. A farmer-centric, contextual approach to solving problems through new products while addressing the economic realities on the ground is essential to achieving sustainability.

Enhancing Food Production And Availability At Affordable Prices

The G20 Leaders' Declaration (2023) on food and energy security brings the focus on enhancing food production and availability at affordable prices for economically weaker sections.

Among other key initiatives, the declaration committed to (a) strengthening research cooperation on climate-resistant and nutritious grains such as millets, sorghum, and other staple crops such as rice, wheat, and maize (b) increasing access, availability, and efficient use of fertilizers and agricultural inputs with the goal to improve soil health (c) accelerating innovation and investment for increasing agricultural productivity and reducing post-harvest losses and building sustainable and climate-resilient agriculture and food systems (d) developing Agricultural Market Information Systems (AMIS) as well as early warning systems to avoid food price volatility. All these are clearly relevant to the Indian context.

Need For Efficiency In Post-Harvest Management

There is an urgent need for devising a holistic and comprehensive policy to address the challenges of bringing efficiency in post-harvest management while promoting optimal use of input resources and sustainable agricultural production practices.

This will necessitate increased R&D funding to frame a bolder research infrastructure, better management of agricultural resources including youth empowerment, strategic policy changes to accommodate the changing environment, and the creation of more income generation opportunities. Local Adaptations to manage the rapid climate change need partnerships with local agencies in private and public sectors and policies to enable such collaborations will need to be developed at national levels.

Agriculture needs partnerships between academia, public and private sectors. While the public sector undertakes the mission to enhance basic knowledge and innovate, the private sector can continue to play a major role in economic value creation, raising and efficiently deploying capital, and enhancing innovation.

PPP To Strengthen Market Linkages

Developing a healthy Public Private Partnership to strengthen market linkages essential to the future of agriculture, especially in developing economies. As new technologies evolve, it is essential to work towards the development of policies to help the access, introduction, and adoption of novel, breakthrough technologies in the agricultural space.

cultivation practices to restore the natural crop ecosystem with the use of inorganic and organic or bio-fertilizers, biostimulants, and biopesticides for enhancing crop yield. This is the basic premise of the recent and oft-chanted mantra of 'Regenerative Agriculture' which essentially relies on reintroducing the biological functions of the soil primarily through agronomic practices such as minimal tilling, crop rotation, and the use of biological nitrification processes in the soil. The key principles of regenerative agriculture are:

1. Minimal disturbance to the soil – essentially a No-till approach to farming
2. Use of livestock and related activities which help
3. Enhance the soil biodiversity in terms of soil biota including microorganisms.
4. Use of cover crops that protect the soil and water allowing them to remain in the soil.

As India continues to make efforts to increase productivity and modernize agriculture, the key features of a regenerative approach could still be preserved through the application of sound scientific principles and innovative tools to adapt to the changing needs of the crop and the environment. Regretfully, most of the breakthrough innovations are still not currently available to most farmers.

Globally, the adoption of new technologies remains a major issue since many of these do not address what the farmer really

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Sustainable Growth of Agriculture For Food-Secure Future

The global agricultural sector is facing numerous challenges, including the need to feed a growing population, mitigate climate change impacts, and ensure food security. To address these challenges, there is an increasing emphasis on accelerating innovations and investments in agriculture. This article explores the significance of these efforts in escalating agricultural productivity, strengthening the value chain to reduce food loss and waste, improving soil health, and recognizing the pivotal role of the crop protection industry.

Innovation plays a critical role in transforming agriculture and increasing productivity. With the world's population projected to reach nearly 10 billion by 2050, there is a pressing need to produce more food using fewer resources. This requires the adoption of innovative technologies and practices that enhance efficiency and sustainability in agriculture.

One area of innovation is precision agriculture, which utilizes advanced technologies such as remote sensing, drones, and data analytics to optimize crop management. Precision agriculture enables farmers to make informed decisions regarding irrigation, fertilization, and pest control, leading to improved yields and reduced environmental impact.

Investments in R&D are essential for driving agricultural innovation. Governments, private sector entities, and research institutions need to collaborate to fund and support research projects focused on developing new crop varieties, improving agricultural practices, and finding sustainable solutions to challenges like climate change and water scarcity.

Strengthening the Value Chain

The current global food system faces significant challenges in terms of food loss and waste. It is estimated that approximately one-third of all food produced is lost or wasted along the value chain, from farm to fork. This represents a significant loss of resources, including water, land, and energy, and exacerbates food insecurity.

It is crucial to focus on strengthening the value chain. This involves improving storage and transportation infrastructure, enhancing post-harvest handling practices, and promoting efficient distribution systems. Investments in cold chain technologies, for instance, can help prevent spoilage and extend the shelf life of perishable foods.

Innovations in packaging and processing techniques can contribute to reducing food waste. Sustainable packaging solutions, such as biodegradable materials, can help extend the shelf life of products and reduce packaging waste. Additionally, advanced processing methods like freeze-drying and canning can preserve food for longer periods, reducing the likelihood of spoilage.

Improving Soil Health

Soil health is a fundamental aspect of sustainable agriculture. Healthy soils support robust crop growth, enhance nutrient availability, and contribute to climate change mitigation. However, soil degradation due to factors like erosion, nutrient depletion, and pollution poses a significant challenge.

Addressing soil health requires a judicious use of quality agricultural inputs and practices. This includes optimizing fertilizer and pesticide use, implementing crop rotation, and adopting conservation agriculture techniques like no-till farming. Investing in soil testing and monitoring programs can provide farmers with valuable insights into their soil's health and guide appropriate management strategies.

Crop protection products, including pesticides and bio-stimulants help safeguard crops from pests, diseases, and weeds. It is crucial to promote the responsible and sustainable use of these products. This involves supporting R&D efforts to develop safer and more environmentally friendly alternatives, promoting integrated pest management practices, and providing education.

To achieve sustainable growth and ensure a food-secure future, India must prioritize and implement strategies that promote environmentally friendly practices, enhance productivity, and empower farmers.

Key Measures For Achieving Sustainable Growth

• Climate-Smart Agriculture

This includes promoting the use of drought-resistant and heat-tolerant crop varieties, implementing efficient irrigation techniques, and encouraging agroforestry to enhance soil fertility and carbon

sequestration. Investing in climate-resilient infrastructure and providing farmers with timely climate information can help mitigate risks and improve productivity.

• Water management

Encouraging the adoption of precision irrigation techniques, such as drip and sprinkler irrigation, can minimize water wastage. Additionally, promoting rainwater harvesting, constructing small-scale water storage structures, and implementing water-efficient farming practices like conservation agriculture can enhance water availability and reduce reliance on groundwater.

• Soil health and conservation

Promoting organic farming practices, such as composting, crop rotation, and integrated nutrient management, can improve soil fertility and reduce dependence on chemical fertilizers. Implementing soil conservation measures like terracing, contour ploughing, and agroforestry can help prevent erosion and enhance soil moisture retention.

• Technology adoption

Encouraging the adoption of precision farming technologies, such as remote sensing, drones, and Internet of Things (IoT) devices, can enable farmers to monitor crops, optimize resource use, and make informed decisions. Providing access to affordable farm machinery, such as small-scale mechanization tools, can enhance productivity and reduce labour-intensive practices.

Farmer empowerment and capacity building

Empowering farmers through knowledge and skill development is crucial for sustainable agricultural growth. Strengthening agricultural extension services and promoting farmer-centric programs can provide farmers with access to information on best practices, market linkages, and financial support. Additionally, facilitating farmers' participation in decision-making processes and promoting farmer producer organizations can enhance their bargaining power in the market.

Diversification And Value Addition

Supporting the establishment of food processing units and cold chains can enable value addition and reduce post-harvest losses. Additionally, promoting organic and local food systems can enhance sustainability, improve nutrition, and create market opportunities for small-scale farmers.

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Protecting Crops With Innovative Solutions



Sustainable crop protection includes location specific crop solutions that determine the best set of practices/activities by considering the strengths, opportunities, weaknesses, and threats of IPM and IRM programs

Sustainable agricultural practices are intended to protect the environment and natural resources along with production of food and fibre. An integrated approach for plant and animal production practices for long-term results such as production of sufficient human food, feed, fiber, and fuel to meet the needs of a sharply rising population, protection of the environment and expansion of the natural resources supply and sustainment of the economic viability of agriculture systems. Crop protection plays an important role in sustainable agriculture by managing pests by combining biological, cultural, physical, and chemical tools in ways that minimize economic, health and environmental risks.

A wide range of technologies have been used to make agriculture more efficient. The rapid development of precision agriculture has been made possible using the Global Positioning System (GPS) with geographical information systems (GIS) techniques and remote sensing data. The primary objective of the research is to evaluate the function that crop-protection technologies play in ensuring the continuity of agricultural output. The specific objectives of the study include the following.

- To establish the effect of biological crop protection on sustainable agricultural productivity.
- To explore the relationship between chemical crop-protection techniques and sustainable agricultural productivity.
- To determine the effect of mechanical crop-protection techniques on sustainable agricultural productivity.

Establishing a pest-resistant crop by employing cultivars that are less vulnerable to pests and cultural measures that reduce pest survival and reproduction, such as crop rotation and sanitation, while conserving competitors and natural enemies, is a sustainable method of controlling pests. With general pest population thresholds and reconnaissance, reduced-risk insecticides are used sparingly. Innovation to reduce food loss and waste on and beyond farms is another area of concern.

Green Chemistry

Protecting the crops with innovative products and solutions that focus on the needs of farmers, society, and nature. Develop and produce products that promote strong and healthy plant growth and enhance the ability of plants to defend themselves. Such products should be based on green chemistry and naturally occurring substances and processes (bio controls, phytochemicals). The advancement in crop protection includes smart crop monitoring, drone farming, autonomous farm base machinery and smart equipment management. Smart crop monitoring of automated irrigation, nutrient based fertilizer applications and using image analysis in crop protection and growth.

Location Specific Crop Solutions

Sustainable crop protection includes location specific crop solutions that determine the best set of practices/activities by considering the strengths, opportunities, weaknesses, and threats of IPM and IRM programs. Controlled and slow-release crop solutions-crop solutions with reduced leaching of chemicals to

groundwater to ensure precise dosing at each plant development stage. Selection of the dose and form of crop solutions under the plant's nutritional requirements, type, abundance of soil and weather conditions. One shot crop solution with a reduced number of sprays-crop solutions that provide bountiful and healthier harvests with lesser number of sprays.

ABOUT THE AUTHOR

MR Bhavesh Shah is the Managing Director of GSP Crop Science



Sustainable & Modern Practices

Turbocharging The Agri Sector

The agricultural sector is witnessing a metamorphosis not seen in decades. With climate change threatening to disrupt age-old farming practices, it is imperative for stakeholders to come together and devise new techniques to help the sector and farmers continue to produce robust yields while conforming to sustainable practices.

Being an integral of our nation's economy, the agricultural sector accounts for approximately 16.5 percent of India's GDP and has helped India burnish its reputation as one of the largest and most diversified food producers in the world. However, the agri ecosystem is grappling with hazards which are threatening to spiral out of control. Although the external factors portend challenging times, there are encouraging developments which can help the sector negate threats.

India is among the top-5 producers of agrochemicals in the world and boasts an extensive crop protection distribution network. Furthermore, the rapid strides made by entities in agricultural technology space have enabled greater precision in the analysis of soil conditions as well as more accurate information related to weather conditions.

As the agriculture sector is shifting towards a tech-smart territory, digital crop monitoring platforms are being used extensively. These digital solutions also allow for the optimisation of the use of resources resulting in more effective crop protection and lesser damage to the environment.

Emerging Trends In Agri-Tech Landscape

It is important to note that simply the production of crop protection solutions isn't enough to meet the ever-rising demands of farmers. From production and distribution to utilisation, the entire process needs to be made more efficient than ever. Such a desired efficiency can be achieved by adopting the latest agri-tech trends.

Since 2013, the number of startups has grown from less than 50 to over 1000. This change has been fuelled significantly by the rising access to internet in rural India. Consequently, India's regulatory environment is rapidly evolving to facilitate the growth of digital technologies in agriculture, including apps.

Direct-to-farmer sales channels are among the latest agri-tech trends. This is where providers of farming supplies (seeds, agrochemicals and fertilizers) bypass retailers or middlemen

and use technology such as digital platforms to provide services directly to farmers.

Firms that are primarily engaged in offering finance through rural/farm loans are using technology to better understand the farmer. This enables them to provide targeted products and reduce loan risks. Such tech includes apps that meet farmers' advisory needs and finances.

GOI Initiates

Besides tech startups and lenders, the government is also taking important steps to integrate technology and innovation into the agricultural sector. Some prominent examples include Agri Stack, a unified database of agricultural datasets that will be linked to farmers based on their land holdings. This database will enable agri-tech companies to customise products and services based on farmers' requirements which will vary by soil conditions, crops and land size. Another initiative is the Soil Health Card, which aims to furnish farmers with soil health cards that offer customised suggestions for nutrients and fertilizers based on the specific crops.

Opportunities and Challenges

According to the UN Food and Agriculture Organization (FAO), up to 40 percent of global agricultural production is damaged by pests annually. Coupled with the challenge of climate change, the agriculture sector is struggling to produce yields at a prolific rate.

It has already been proven that global warming lessens the uptake of micronutrients from the soil, resulting in poor nutritional quality in crops. Additionally, soil fertility management needs to be upgraded or it may further decrease the supplementary dietary supply of micronutrients. While India's population is increasing, the per capita size of land is decreasing. The greater the population, greater the demand for increased efficiency in food production.

Time For Transformation

All these factors make it crystal clear that India's crop protection industry is in need of a massive transformation.

Plant health and yields depend heavily on soil moisture level. Both abundance and lack of moisture can weaken crops and amplify the growth of weeds. Farmers need efficient preventive measures against this issue and this is where the crop monitoring platforms can provide valuable data in identifying the areas of the



With a slew of developments set in motion, India's crop protection industry is ready to ride the agri-tech wave and usher in a new shift in the agricultural sector

land facing moisture issues. This can help farmers plan a more optimised irrigation management system.

In similar vein, crop rotation is among the most valuable crop protection methods. It is the practice of growing a series of diverse crops in the same area across a sequence of seasons to optimise nutrients in the soil, improve soil health and combat weed/pest pressure. The digital monitoring platforms make it easy to monitor crop rotation by providing quick data on the order in which these crops are grown in specific areas.

Thus, with a slew of developments set in motion, India's crop protection industry is ready to ride the agri-tech wave and usher in a new shift in the agricultural sector. But any transformation process takes time and in this case too, it is important for stakeholders to work together to ensure we embrace the changes to help the agricultural sector flourish.

ABOUT THE AUTHOR

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An evaluation of the soil's life is necessary for improved nutrient uptake, crop health, and crop protection against biotic and abiotic challenges

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The entirety of life in earth is supported by soil. Soil is fundamental to people, livestock, vegetation, and ecosystem. Since soil is a limited resource, it cannot be replenished during our lifetime. The food we eat, the water we drink, the air we breathe, our health, and the health of every living thing on the earth are all impacted by soils.

Our ability to grow food would be impossible without healthy soils. Indeed, it is believed that our soils provide 95% of our food, either directly or indirectly. Therefore, the foundation of both our sustainable future and food security is healthy soils. Yet soils and everything they must provide are under assault from different interventions.

Declining Productivity

India is not an exception to the global 20% of cropland whose productivity is continuously declining because of soil degradation (UNCCD, 2017). This issue requires immediate response to allay worries about food security. When the soil is in good physical, chemical, and biological conditions and can support the growth and development of land plants, it is said to be in a healthy state. Measuring the health of the soil can be done quantitatively, qualitatively, or both.

GOI's promotion to Organic farming, natural farming and "Soil Health Card" project is a commendable step in this direction. "Soil Health Card" gives a quality evaluation of the nutrients in the soil, assisting farmers in making frugal use of fertilizers. It gives a quality evaluation of the nutrients in the soil, assisting farmers in making frugal use of fertilizers.

Farmers continue to complain about low output despite nutrition management. Concentrating only on nutrition is insufficient for sustainable practices. An evaluation of the soil's life is necessary for improved nutrient uptake, crop health, and crop protection against biotic and abiotic challenges. Let's examine the definition of soil life and its present state.

Protecting The Soil

A healthy soil is a living ecosystem made up of both larger and tiny species can be found in good soil. Soil microorganisms primarily carry out a variety of essential tasks. They transform minerals and decomposing materials into nutrients for plants. Through nutrient cycling, these microorganisms act as the plants' "stomach," giving them phosphorus, nitrogen, and a host of other nutrients.

Bacteria shield plants from pests including weeds, insects, and diseases. In the end, microbial activity increases agricultural productivity by enhancing soil structure, soil water and nutrient holding capacity, and mitigating the effects of climate change.

Therefore, testing and improving soil microbial health through government initiative—that is, the soil's life—is crucial to raising agricultural output.

Soil

The Living Ecosystem

Soil pollution is mostly caused by agriculture. Many of the current methods for managing crops and soil are not sustainable. Soil pollution not only harms the environment but also has a large financial impact because it reduces crop yields and quality. Stopping soil contamination should be a major priority on a global scale. Since most pollutants are caused by human activity, it is directly our responsibility to put the necessary reforms into place to ensure a less polluted and more secure future.

Antibiotics are used in agriculture alone nearly four times more frequently than in human treatment. Moreover, the overuse of sophisticated agrochemical compounds, such as chemical fertilizers, herbicides, fungicides, and pesticides, as well as the neglect of adding enough organic matter, which provides food for soil microorganisms, is eroding the soil's ability to support life.

Because of this, crop plants are deficient in numerous vital symbionts that are needed to create or make available nutrients, minerals, vitamins, antioxidants, and a host of other metabolites that are critical for both personal defence and good health. Numerous studies have suggested that numerous significant species of microbes may already be extinct, some of which may be crucial to human health and wellbeing. This may raise the possibility of pest and pathogen outbreaks that endanger food security and safety.

Soil Restoration

To better understand mitigation strategies for soil restoration, we must first assess the health of the soil's microbes along with

nutrients using the soil health card system. A crucial component of soil restoration is the reintroduction of microflora, which depends on the availability of enough organic matter for them to feed on. The main cause of biofertilizer and biopesticide inefficiency is incorrect field application.

Despite government promotion of the use of biofertilizers, organic fertilizers, and biopesticides, the people putting these strategies into practice are largely inexperienced in agriculture extension. They ought to receive scientific training on new items, new technologies, and relevant applications.

To improve the acceptance of bio-organic applications, farmers should also get training on the proper handling, application and compatibility of chemical and biological inputs. Moreover, a lot of state-run agricultural universities and research centres don't usually advise using biopesticides for pest management and biofertilizers in fertigation schedules. It is necessary to mandate the use of the bio-organic method in crop practices.

Restoring the microbial health of the soil is more important because soils are an essential ally for nutrition and food security. Sustainable agriculture relies heavily on controlling soil microbial health and nutrition. Regenerative agricultural techniques along with the advancement of scientific regeneration techniques, financial assistance, farmer education, and their combination with industrial farming have the potential to change Indian agriculture to one that is favourable to farmers, consumers, and—above all—the environment!



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The agricultural landscape in India is undergoing a noteworthy transformation, marked by the increasing importance of crop protection. India's crop protection chemicals market is poised for growth, with a steady compound annual growth rate (CAGR) of 4.8% expected between 2023 and 2029. This growth is driven by several factors, including the quest for higher agricultural yields, the adoption of eco-friendly and safe crop protection products and the urgency to combat food insecurity.

In recent years, India has made substantial progress in enhancing its crop protection strategies by integrating innovative technologies and sustainable practices. The integration of modern agricultural practices with traditional wisdom has led to the development of an effective and environmentally friendly approach to crop protection. This has helped in preserving the fertility of the soil and minimizing the adverse effects of chemical usage on the ecosystem.

Role Of Crop Protection in Indian Agriculture

Crop protection and nutrition products including herbicides, insecticides, fungicides, biologicals and PGRs play a vital role in safeguarding and improving the crop yields. One of the key benefits of crop protection is the mitigation of crop losses due to pests, weeds and diseases. In India, various pests like white fly & thrips in cotton, and diseases such as sheath blight in paddy & early and weeds in Soybean can cause substantial losses. Effective crop protection products serve as the bulwark against these issues, allowing crops to flourish and securing a stable food supply. Furthermore, crop protection contributes to maintaining the quality of agricultural produce. With the implementation of stringent regulations and quality control measures for crop protection industry, farmers can ensure that their crops meet the requisite safety standards, both for domestic consumption and export.

One positive change that we see is now the industry is moving from product to solutions approach, focusing on identifying the need of the farmers and working on providing the solutions for the same within the reach. Indian companies are bringing in the latest technology products by their R&D and international collaborations so that Indian farmers get the best possible solutions at par with the international agriculture. And they do not stop here but extend themselves for the education of farmers towards the judicious use.

Beyond protecting crop yields and quality, crop protection also plays a vital role in conserving biodiversity. The global shift towards sustainable agricultural practices has encouraged Indian agrochemical institutions to invest in research and develop eco-friendly alternatives in terms of safer formulations and greener chemistry. These alternatives offer a greener and more sustainable approach to crop protection. Notably, some biopesticides have also started making inroads into the Indian market. These bio-based chemicals are not only effective but also environmentally friendly, reducing the ecological footprint of agriculture.

Through sustainable agricultural practices, Indian farmers have actively contributed to the preservation of natural habitats and the protection of beneficial organisms such as pollinators and natural predators. Integrated pest management (IPM) strategies have gained prominence, emphasizing the judicious use of pesticides and the incorporation of biological controls.

Moreover, the adoption of advanced technologies like precision agriculture, biotechnology, and remote sensing has revolutionized the way crop protection is practiced in India. These technologies empower farmers to make informed decisions regarding input application, leading to optimal resource utilization and minimized environmental impact. But we feel there is long way to go for the same as they are still in the nascent stages.

Government Initiatives Driving Sustainable Crop Protection

The government of India has also played a significant role in promoting sustainable crop protection practices through the implementation of various policies and initiatives. By providing financial assistance,

training and access to modern technologies, the government has encouraged farmers to adopt eco-friendly and sustainable agricultural practices. Moreover, government is encouraging the industry for research and development in crop protection. Additionally, collaborations between public and private sectors have facilitated the dissemination of knowledge and the development of innovative solutions, further strengthening the agricultural sector in India.

Crop protection is indispensable in the context of sustainable growth in Indian agriculture. It not only preserves crop yields but also aligns with the principles of environmentally responsible farming. As India confronts the challenges posed by a changing climate, a growing population, and food security concerns, crop protection measures are central to ensuring the resilience and productivity of the agricultural sector.

ABOUT THE AUTHOR

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Crop Protection

Ensuring Sustainable Growth Of Indian Agriculture



As India confronts the challenges posed by a changing climate, a growing population, and food security concerns, crop protection measures are central to ensuring the resilience and productivity of the agricultural sector



Crop Protection Vital For Farmer Prosperity

“ While discussing crop protection, two major objectives emerge. These are protection of yield levels and preservation of nutritive value. In line with these objectives, the very nature of protecting the crops is changing

Among the major challenges faced by global agriculture are plateauing of yield levels and widening of yield gaps. Despite adopting high performing seeds, nutrient forms, delivery systems and innovative crop protection chemicals, the rate of increase in farm productivity is far from satisfactory level.

The recent reports on the impact of climate changes on agriculture specifically highlight the impact on crop-pest relations. Various types of minor crops are becoming major ones, resurgences are frequent. The physiological stress that the crops undergo due to climate changes aggravates these situations by increasing the susceptibility levels.

Beyond preserving the soil and nourishing the crops, protecting the nutritious yield plays a key role in enhancing the agriculture productivity.

While discussing crop protection, two major objectives emerge. These are protection of yield levels and preservation of nutritive value. In line with these objectives, the very nature of protecting the crops is changing.

Pest Control Vs Protection of Crop

Pest control involves the practice of controlling the pest population with pesticides when the population grows beyond the ET level; revealed by the specific symptoms of damage on the crops. In this method, the activities to protect the crop / yield start after the incidence of crop damages; that are in many instances non reversal and contribute to yield losses/reductions.

Plant Protection involves the practice of supporting the crops during their susceptible stages growth. By this, one can prevent damage to the crops to preserve the physiological energy to grow and produce as per the genetic potential.

It is known that the extracts of various medicinal and aromatic herbs have pesticidal properties. For instance, Adathoda, Nerium, Vinca, Ivy, Lantana, Cymbapogan, Aloe etc. Field efficacy reports are also available about these products in protecting the crops from specific insect pests and diseases when applied prior to the susceptible growth stage of the crops.

The Next Steps

- Documentation of crop – pest – formulation reports.
- Development of stable formulation to enhance the shelf life while preserving the potency.
- Laying down guidelines for registering these types of products (to prevent spurious spoiling the market)
- Popularizing them through ICAR and SAU systems through inclusion in the Package of Practices.

Benefits

Crop protection has various benefits especially when herbal formulations are employed. Some of them are as follows.

- Prevents yield loss
- Ensures zero residues on the crop, yield and on the environment
- Ensures nutritional sufficiency along with food sufficiency
- Creates opportunities for the use of cultivable waste lands for the cultivation of these medicinal herbs as they are generally hardy and thrive well.
- Opens up new enterprise in cultivation, processing and marketing of herbal pesticides.
- First mover advantage in the global market in Herbal Pest Control segment.

ABOUT THE AUTHOR

Mr Narayanan is Director Marketing & Sales of fertilizers and industrial products. He has 30 years of experience in agri-business industry, covering manufacturing and marketing of Agro inputs (Seeds, Fertilizers, Pesticides). Mr Narayanan has handled nurseries, orchards, plantations, agriculture biotechnology ventures in India and abroad



Rethinking Indus Water Treaty

Critical Review for a Sustainable Framework



Water storage, sediment management and climate change adaptation measures are critical for construction of hydroelectric projects on the Western Rivers for sustainability of the Indus Water Treaty

ABOUT THE AUTHOR

Mr Devendra Kumar Sharma has 42 years of experience in water resources and energy sectors in India and abroad. He is a Member of the National Security Advisory Board, GOI and serves as the Chairman of Himachal Pradesh Electricity Regulatory Commission. Mr Sharma is the former Chairman of Bhakra Beas Management Board, GOI. He has served as Managing Director of Himachal Power Corporation Ltd., and also worked in the corporate sector for almost six years

The Indus Water Treaty between India and Pakistan, signed in Karachi on 19th September, 1960 by the then Indian Prime Minister Jawaharlal Nehru and the then Pakistani President Ayub Khan has completed 63 years of its existence. This water distribution treaty was arranged and negotiated by the World Bank, to use the water available in the river Indus and its tributaries. In 1960, at the time of signing of the Treaty, it was considered that this treaty would bring an end to the water dispute between India and Pakistan.

Sixty-three years into its inception, the Indus Water Treaty must reconcile with immense changes in technical, environmental and socio-economic factors. The pace of change challenges the operating parameters as well as the spirit of the Treaty. In the last 63 years, it has become clear that increased sediment load in the rivers, sustainability of reservoirs, technological progress, water stress in the Indian States as well as in some parts of Pakistan have changed the key metrics for management of water resources in the region.

Restrictions imposed under the Treaty on the development of hydroelectric projects on the Western rivers in India are not viable. The Treaty must revisit its outlook and evolve as the threat of climate change becomes increasingly real. There is urgent need to re-negotiate the Treaty under Article XII (3).

Irrigation system of undivided Punjab before Independence and its distribution after partition

Mighty Rivers and the water they drain are pivotal to the idea of Punjab. During Rig Vedic age, Punjab was called Sapt Sindhu (the land of seven rivers). In the Ramayana, Mahabharata and Puranas, the name of Panchnad was mentioned for Punjab. This region also had the title of 'Braham Vrata' - the region between the mythical rivers Saradvati and Drishadvati.

Undivided Punjab was blessed with water resources of six mighty rivers, the lifeline for this historically agricultural state. These rivers are:



1. Indus
2. Jhelum
3. Chenab
4. Ravi
5. Satluj (erstwhile Sutlej)
6. Beas

After partition in 1947, East Punjab (42% area) became part of India while West Punjab (58% area) became part of Pakistan. Before the partition of India, five major canals in undivided Punjab were constructed in the early 20th century. These are:

1. Lower Chenab Canal
2. Lower Jhelum Canal
3. Upper Jhelum Canal
4. Upper Chenab Canal
5. Lower Bari Doab Canal

Out of 26 million acres of land irrigated annually by the Indus canals, 21 million acres of irrigated land went to Pakistan whereas only 5 million acres came to India in East Punjab. Within the Indus plains, the area irrigated in 1945-46 was 19.5 million acres in Pakistan and only 3.8 million acres came to India. According to 1941 census, the population dependent on water of the Indus system, 25 million population was in Pakistan and 21 million in India. After partition, apart from canals at Upper Bari Doab Canal (UBDC) and Ferozepore, in the remaining canal system 131 canals were in Pakistan and only 12 in India. Thus, the ratio of water resources allocation was not proportionate to the population of the two Punjab.

This allocation of water resources had wider implications beyond bordering regions. Areas distant from the rivers and hilly region in the East Punjab were awaiting development at the time of Partition. Out of the total quantity of water used, canals on the Indian side used only 8.3 million acres feet as against 64.4 million acres feet in Pakistan. India had around 2.2 acre-feet of water per acre of irrigated area compared to 3.3 acre-feet per acre in Pakistan.

The few canals which came to India after partition, were very thinly spread compared to those in Pakistan. This becomes important because regions of Indus plains in East Punjab (India) were much less developed compared to the population which fell in Pakistan.

As a result of the partition, it can clearly be seen that the East Punjab portion in India was water thirsty and was almost left to starve with very little development and only meagre portion of the irrigation system. Even today, India's Punjab falls in an 'over-exploited' category with 145% drawl of groundwater. The groundwater table in most parts of East Punjab in India has gone down and is in the range of 200 to 300 m below surface.



India and Pakistan need to agree to a new framework of the Indus Water Treaty to allow the region to gain the maximum sustainable benefits from the Indus River system



To overcome water crisis in the East Punjab (India), immediately after independence, India prepared a project report to divert the river Chenab, in the year 1949, by constructing a dam across it in Himachal Pradesh, located around 7 km downstream of village Tindi in the State. This would have diverted water of the River Chenab to Churah valley in the river Ravi basin in Himachal Pradesh. This proposal, however, was shelved after signing of the Indus Water Treaty in the year 1960. This illustrates how the Treaty undermined development efforts rather than promoting them.

Provisions of the Indus Water Treaty

The Indus Water Treaty between India and Pakistan was brokered by the World bank. The Treaty at that point of time resolved the disputes between both emerging economies to peacefully manage a valuable natural resource. The Treaty was signed with hope and optimism. However, over the years numerous technical and economic issues, as well as unprecedented challenges that come with climate change have outpaced the frameworks and spirit of

the Treaty. Moreover, even with the current state of the Treaty one must reconcile with the disproportionate allocation of water resources relative to the catchment areas and per capital demand for those resources.

As per Indus Water Treaty, India is allowed only around 19% of the water share of the Indus system through the Eastern rivers though it has almost double the catchment area of this percentage. On the other hand, Pakistan receives around 81% of the water share of the Indus system, having around half of the catchment area of this percentage falling in Pakistan. In other words, Pakistan was given disproportionate and excess share of water despite having half the catchment area, whereas India having almost double the catchment area has been given half of the water share.

Despite the disproportionate allocation of water resources, India has upheld the spirit of the Treaty without much reciprocation. For instance, despite Pakistan's failure to pay seigniorage charges for maintenance of Madhopur and Ferozepore Headworks as per the

Agreement dated October 15, 1948, India upheld its commitment to the region. From November 1, 1949 India as per Article V of the Treaty paid Pound Sterling 62,060,000 (which means around \$ 4 billion at today's value) towards the costs of the replacement works.

This demonstrates how the Treaty has been most generous towards Pakistan while undermining India's share of water resources as a function of catchment area and other factors.

Construction of hydroelectric projects on Western Rivers by India

One of the most significant limitations of the Treaty is its impact on developing Hydroelectric projects on the rivers - Chenab, Jhelum, and Indus – collectively referred to as the Western Rivers.

Annexure D of the Treaty governs use of the waters of Western Rivers for generation of hydroelectric power. Under Para 8, Annexure D, of the Treaty hydropower plants on the Western Rivers are to be constructed by India so as to be consistent with

'sound and economical design and with satisfactory operation of the works'.

It also clearly defines that the hydroelectric projects be constructed with 'customary and accepted practice of design for the designated range of the Plant's operation'. The Treaty clearly states how new projects should be constructed as per the accepted range of design for satisfactory operation of the projects. However, the Treaty has clauses under Annexure D that contradict this principle – limiting the validity of the arguments under the Annexure above.

This contradictory design is evident in Annexure D in which the Treaty is being interpreted to restrict provisions of outlets below the dead storage level, unless necessary for sediment control or any other technical purposes. Sediment load in Chenab and other Western rivers has become much higher than it was in the year 1960. The Treaty also refers to the unfeasible proposition of ungated spillways to be provided for development of hydroelectric projects on the Western Rivers. This is unfeasible for Western Rivers because they flow with steep gradient in the hilly regions.

Salal and Baglihar hydroelectric projects

A case in point is the dam of Salal Hydroelectric Project constructed by India on the River Chenab and commissioned in the year 1987. This dam has been completely silted almost up to the top of the dam. This project's operation and maintenance has become a challenge due to excessive sediment load and wear and tear of the turbine parts.

Sediment load in the river Chenab at site of the Salal Dam is such that in the upper reaches of the reservoir, sediments have started building/rising above full reservoir level and have started encroaching on fields of farmers. Sediments have even started entering the houses of the villagers above full reservoir level, along the river banks.

Similarly, Dam of Baglihar Hydroelectric Project (900 MW in Stage I & II) located on the River Chenab has suffered the same fate with filling up of the reservoir almost up to its top. The local population cannot be forced to undergo miseries due to flawed interpretations of the Treaty. Even Pakistan, at international fora, agrees that part of water storage of its Mangla and Tarbela dams has been filled with sediments.

Sedimentation - The new challenge

The subject of sediment control has grown very rapidly, has acquired international salience and the entire world is fighting to control the monster of sedimentation in their reservoirs.

It would be unfair to say that hydroelectric projects in India on the Western Rivers should continue to be constructed as per the standards prevailing for sediment control and operation of the projects as they existed in 1960. The Treaty must adopt an

evidence-based framework and be updated to fulfil the provisions of ensuring 'sound and economical design and with satisfactory operation of the works' contained in it. Pakistan is providing low level sluice spillways almost in all its hydroelectric projects which are under construction or have been constructed in the past.

Similarly, projects in India are also required to be constructed with 'customary and accepted practice of design for the designated range of the plant's operation' as per provisions of the Treaty. The Treaty is limiting India's ability to adopt such similar state-of-the-art infrastructure as India cannot be expected to dump billions of dollars in the river on construction of hydroelectric projects such that its dams get filled up with sediments in a few years after construction. There cannot be dual standards for construction of the hydroelectric projects in India and Pakistan.

Solution to Sedimentation – Examples of Rehabilitation of Dams from China and Japan

Low level sluice spillways are now being provided throughout the world to ensure long-term sustainability of hydroelectric projects.

Yamasubaru Dam in Japan was constructed in the year 1931 on river Miyazaki with overflow spillways, is another example. To tackle the sedimentation problem, two sluice spillways have been provided in the dam by cutting the existing spillways section in the middle of the dam by 9.3m and the lowering the invert of existing overflow spillway for providing sluice spillways. This work has been completed in the year 2022.

Such low-level sluice spillways have also been introduced in other existing dams in Japan. These examples clearly bring out that sluice spillways are essential for tackling the menace of sediments in the river. This shows that the interpretation of provisions of the overflow spillways in construction of new dams is unsustainable.

These examples above show how the number and size of sluice spillways must be optimised based on the international design practice and not be restricted because of unfounded fears of invalid interpretation of provisions of the Treaty. Thus, for sustainability of hydroelectric projects being constructed by India on the Western Rivers, it is essential to provide low level sluice spillways. This calls for a revision of restrictions under Annexure D, Para 8 of the Treaty.

Some Information From The Treaty

As per Para 9 Annexure D of the Treaty, 'India shall, at least six months in advance of the beginning of construction of river works connected with the Plant, communicate to Pakistan, in writing, the information specified in Appendix II of this Annexure'. Under this Annexure, Pakistan has objected to all projects, whether small, medium or large. Annexure D has curbed execution of Indian projects thereby leading to cost and time over-runs. More importantly, such provisions are not bilateral, giving one party the

asymmetric agency against the other. Therefore, it is essential to revisit such provisions, in the spirit of bilateralism – which should lie at the foundation of all Treaties.

Annexure E on the other hand lays down provisions for storage of waters by India on the Western Rivers. At the moment, average annual unutilised water going to sea in Pakistan is around 35 million acres feet (MAF).

It would be in the larger interest of both the nations to store water in reservoirs on the Western Rivers in India so that it is utilised for benefit of humanity. Both countries need to move forward and carry out review of the storage of water allowed under the Treaty.

Throughout the World, as and when an upstream facility for water storage and retention of sediments is created by construction of a dam for hydroelectric or for irrigation project, the downstream user(s) have to share the cost of such storage facilities.

Water Storage – The new imperative

Water storage has become critically important in a world where climate change resilience is a must. Water availability in the rivers has been severely impacted due climate change since signing of the Treaty in 1960. Pattern of inflow in the Himalayan rivers is changing due to climate change. Extreme hydrological events are already on the rise. As the intensity of extreme weather events becomes more severe and their frequency unpredictable, it is imperative to have storage of water on these Western Rivers. Water storage dams have now been recognised to combat the adverse impacts of climate change as well as for energy transition. India's serious efforts to deal with climate change are vital not only for its large population but also for mankind.

Given the complexity and burdens that come with climate change adaptation, the Treaty must be revisited to revise Annexure E towards a more resilience storage and distribution mechanism for both nations.

Conclusion

Much has changed since the Indus Water Treaty was ratified in 1960. Considering the historical water disputes and a disproportionate allocation of water relative to drainage and population, the parameters of operating and implementing the Treaty must evolve. The Treaty must not restrict India's ability to upgrade and maintain its hydroelectric infrastructure as per the state-of-the-art.

Considering sediment load in the rivers, water stress in Indian part of East Punjab which extends to neighbouring states of Haryana, Rajasthan and Himachal Pradesh in India, and similarly downstream in some parts of Pakistan, it is essential to revisit the Treaty for benefit of both the nations.

(Published in NatStrat)



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“ The application of silica nanoparticles (SiNPs) may be the solution for increasing the yield to combat the agriculture crisis soon

Crop Protection The Biological Way



ABOUT THE AUTHOR

Mr Vipin Saini is the CEO of Biological Agri Solutions Association of India (BASAI), and CEO Sunrakshan Foundation

According to an estimate by the Food and Agriculture Organization (FAO), the world population has reached 7.55 billion in 2017 and will reach 9.8 billion by 2050. Accompanying this growth is a demand for grain that is expected to increase at least 2.2-fold from 1970 to 2020 (2.5 billion tons). In contrast to needed increases in grain demand to parallel population growth, the amount of cultivated area in the world in 2015 was virtually the same as it was in 1965, with no rapid increase expected in the future. Therefore, combined with the predicted population growth, it appears that cultivated area per person will continue to decline worldwide.

Climate change is also looming as a major threat to grain production. On the one hand, temperatures rise could extend the growing season in certain areas, and it is possible that increased carbon dioxide levels may facilitate photosynthetic carbon dioxide fixation in certain types of plants, potentially leading to increases in grain productivity. Especially in areas in the Eurasian continent and high-latitude regions of North America, increased temperatures are expected to enhance grain crop yields. Many other areas, however, are likely to witness lower grain crop yields due to the influence of climate change. Moreover, many of the areas predicted to suffer reduced crop yields are currently major grain-producing regions. This means climate change threatens to greatly affect crop production. Across the world, the loss of yield in 2050 compared to 2000 is expected to be 24% for maize, 11% for rice, and 3% for wheat.

2030 Agenda for Sustainable Development

In adopting the 2030 Agenda for Sustainable Development, the United Nations committed itself to eradicating hunger and poverty, and to achieving other important goals, including making agriculture sustainable. Feeding humanity will require at least a 50% increase in the production of food and other agricultural products from 2012 levels by mid-century.

Today, agriculture is called upon to recover its productivity in environmentally friendly terms and to face challenges such as climate change and international political–military events that threaten global sufficiency in agricultural products. Specifically, through descriptive and regression analysis, the roles of biological

crop protection, chemical crop-protection techniques, and mechanical crop-protection techniques were explored, and it was found that they either have a positive effect or a significant relationship with sustainable agricultural productivity. To meet the current environmental, economic, and political challenges, the agriculture sector at the global and local level should improve and further adopt existing technologies, consolidate the use of integrated pest-management strategies, and fully introduce innovations, combined with digital transformation, into agricultural management and production.

Urgent Need To Improve Science Of Crop Protection

Crop losses from pests threaten global food security and safety. In the last six decades, pest control using chemical pesticides has resulted in important yield gains per unit area, worldwide. However, the long-term sustainability of chemical pest control has been increasingly thrown into doubt due to the negative impact on human health, biodiversity, and the environment. Consequently, there is an urgent need to improve the science of crop protection to tackle the five key challenges of 21st century agriculture holistically:

1. maintaining or improving agricultural productivity,
2. producing healthy food,
3. reducing the negative impacts of agriculture on ecosystem and human health,
4. ensuring the economic viability of farms, and
5. adapting agriculture to climate change.

Agro-ecological Crop Protection

Agroecological Crop Protection (ACP) can be one of the powerful approaches to address these challenges. ACP is the application of the principles of agroecology to crop protection in order to promote virtuous and sustainable changes in agriculture and food systems. ACP combines multiple approaches and disciplines including ecology, agroecology, and Integrated Pest Management. It promotes a crop protection system compatible with healthy agricultural and food systems, agroecological principles and the “one health” approach. It can be predicted that ACP will meet the challenge of pesticide-free agriculture in the future.

“ Biological agri-inputs along with its biotechnological & nano technological interventions can lead the way to attaining sustainability in agriculture

Organic chemistry has been, and for the foreseeable future will remain, vitally important for crop protection. Control of fungal pathogens, insect pests and weeds are crucial to enhanced food provision.

To contribute to programmes of integrated crop management, there is a requirement for chemicals to display high specificity, demonstrate benign environmental and toxicological profiles, and be biodegradable. It will also be necessary to improve production of those chemicals because waste generated by the production process mitigates the overall benefit.

Three aspects are considered in this review: advances in the discovery process for new molecules for sustainable crop protection, including tests for environmental and toxicological properties as well as biological activity; advances in synthetic chemistry that may offer efficient and environmentally benign manufacturing processes for modern crop protection chemicals; and issues related to energy use and production through agriculture.

Soil Health-Based Agricultural Management Practices

Soil health-based agricultural management practices are widely promoted to reduce erosion, increase nutrient use efficiency, improve soil structure, and sustain or increase yields. Pest and disease management are less frequently considered as components of a soil health management system. We present a framework for how the crop protection industry can advance soil health by developing systems of crop protection innovation that simultaneously target soil health outcomes, either through direct impact on soil or by enabling practices that promote soil health outcomes. Such an approach could lead to cross-sectoral, integrated agricultural solutions that achieve agronomic, environmental, and economic goals.

In the era of climate change, global agricultural systems are facing numerous, unprecedented challenges. To achieve food security, advanced nano-engineering is a handy tool for boosting crop production and assuring sustainability. Nanotechnology helps to improve agricultural production by increasing the efficiency of inputs and minimizing relevant losses. Nanomaterials offer a wider specific surface area to fertilizers and pesticides.

Nanomaterials

Nanomaterials as unique carriers of agrochemicals facilitate the site-targeted controlled delivery of nutrients with increased crop protection. Due to their direct and intended applications in the precise management and control of inputs (fertilizers, pesticides, herbicides), nanotools, such as nano biosensors, support the development of high-tech agricultural farms. The integration of biology and nanotechnology into nano sensors has greatly increased their potential to sense and identify the environmental conditions or impairments. In this review, we summarize recent attempts at innovative uses of nanotechnologies in agriculture that may help to meet the rising demand for food and environmental sustainability.

Silica Nanoparticles

Agriculture crops encounter several biotic and abiotic stresses, including pests, diseases, nutritional deficits, and climate change, which necessitate the development of new agricultural technologies. By developing nano-based fertilizers, insecticides and herbicides, and early disease diagnostics, nanotechnology may help to increase agricultural crop quality and production. The application of silica nanoparticles (SiNPs) may be the solution for increasing the yield to combat the agriculture crisis soon.

SiNPs have unique physiological properties, such as large surface area, aggregation, reactivity, penetrating ability, size, and structure, which enable them to penetrate plants and regulate their metabolic processes. Pesticide delivery, enhanced nutrition supply, disease management, and higher photosynthetic efficiency and germination rate are all attributed to SiNPs deposition on plant tissue surfaces.

SiNPs have been demonstrated to be non-toxic in nature, making them suitable for usage in agriculture. In this regard, the current work provides the most important and contemporary applications of SiNPs in agriculture as well as biogenic and non-biogenic synthetic techniques. As a result, this review summarizes the literature on SiNPs and explores the use of SiNPs in a variety of agricultural disciplines.

Copper is an essential micronutrient required for maintaining effective health and nutrition in plants. Due to their cost-effectiveness, unique nanoscale properties, well-established antimicrobial activity, and broad-spectrum applicability, copper nanoparticles (Cu-NPs) are finding great potential in agriculture applications for pest management and disease control.

Various nano-enabled strategies are proposed to improve crop production and meet the growing global demands for food, feed and fuel while practising sustainable agriculture.

Biological agri-inputs along with its biotechnological & nano technological interventions can lead the way to attaining sustainability in agriculture.



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Saguna Regenerative Technique

Enhancing Crop Protection for Sustainable Growth

To ensure sustainable growth in agriculture, innovative approaches are needed. One promising technique that has gained attention in recent years is the Saguna Regenerative Technique (SRT). SRT is a holistic, nature-inspired approach to crop protection and sustainable agriculture.

Understanding Saguna Regenerative Technique (SRT)

The Saguna Regenerative Technique (SRT) is a no-till, conservation agriculture method for rice-based farming. It can be used for 25 to 30 different crops including cereals, vegetables, pulses, oilseeds, millets, cotton, and maize among others.

It is a holistic system that aims to create a sustainable and resilient ecosystem while promoting biodiversity. The main focus of this method is on improving soil health through practices such as crop rotation, and minimal soil disturbance. By implementing these practices, the soil's organic matter content increases, water retention capacity improves, and beneficial soil microorganisms thrive, leading to overall soil regeneration.

With a regenerated and healthy soil ecosystem, farmers can expect improved crop yields, increased resistance to pests and diseases, reduced reliance on synthetic inputs, and enhanced sustainability in the long run.

SRT Reduces water requirement for crop cultivation to the tune of 40% (especially for rice), reduces the cost of production by 40% and reduces back-breaking labour by 50%. It also stops the emission of greenhouse gases and effectively does carbon sequestration to improve soil fertility.

Rural Empowerment With SRT

The amazing ability of rural empowerment has been observed even with tribal families where their annual income has risen 4 times. Above all, it brings joy and confidence to the farmer which

has now started the reverse trend of able youth returning to the farming profession.

The technique is favourably addressing 7 of the 17 SDGs by the United Nations. Also, SRT is validated by FAO, Rome which is available at <https://www.fao.org/teca/en/technologies/10108>

Crop Protection through SRT

Crop protection is a critical aspect of agriculture, as pest infestations and diseases can lead to substantial yield losses. SRT offers unique solutions for crop protection that align with its regenerative principles. One fascinating aspect of SRT is its emphasis on enhancing plant health to bolster crop protection.

1. SRT encourages the rotation of different crops in a systematic manner. Crop rotation disrupts the life cycles of pests and diseases, reducing the need for chemical interventions.
2. By fostering a biodiverse environment, these natural predators can thrive and keep pest populations in check.
3. Certain plant combinations can deter pests. For example, planting marigolds alongside tomatoes can help repel nematodes. SRT utilizes these natural synergies to reduce the need for chemical pesticides.
4. SRT promotes the cultivation of crop varieties that are more resistant to pests and diseases.

Incorporating these principles into SRT practices further strengthens the foundation of sustainable agriculture and crop protection. By nurturing plants farmers can significantly reduce their dependence on chemical pesticides and promote the cultivation of resilient crops that are more resistant to the challenges of modern agriculture. This approach enhances the sustainability and health of our food production systems while also contributing to the broader objectives of SRT, such as farmer happiness, profitability, and environmental stewardship.

Farmer Happiness and Profitability

Farmers' happiness and profitability are two essential factors for the sustainability of food production. The two dreaded problems of the world today, food shortage and global warming, are interconnected and can only be solved by farmers. However, it is essential to note that the importance of farmers' happiness has often been overlooked.

The team behind SRT did not initially have the objective of happy and confident farmers, but when the technique was slowly adopted by farmers, it became a major observation that farmers were becoming happy. The sense of harmony with nature, reduced reliance on chemicals, and improved economic prospects contribute to their happiness.

The second most important aspect heard worldwide is the rising cost of production in farming, leading to reduced profitability. While farmers cannot control the selling prices of their products, they can influence their cost of production. SRT addresses these concerns by reducing the cost of production through practices such as reduced tillage operations and decreased reliance on expensive synthetic inputs. By reducing the cost of production, farmers' profitability is assured, even in the face of market uncertainties.

SRT - Promising Path To Sustainable Crop Protection

The Saguna Regenerative Technique (SRT) offers a promising path to sustainable crop protection and agriculture, alongside the essential goals of farmer happiness and profitability. By emulating natural systems, SRT not only enhances crop resilience but also provides environmental and economic benefits.

As we confront the challenges of feeding a growing global population while mitigating the effects of climate change, SRT stands as a beacon of hope, guiding us towards a more sustainable and regenerative future for agriculture. It is crucial for policymakers, farmers, and consumers to support and invest in regenerative techniques like SRT to ensure the long-term health of our planet, the well-being of future generations, and the happiness of those who feed us.



SRT reduces the cost of production through practices such as reduced tillage operations and decreased reliance on expensive synthetic inputs. By reducing the cost of production, farmers' profitability is assured, even in the face of market uncertainties



ABOUT THE AUTHOR

Mr Shekhar Bhadsavle, Krishi Ratna & Krishi

Bhushan, is Founder and Managing Trustee, Saguna Regenerative Technique (SRT) and Saguna Rural Foundation (SRF). He is also the Managing Director of Saguna Sustainability Solutions Pvt Ltd, Raigad, Maharashtra





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Let us all seed
our generation next
to be our fruit bearers
and nurture the
nature to nourish us
sustainably

ABOUT THE AUTHOR

Ms Sangeeta Bojappa Moorthy is an Agripreneur, urban Farming visionary, practitioner, educator, solutioneer and a mentor in futuristic farming practices including soil-less cultivation

Towards Greener Ecosystems

To conserve natural resources and the need to meet the sustainable development goals has given rise to urban agriculture, newer farming methods like Hydroponics, indoor and family farming. Digitization, Artificial Intelligence, block-chain technology, and various other digital tools have also emerged as promising tools to develop a self-reliant society, and a greener ecosystem.

Nutritional security is to be given due importance along with food security. It incorporates all the aims of food security with

additional emphasis on the need for wholesome, healthful foods and well-being for everyone, which in turn promotes Human Security. And without human security, there is no national or global security.

Food-Security Measures

GOI needs to take on a bigger role other than their traditional regulatory and facilitating functions. By challenging the traditional legacy model and pursuing such a program, the government can ensure food security and reduce dependency on imports. GOI has

become a net exporter not only of products but also IP and new solutions, increasing productivity and supporting the shift towards an innovation- knowledge-based /circular economy while focusing on substantial investment in agricultural research, irrigation, extension services, and climate-smart agricultural practices.

Agricultural companies must help farmers adopt sustainable farming practices with right advice on seeds, agri inputs and a package of practices specific to suit the region's climatic conditions. Farmers need to adapt to changing times and embrace technological innovation interventions by guarding soil health.

Agricultural Ecosystems

Time has come to stop greenwashing certain traditional practices as environmentally friendly. There is a need to adopt green investments to address the economic, environmental, and social goals for improving the quality of our lives and conserving natural resources for present/ future generations.

To be economically sustainable, these innovations/practice/process and policy must provide incomes and create jobs. To be socially sustainable, they must include food /nutritional security goals for the poor and vulnerable.

To be environmentally sustainable, we must preserve natural local resources, and adopt eco-biodiversity for an ideal growing agricultural environment. We should also aim at minimising greenhouse gas emissions, and food loss/ waste.

For sustainable agriculture to be the end-all solution, target segments to be dealt with are as follows.

FARMING COMMUNITY

Educate them to accept change and embrace innovative technologies in the rapidly ever-changing agricultural environment. Adopt sustainable food production systems and implement resilient agricultural practices that increases productivity and production, helps maintain ecosystems, that adapts to climate change, extreme weather, drought, flooding and also, which progressively improves the land and soil quality as well.

These package of practices for farmers should include introducing drought-resistant or high yielding seeds, sustainable and less labour-intensive farming techniques like Micro-drip irrigations, protected cultivation, farming practices like Hydroponics/indoor farming, workforce inclusion of more female farmers, introducing insurance to promote risk-seeking behaviour ,encourage social acceptance of new technologies, ROI based commercial viability project implementation, adapt real-time trainings and resources availability for implementation. Agricultural diversification to higher-value commodities, Way of operating as well towards cluster, community, SHG and FPO's formation for better produce/product value, marketing visibility and sale price.

AGRICULTURAL/FARM INPUTS

Our sustainable efforts to be more focused on

Energy - To focus on Reducing the dependency on fossil fuels and increase it on renewable resources like solar, wind, biomass, hydro, bio and other emerging alternative fuels.

Seeds/Substrates - sustainable seeds systems for timely access, affordable quality seeds, right and affordable environmentally friendly planting materials.

Fertilizer - Application of fertilizer that ensures optimal water, energy, nutrition usage taking in consideration its impact on environment.

Pesticides/Plant Medicines - Judicious pesticides application based on Integrated Pest Management (IPM) which is seen to achieve sustainable agricultural production with less damage to the environment and safer food production. Efficient integration of ICT for surveillance of insects /diseases and invasive pests with artificial intelligence (AI) for pest diagnostics and weather forecasting is certainly proving to be a fire-ball tool.

Innovative Technologies - Trending concepts like 'Digital', 'All things Internet,' 'Reach all', 'Contact-less', 'Remote all', 'Automate all' and 'Digital currency' etc are rhyming in our lives. Hence Investment in Artificial intelligence is beneficial as it provides data to implement our action in the fastest/accurate/sustainable manner towards the Agricultural production, Market, and consumer centric food system.

Agriculture Value Chain

Adoption of food sensing tools for food safety, quality, Block chain /IOT and mobile service for transparency and traceability with emerging microbiome technologies for crop resilience, road loss is essential.

Digitization addresses food concerns and drives sustainability by reducing food wastage, lowering inefficiencies and costs in food supply chains for bettering quality significantly.

Ensuring Good Food

Consumers also should arm themselves to grow their own food and develop it as a survival skill set, adopt, grow and eat local, community conscious commitment living.

Our approach towards food sovereignty and agroecology must be sustainable for the present and future. "More crop per drop" "health per acre" wealth per acre" is possible with adoption of holistic mindful actions towards inclusion of all living beings harmoniously with Nature. Sustainable way is the right way to weed out all our agricultural woes.

Let us all seed our generation next to be our fruit bearers and nurture the nature to nourish us sustainably for present and in the future by aligning ourselves with the Nation's recent vision of Vasudhaiva Kutukbakam (Earth is One Family).

The Revolution In Plant Protection

Share of gross value added in agriculture and allied sectors in 2022-23 as per the Ministry of Statistics & Programme Implementation, GOI in total Indian economy based on current prices is 18.3% and growth rate based on 2011-12 prices is 3.3%.

It is important for us to protect our crops from the damages caused by insect-pests, weeds, diseases, pathogens etc. to increase agriculture productivity to feed our burgeoning population for which a variety of tools, products and tactics are used without causing ecological damage.

Plant breeding programmes have improved cultivated rice by the transfer, from wild species, of genes conferring resistance to viral diseases. Diversification of resistance is sought to render the hybrids less vulnerable to sudden outbreaks of diseases and insect pests. Linkage of resistance genes with morphological markers enables the inheritance of resistance to be followed easily. It is important that recent advances in molecular genetics are incorporated into integrated pest management programmes.

Crop-Protection Products

Agrochemicals, also known as crop-protection products (CPPs), are either naturally occurring or synthetic compounds that aid farmers to reduce crop losses and increase yield per hectare.

Synthetic chemical agrochemicals have made it possible for agricultural production to increase enormously, and they are still crucial for sustaining consistently high yields despite rising pressure from weeds, insects, and diseases, including invading species from other countries.

The revolution in plant protection has been driven by diverse

factors. Target pests are becoming resistant to agrochemicals. Market forces are making development, registration, and use of new agrochemicals prohibitively expensive. Agrochemicals have real or perceived side effects on non-target organisms like humans.

It is particularly important to increase agriculture output to feed the increasing global population. According to Kubiak et al., 40% of agricultural loss is caused by various weed species, illnesses, insects, and animals. Losses in commercial crops might be either qualitative or quantitative. Lower yields per unit area because of subpar output result in quantitative losses. A decrease in the market value of crops and a reduction in the quantity of vital nutrients they contain create qualitative losses.

Abiotic factors like temperature, accessibility of water, light and nutrients, soil erosion, soil salinity etc. and biotic factors like pathogenic organisms (viruses, fungi, and bacteria), animal parasites (insects, mites, nematodes, snails, rodents, birds, and mammals), and weeds (monocotyledons or dicots) contribute to decreased agricultural production.

Safeguarding The Environment

Farmers are being encouraged by GOI and the state governments to adopt advanced production techniques that safeguard the environment. Global agri-food systems may be made more economically, socially, and environmentally sustainable with the use of digital technology.

Plant protection technologies in sustainable agricultural productivity and management are categorized into three large groups of chemical, biological and mechanical crop-protection techniques.

Among the areas of research that have received the highest attention is the increasingly intensive use of chemical crop protection products to control pests. Integrated pest management (IPM) and the use of biocontrol solutions are experiencing wider acceptance globally as new alternative ways to achieve sustainable control solutions.

Chemical control is an integral part of ICM, an integrated agricultural system based on a healthy combination of all available pest control methods. Crop protection, which is currently mostly accomplished by using chemical agents, is also undergoing change. Another strategy is to use biological controls employing microorganisms which can help in the goal of creating sustainable agriculture with fewer ecological costs.

Environmentally Friendly Nanoplatforms

To address the current challenges of modern agriculture in recent times, advanced materials have been used for the construction of environmentally friendly nanoplatforms with excellent properties for sustainable agricultural development.

Thus, the field of nanotechnology is within the studied field and has gained particular interest in the agricultural sector compared to conventional agricultural practices. To the current challenges of modern agriculture can be added the development of ribonucleic acid (RNA) interference technology [(RNAi technology or post-transcriptional gene silencing (PTGS) technology], which is an environmentally friendly, flexible, safe, and potentially effective alternative solution for crop protection.

Interest In Organic And Low-Input Agricultural Systems

Presently, the boundaries between chemical, biological, and mechanical crop-protection techniques to achieve sustainable crop protection and safe product use are blurred. Interest in organic and low-input agricultural systems has caused the emphasis to move from chemically effective control to other alternative ways.

A wide range of technologies have been used to make modern agriculture more efficient. The rapid development of precision agriculture has been made possible using the Global Positioning System (GPS) with geographical information systems (GIS) techniques and remote sensing data.

Therefore, the assessment of spatial differences in soil properties and characteristics is very important for crops with the help of technology [Internet of Things (IoT), unmanned aerial vehicles (UAVs), and wireless sensor networks (WSNs)]. GOI has been actively promoting use of various technologies including drones in agriculture to facilitate increase in agriculture productivity with focus on sustainability.

Amalgamation of chemical, biological and mechanical crop protection methods along with various technologies are important for sustainable agriculture.

“ Amalgamation of chemical, biological and mechanical crop protection methods along with various technologies are important for sustainable agriculture



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Crop Protection

Pillar of Sustainable Agriculture



Farmers urgently need timely access to a wide range of tools tailored to local conditions to produce more food, whilst adapting to climate change and maintaining biodiversity



ABOUT THE AUTHOR
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In a world with a growing population and increasing demands for food production, the role of agriculture in ensuring food security and sustainable growth has never been more critical. However, agriculture faces numerous challenges, including climate change, pests, diseases, and limited natural resources. To address these challenges and ensure a sustainable future for agriculture, it is imperative to implement effective strategies and solutions. Sustainable agricultural solutions like crop protection are the key to addressing this challenge.

Crop protection encompasses a range of practices and technologies aimed at preventing or managing the damage caused by pests, diseases, and weeds while minimizing the impact on the environment. It involves the responsible use of crop protection products, biological control methods, precision agriculture technologies, and sustainable farming practices.

Multiple Benefits

According to a study published in 2022, 40% of agricultural loss is caused by various weed species, insects, and animals. Losses in commercial crops might be either qualitative or quantitative. Lower yields per unit area because of subpar output result in quantitative losses.

A decrease in the market value of crops and a reduction in the quantity of vital nutrients they contain create qualitative losses. Crop protection solutions enable farmers to optimize their yields, reduce crop losses due to pest attacks, and minimize the need for additional land and resources.

Crop protection solutions also contribute to the reduction of greenhouse gas emissions by allowing farmers to increase yields on existing agricultural land, thus mitigating the pressure to clear forests and natural habitats for farming. Moreover, it helps conserve biodiversity by preserving natural ecosystems.

Innovations in Crop Protection

In recent years, the field of crop protection has experienced remarkable innovations driven by advances in science and technology. These innovations encompass a range of more precise and environmentally friendly solutions. Newer generations of crop protection products have effective low usage rates, new mode of action, and favorable environmental, toxicological, and regulatory profiles – empowering farmers across the world.

Biopesticides, derived from natural sources like plants, bacteria, and fungi, offer highly effective pest and disease control while minimizing their environmental impact. Digital agriculture, which includes technologies such as satellite imagery, drones, and data analytics, empowers farmers to monitor their crops and optimize input application, thereby reducing waste and lessening the environmental footprint.

Integrated Pest Management (IPM) combines various strategies,

including biological control and cultural practices, alongside judicious pesticide uses to sustainably manage pests and diseases.

Policy Frameworks Needed To Generate Pathways

Achieving sustainable agriculture requires a collaborative effort involving governments, industry, and various stakeholders, with public-private partnerships (PPPs) emerging as pivotal in tackling the intricate challenges associated with crop protection and sustainable growth. These partnerships facilitate multifaceted approaches. PPPs and triple-helix model foster innovation by synergizing the expertise and resources of the academic institutes, public and private sectors, enabling governments to champion research and development initiatives that give rise to novel and more sustainable crop protection solutions.

Predictable science-based policy and regulatory environment that incentivize R&D is the need of the hour and should be an important dimension in journey towards Amrit Kal.

It is critical that Indian farmers must have at-par access to newer, greener technologies. Policy ecosystem plays a huge role in bridging this accessibility gap. Governments play a fundamental role in establishing regulatory frameworks that ensure the safe and responsible use of crop protection products, and collaborations between government agencies and industry go a long way in promoting the adoption of environmentally friendly solutions.

Collaborative Efforts

Knowledge sharing is a core component of PPPs, facilitating the exchange of valuable insights and best practices among stakeholders, which in turn empowers farmers to make informed decisions regarding crop protection and sustainable farming practices.

Additionally, through collaborative efforts, capacity-building programs can be provided for farmers, equipping them with the knowledge and skills needed to utilize crop protection products and technologies effectively and responsibly. Lastly, governments contribute by fostering favorable market conditions for sustainable crop protection solutions, including support for market access of innovative products and technologies that promote sustainability.

Vital Need

Crop protection solutions are vital for harvesting sufficient quality food and thereby reducing the need for expanding cropped land. The United Nations Food and Agriculture Organization (FAO) estimates that without crop protection global crop losses would double, creating a devastating impact on global food security. While all farmers are challenged by climate change, smallholder farmers in developing countries are being hit the hardest. They urgently need timely access to a wide range of tools tailored to local conditions to produce more food, whilst adapting to climate change and maintaining biodiversity.

A large white quote icon consisting of two nested L-shaped brackets.

Innovations such as precision agriculture, farm management software, supply chain optimisation tools and the integration of modern technological solutions are increasingly prevalent

India's Agritech Sector The Rise and Reckoning

The story of India's agritech industry over the past few years has been nothing short of a rollercoaster. Once hailed as the golden child of the Indian startup ecosystem, the sector witnessed immense growth, attracted significant investor interest, and experienced surges in funding that left many startups flush with capital.

Post the pandemic in 2021, the agritech sector in India witnessed a significant upsurge in terms of technological adoption and investor interest. The disruptions caused by the pandemic underscored the importance of a resilient food supply chain, prompting farmers and stakeholders to embrace digital solutions with greater enthusiasm.

An in-depth analysis by Inc42 highlighted the innovative paradigms shaping the future of agritech in India. Innovations such as precision agriculture, farm management software, supply chain optimisation tools and the integration of modern technological solutions like the Internet of Things (IoT), Artificial Intelligence (AI), Blockchain Technology, and Big Data became increasingly prevalent in India's vast agrarian landscape.

Agritech Boom and Investor Magnetism

The sector piqued the interest of investors who saw immense potential in a market striving to modernise its age-old agricultural practices. There was a notable influx of investments in startups offering innovative solutions ranging from online marketplaces for farmers to AI-powered crop advisory services. This confluence of technological integration and financial backing set the stage for a transformative era in India's agriculture, promising increased efficiency, reduced wastage, and better income opportunities for farmers. In 2022, the agritech sector in India experienced a

remarkable influx of capital, reflecting its potential to revolutionise the nation's agricultural landscape.

Meteoric Rise of Select Agritechs

According to a comprehensive report by the investment banking firm Avendus Capital, the first nine months of the year alone saw 30 funding rounds in the agritech space, cumulating to an impressive sum of \$796 million. Avendus showcased its bullish outlook on various agritech entities, such as Absolute Foods, Arya. Ag, Dehaat, Farmart, Captain Fresh, Vegrow, Bighaat, Agnext, and Bijak. B2C players like Country Delight and Licious have also been spotlighted by Mint.

Massive growth led to expansive hiring sprees, with some firms doubling or even tripling their workforce in a short span. DeHaat's funding infusion in December 2022, where it raised \$60 million from existing investors, valued it at \$695 million. Waycool raised Series D fund with \$117 million valuing the startup at over \$ 700 million. The Ken reported that plant bioscience startup Absolute and farmgate storage enabler and grain commerce platform, Arya. ag also made their entry into the list of top 5 agritech startups in India after their new fundraising in 2022.

With bulging coffers, these posterkids were racing to becoming India's first agritech unicorn.

Onset of the Funding Winter

In 2022, Indian agrifoodtech raised \$2.4 billion across 133 deals. The most active categories by number of deals were Agribusiness Marketplace & Fintech and eGrocery. However, the sharp rise in funding for India's agritech sector was soon followed by an unexpected downturn.



Funding plummeted by 33% to \$2.4 billion, a significant drop from the \$3.6 billion recorded in 2021. The macroeconomic headwinds had a bigger impact on downstream, consumer-facing categories, where funding declined significantly. The situation further deteriorated in 2023, as the startup ecosystem grappled with what was described as a 'funding winter'. MoneyControl highlighted this financial frost, reporting a staggering 79% decline in startup funding within the first five months of the year.

According to Entracker, DeHaat, Ninjacart, and WayCool were the top three agritech startups, both with respect to funding and scale during the last fiscal year (FY22). While DeHaat and Ninjacart emerged as top two companies in the segment with Rs 1,274 crore and Rs 967 crore revenue in FY22, WayCool took the third position with Rs 927 crore in gross revenue during the last fiscal.

However, Dehaat's expenditure more than tripled to Rs 1,438 crore in FY22 from FY21 and its operational monthly burn in FY22 stood at around Rs 31 crore. Waycool achieved a 2.4X surge in its scale by losing money at the same pace.

On a unit level, WayCool spent Rs 1.39 to earn a rupee of operating revenue in FY22. Its losses widened 2.4X and stood at Rs 360 crore in FY22. Ninjacart managed to control its losses by 18.1% to Rs 308 crore against Rs 376 crore in FY21 and inched close to becoming a unicorn in its last round with a valuation of \$815 million.

In line with its revenue growth, Absolute Foods's expenses and losses also shot up 12.2X and 12.3X to Rs 398 crore and Rs 37.4 crore in FY22. Arya.ag, on the other hand, has the distinction of being the only profitable agritech start-up at scale. It registered a net revenue of Rs 200 crore in FY22 with a net profit of Rs.2.5 crore.

The agriculture economy offers lower margins, but reversing loss making or subsidised business with a shift to 'viable' margins can become very difficult in this segment, according to Mr Anand Chandra, co-founder and ED of Arya.ag. Mr Chandra says, "Arya.ag has been able to establish strong product-market fit with its FY23 revenues touching Rs 300 crore (with gross revenues of over Rs.1750 crore) and achieving a net profit of Rs 15 crore. We are confident of increasing our revenues to Rs 500 crore in FY24 with a net profit of Rs 35 crore."

The company has so far received USD 65 million in external equity capital and appears to be among the most capital efficient agritechs.

Challenges

From delayed salaries and pay cuts to layoffs, operational cutbacks, and a drastic shift in growth strategies, most companies especially tech start-ups, found it challenging to maintain their operations at the previously established scale. 28,800+ employees have been laid off by over 110 startups since 2022.



India's agritech sector is poised for accelerated growth with the combined effort of enterprising start-ups, private investors, social and government initiatives



In agritech too, Ninjacart laid off at least 200 employees across functions and key cities, but the management denied executing cost-cutting measures.

DeHaat laid off about 5% of its employees last year, other venture capital-backed firms like Bijak, Captain Fresh, BharatAgri and Gramophone too have recently undertaken layoffs. Waycool too announced a layoff of around 300 employees in July 2023.

"With the fluctuations in the agri industry, it becomes essential to have a business model that focusses on steady and sustainable growth leveraging cost efficiencies. We have been very strategic with our growth and we have not laid off any of our team members," added Mr Chandra from Arya.ag which currently has 2600+ employees.

From aggressive growth and expansion, the focus has shifted to consolidation and survival. While the immediate challenges posed by the funding winter are undeniably harsh, many investors

and entrepreneurs suggest it is fostering a more resilient startup ecosystem in India. The cash-burn models, which many agritechs had adopted during boom times, have come under scrutiny. Investors and stakeholders have begun to emphasize profitability and sustainability over mere growth.

The Silver Lining

The agritech sector's trajectory over the past few years offers critical insights into the broader startup culture in India. The rapid rise, followed by the challenges of the funding winter, underscores the necessity of striking a balance between aggressive growth and sustainable operations.

Since January 2022, close to 15 venture capitalists have launched new funds and a clutch of them will also focus on agritech startups. The Indian government has also shown its deep interest in agritech startups. The increased agricultural credit target and the government's commitment to build storage facilities closer to the farm gate will also sustainably empower farmers.

Agriculture Accelerator Fund

The introduction of the Agriculture Accelerator Fund aims to accelerate the pace of innovation by bringing innovative and affordable solutions to transform agricultural practices and increase productivity and profitability. Multiple foundations in India such as The Bill and Melinda Gates Foundation (BMGF) and Tata Trusts are also playing an enabling role for agtech startups.

"By bringing in the right balance of technology, human resources and models that are built on strong unit economics, it is possible to develop a profitable and sustainable agritech company in India despite the challenges or fragmented markets and processes. We have been able to prove it through Arya.ag and we believe others will join our league soon," said Mr Chandra on the future of Agritech.

Prioritize Sustainability Over Unchecked Expansion

In essence, the funding winter has merely exposed the vulnerabilities of the agritech sector, compelling it to mature rapidly. The challenge for most startups will be to wring out more efficiencies and prioritize sustainability over unchecked expansion.

As Avendus has pointed, agritech companies are expected to have higher growth rates but operational profitability is key for sustainable outcomes. With relatively thinner margins vis-à-vis consumer companies, agritechs would need to be capital efficient.

The agritech sector in India is poised for accelerated growth owing to the combined effort of enterprising start-ups, private investors, social and government initiatives. Undoubtedly, innovation and technology will continue to shape our future and solve the problems of scale and profitability in agriculture for impact.



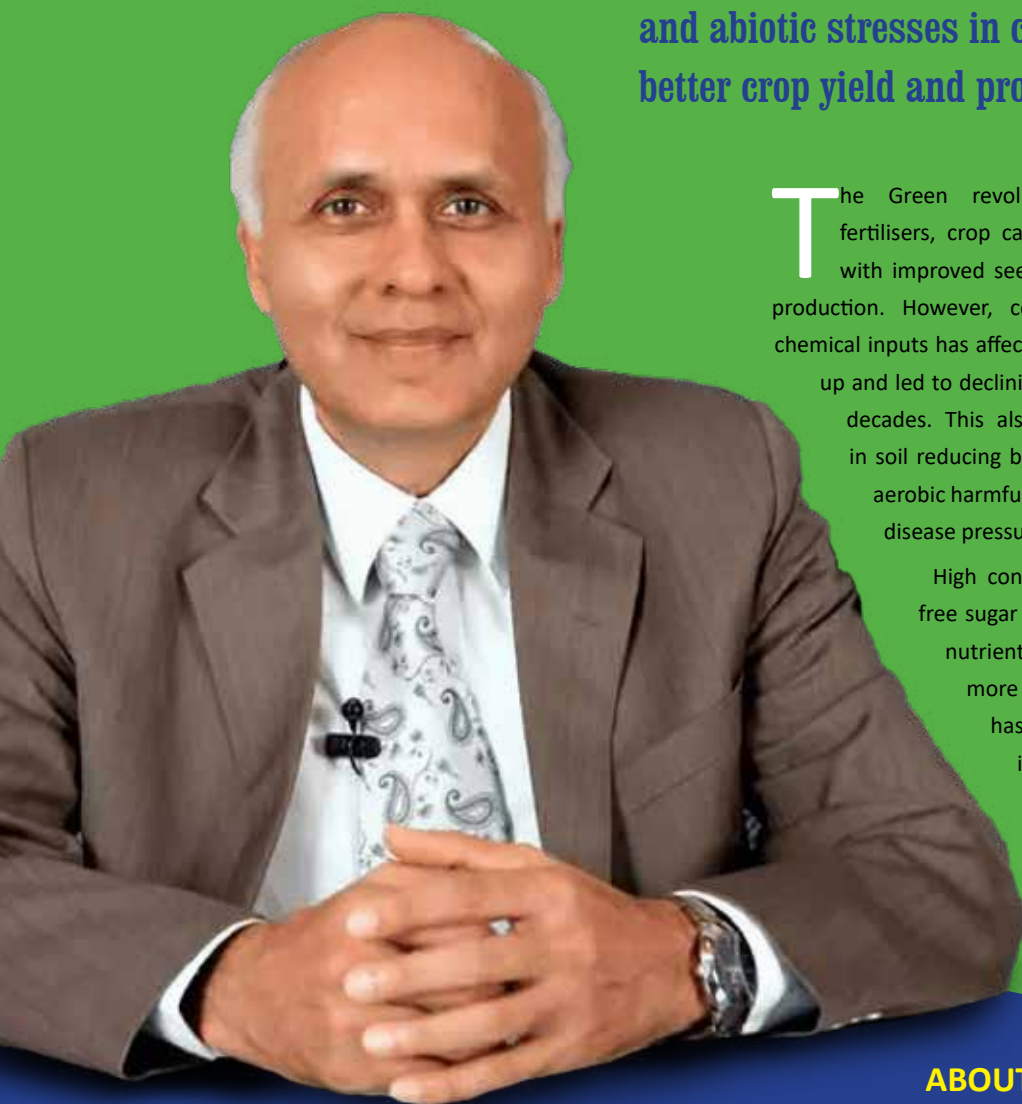
Set to Transform Farming in India with the Launch of SEVEN Revolutionary Lightweight 4WD Tractors



Built Tough in India... for India & the World

New Crop Protection Approach for Sustainable Agriculture

“ The Zydex technology platform of Bio-fertilizers, special adjuvants, and biological products, offers improved soil structure and enhanced soil biology. This builds tolerance against biotic and abiotic stresses in crop plants, resulting in better crop yield and produce quality



The Green revolution introduced modern chemical fertilisers, crop care chemicals, mechanized tilling along with improved seeds which boosted country's food grain production. However, continuous, and non-judicious use of chemical inputs has affected the soil fertility, raised toxicity build up and led to declining or stagnant production over last two decades. This also changed the biological composition in soil reducing beneficial microbes and increase in non-aerobic harmful microbes leading to increasing pest and disease pressure.

High concentration of nitrates, ammonium and free sugar in the plants due to excessive chemical nutrients like Urea & DAP are making the crops more vulnerable to pest and diseases. There has been increased attack of harmful insects & pests on commercially grown crops leading to increased use of crop care chemicals and issues of resistance development among pests to various chemicals.

ABOUT THE AUTHORS

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The eco-agriculture/ organic agriculture has been able to demonstrate elimination of chemical fertilizers and experienced substantial reduction in infestation of harmful pathogens and pest attack in the crops. This confirms the mechanism and hypothesis that application of chemical fertilizers is responsible for vulnerability of crops to diseases and pest attack. 40 years of observations in organic farms have shown that disease and pest infestations have been substantially lower there compared to chemical farms.

Deterioration Of Agricultural Land

Another area of concern for Indian agriculture is deterioration of agricultural land due to over exploitation and high use of chemicals in form of fertilizers and pesticides. In some areas, due to mono-cropping for a long period, some pathogens have gone beyond threshold level and become difficult to control, making those fields unviable for commercial cropping of specific crops.

New technological breakthrough to enhance crop resistance through bio-protection has been developed. It utilizes developing significant population of healthy microbes in the soil as well as on the standing crop canopy to resist pathogenic fungal/ bacterial attack along with reduced vulnerability to insects and pests. This works well when the chemical fertigation is replaced with bio-fertilizers achieving the objective of eco-farming.

The latest bio protection technology is developed to address soil borne diseases and the above ground infestation effectively.

For good crop response and fertility, it is critical to have 3:1 fungal to bacteria biomass. Currently it is at 0.1-0.3 of fungal biomass to bacterial biomass. So, it is imperative that for enhancing the soil fertility and bio-protection, new technologies and techniques



to enhance fungal population will be the key for pest & disease protection in the soils. This will further improve the soil fertility and crop yield.

The Role Of Fungi

The loss of fungal population has also resulted in enhanced population of root attacking nematodes causing a lot of damage to the roots by creating nodule and reducing the nutrient uptake substantially. Useful fungal population species (like Mycorrhiza, Trichoderma etc) enhancement is very critical for plant growth and the key to tackle the pathogens in the soil like root attacking nematodes, soil borne diseases without using chemical pesticides/ fungicides.

The fungal species tend to cover the roots and build symbiotic relationship. This ensures, repelling the attack of pathogenic fungal species along with controlling the population of root attacking nematodes. Thus, eliminating the need of treating soil with chemicals for killing these pathogens and nematodes.

The field application of effectively bio-digested fungal rich manure has shown to eliminate the white grubs, reduce weed population, almost eliminating the fungal pathogenic attacks on the roots and control the menace of root attacking nematodes, demonstrating that the bio-protection technology is effective. It is also cheaper, eco-friendly using local resources leading to sustainable agriculture. Most important benefit is reversal of soil degradation experienced in last 2-3 decades. The field experience in India and many other countries have shown excellent consistency and 100% success rate.

Foliar Bio-Protection For Crops

Chemical pesticides work on kill mechanism and have long residual life cycle in soil and environment. The kill mechanism allows pests to evolve to become resistant to these chemicals and create bigger threat to the crops as well as environment. These chemicals also kill beneficial insects leading to ecological imbalance. This has led to the emphasis on adopting techniques and technologies which do not focus on kill but repelling the harmful pests and protecting the plant from the pathogens.

Latest study from Dr James White of Rutgers University, New Jersey, USA confirms that the microbial species enter and live in the plants just like micro-biomes in human gut and help the plant to grow. Current understanding is that they provide the nutrients and perform many functions critical to the plant health.

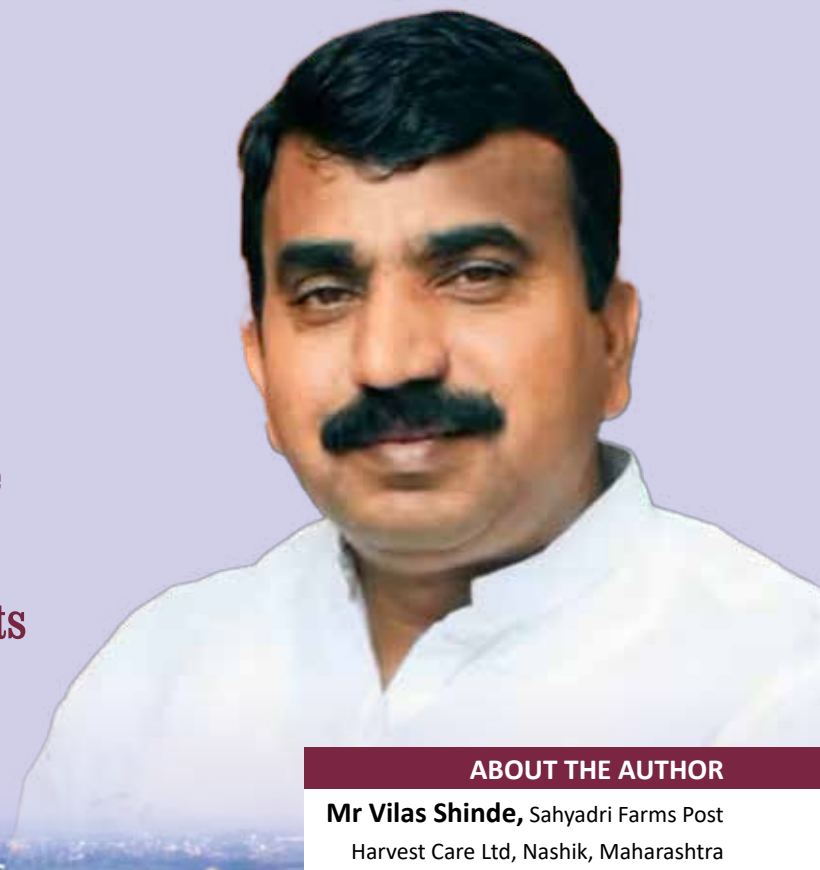
Zydex has developed a range of new technologies utilizing crop friendly microbes with natural crop protector like Neem Oil with effective micro encapsulation technology which works as a protective shield creating a bio-layer on plant canopy. They protect against the infestation of harmful fungal pathogens and reduce the attack of insect and pests. The application of these products helps in developing beneficial pest population leading to more effective crop protection through natural means.

FOOD PROCESSING

Major Driver For Agricultural Growth



Sahyadri Farms Post Harvest Care Ltd is a 100% farmer-owned company. We are trying to make farming a profitable and sustainable business and provide safe, healthy and affordable farm produce, and value added products to the consumers



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Sahyadri Farms – Mohadi Campus

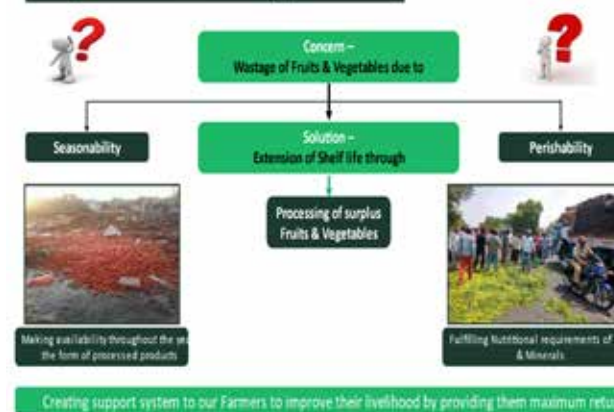


Food inflation in India can be largely attributed to the post-harvest losses and to a little extent to the falling production growth rates in the horticulture segment. Such post-harvest losses amount to close to 5% in the fruits and vegetables group and lesser in other segments such as grains, animal produce, seeds etc.

Main Issues Faced By Indian Agriculture

- Small land holding of farmers and 80% area is non-irrigated
- Low productivity in the farm level
- Negligence towards quality required by the consumer
- Increased cost of production and Disturbed agriculture finance system
- Unpreparedness to natural calamities & losses
- Poor post harvest management and Lack of basic infrastructure
- Marginal linkage between Farmers and the process industry
- Season constraint in Fruits and vegetables
- Perishability in case of horticultural crops

Why We need Processing



Food Processing Scenario In India

India moving from a position of scarcity to surplus in terms of food production, the opportunities for increasing food processing levels are innumerable. India's food processing sector, in recent years, has been known for its high-growth and high-profits, thus, increasing its contribution to the world food trade every year.

Currently, India is processing less than 10 % of its agricultural output, thus, presenting immense opportunities for increasing these processing levels and leading to investments in this sector. With agriculture and its allied sectors being the largest source of livelihoods in India, 70 % of its rural households still depend primarily on agriculture for their livelihood. Thus, this sector provides a huge employment generation potential as well.

IQF FROZEN LINE



Sahyadri Farms Post Harvest Company Ltd

The food processing sector has been acknowledged as a high priority industry by the government of India and is currently being promoted with various fiscal reliefs and incentives. Currently, commercial processing of fruits and vegetables is extremely low in India, at around 2.2% of the total production as compared to countries like Philippines at 78%, China at 23% and the United States (U.S.) at 65%.

The Indian food industry's output is expected to reach \$ 535 Bn by 2025-26. Rising household incomes, urbanization and the growth of organized retail are currently some of the major drivers of this market. The Indian market is fast evolving and has seen some major changes in terms of changing consumption patterns due to urbanisation, changes in the gender composition of the workforce, and growing consumption rates. The growing consumption of food is expected to reach \$ 1.2 Trn by 2025-26, owing to these factors.

Processing Cycle & Distribution



Indian Food Processing Market

India not only has the advantage of a huge domestic market but also with abundant raw material, is a large sourcing hub for agriculture products. Additionally, more than two-thirds of India's 1.3 Bn people are young with growing incomes which also creates a large market for food products.

In terms of statistics, India has one of the largest working populations in the world and, with a rise in disposable incomes, this segment of the population is also becoming the biggest consumer of processed foods in the country.

With an increase in urban working culture and fast-paced lifestyles, there is limited time available for cooking and meal preparation. Thus, processed foods such as ready-to-eat products and snacks have become quite popular, particularly in urban areas.

By 2030, Indian annual household consumption is set to treble, making India an opportune market for consumption of processed foods.

The increasing penetration of organized food retail outlets are offering a wide range of options to consumers. These outlets provide consumers access to diverse products, usually with attractive discounts.

Further, the proportion of working women in the industry has been increasing continuously both in the urban and rural regions.

Need For Integrated Value Chains for Horticulture Crops



Grapes



Mango



Tomato



Banana



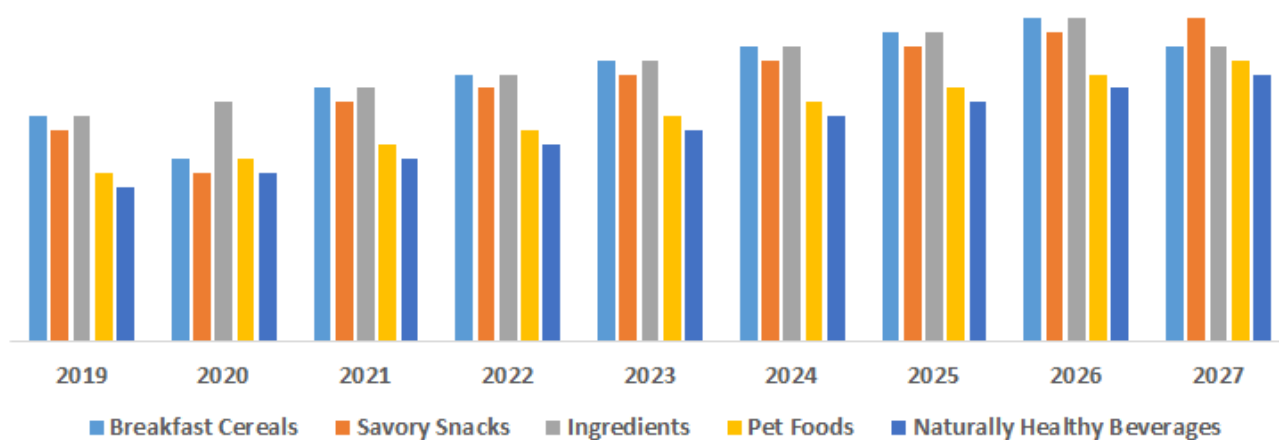
Pomegranate



Sweetcorn

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Indian Food and beverages Market, by Product Type 2020-2027



Challenges Faced by Food Processing Industry In India

Supply and demand side bottlenecks

Small and dispersed marketable surplus due to fragmented holdings, low farm productivity due to lack of mechanization, high seasonality, perishability, and lack of proper Intermediation (supply chain) result in lack of availability of raw material. This in turn, impedes food processing and its exports.

Demand of processed food mainly restricted to urban centres

Infrastructure Bottlenecks More than 30% of the produce from farm gate is lost due to inadequate supply chain infrastructure.

Need of Food Processing

The need-based processing facilities to make economical crop value chain should be created to overcome these issues from both sides.

The Way Forward

Intervention At Farm-Level

- Efficient resource management
- Productivity improvement at par with global competition
- Quality improvement at par with global standard
- Quality Input/Nursery
- Testing facilities
- Reduction in Cost of Production
- Efficient Finance
- Crop Insurance
- Global Exposure and Skilling

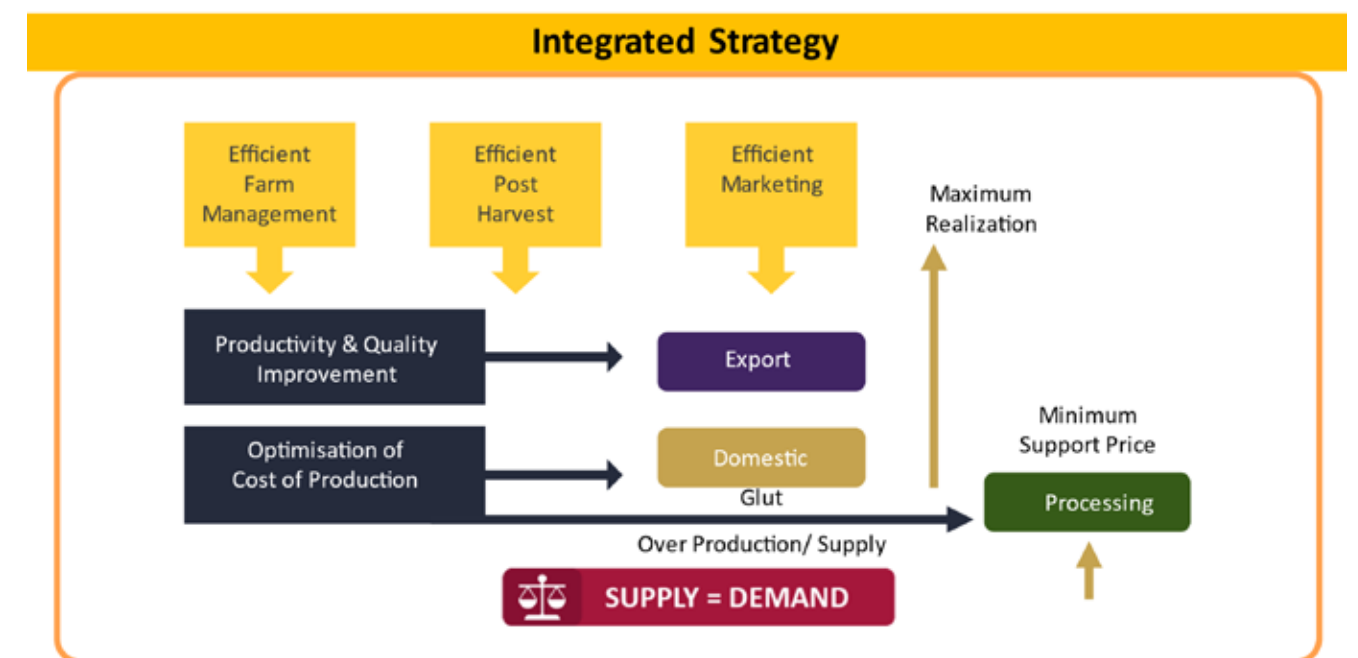
Intervention Product Value Addition

- State of Art Post Harvest and food processing Facilities
- Capable Professionals
- Exhaustive Research & Development
- Skilling

Intervention Sales & Marketing

- Wide Global Networking
- Direct to Consumer Approach
- Established Domestic Wholesale Network
- Developing Domestic Retail Network
- Need Based Processing
- Brand Building
- Skilling

Sahyadri Farms Post Harvest Care Ltd is a 100% farmer-owned company. We are trying to make farming a profitable and sustainable business and provide safe, healthy and affordable farm produce, and value added products to the consumers.



Sahyadri Farmers Producer Company Ltd.

Major Need For Crop Protection Solutions

Agriculture to me means providing food to humans and domesticated animals. It dates back to our origins. By sustainable Agriculture, I mean, arranging the required amount of healthy & nutritious food and fodder for human race and its domesticated animals.

Sustainable Agriculture must take care of all stake holders.

1. A large population, which needs to be fed a healthy food without any risk of famines or food shortages, which were order of the day when we were practising only organic agriculture.

2. Farmers: A large population of farmers, who earn their living from agriculture.

3. Environment: Minimum damage to environment and to maintain ecological balance.

There is no single solution for all these. We must work on balancing all these factors.

One factor which cannot be compromised is the availability of healthy food to the teeming billions.

This requires judicious use of crop protection solutions taking care of minimum residues and least damage to the environment. It is most complex scenario to deal with.

There are various lobbies pleading for their chosen causes, without thinking of the consequences for other stake holders.

Our agricultural universities and institutions must develop more GM crops, more disease resistant varieties.

Biological Solutions

The crop protection industry needs to develop more biological solutions to control various diseases. Everybody must understand that plants are living being and get affected by vagaries of nature, competition from the weeds and get infected by various diseases.

The diseases need to be controlled to save the farmer and to ensure food security.

The media has projected the use of crop protection solutions in

a very negative manner to such an extent that a common man feels he is eating some poison.

For example, in the 19th century, potato was the staple crop in Ireland. There was a potato famine in Ireland due to potato Early and Late Blight.

Most of the population was affected. A large number of people died and many had to migrate due to the famine.

The Truth About Pesticides

Most of pesticides have a very low Minimum residue limit, ranging mostly in the range of 1 to 3 ppm levels. We process and cook food, which again reduces the residue content. Maximum pesticides are contact killers, so there are hardly any residue in the agricultural produce.

We need to educate the farmer for proper and judicious use of pesticides. Many farmers use overdose of various chemicals, thinking, more use, will control the disease faster. We need to tell them the plants are living things and get damaged by overuse, resultantly reducing the yields.

The crop protection industry in collaboration with state departments of agriculture to educate the farmers about safety measures and to avoid over or under doses.

We need to run information campaigns to educate the public about the real position on the ground and should refrain from create hypes.

Let us take an example. Tricyclazole has an MRL of 3 ppm. The rice is shelled and cooked before being eaten. What goes into human body is just a fraction of MRL percentage. And the European Union wants to reduce it to euro levels.

On the other hand, when we get affected by any infection, we take 500 mg of an antibiotic 2 to 3 times a day for 3 to 5 days.

The crop protection solutions being used are commensurate with the requirement and these can be further improved by proper training, new research, and public awareness.



The crop protection industry needs to develop more biological solutions to control various diseases



ABOUT THE AUTHOR

Mr S K Chaudhary is Promoter Director of Safex Chemicals group, having turnover of more than 1500 Cr and have production assets in India and England. He has more than four decades of experience in the agricultural input industry

Tackling India's Water Crisis

AND OTHER CHALLENGES FOR THE AGRI SECTOR

“ Small land holdings make it impossible to apply modern inputs, adopt scientific methods for improving the soil, conserving water, protecting plants, and introducing mechanized processes



ABOUT THE AUTHOR

Dr NK Arora is Proprietor, A-One Warehousing & Logistics Solutions and Advisor to TQS, a Tata company

India's biggest problem is that of rampant water-waste in agriculture that consumes around 78% of India's total freshwater resources. India's per capita water availability is down to around 1,400 cubic meters per annum now as compared to 5,177 in 1951. This is projected to fall to 1,140 by 2050.

In India, 80% of the surface water is utilised for agriculture, putting significant pressure on groundwater resources. Freshwater withdrawals have doubled every 30 years in the last 100 years.

These resources are particularly in states with a high agricultural output of water-thirsty crops like Paddy, Cotton, and Sugarcane. If business continues as usual, India could soon face an unprecedented groundwater crisis, which will have a massive impact on the country's agro-economy and food security.

Dealing With Water Crisis - Varied Technologies

Soil sensors analyse moisture content of soil and relay the information to a cloud-based platform. This controls the water released to crops. Drone enabled thermal imaging of farms helps in predicting temperature and water requirement of crops. IoT sensors detect leakages in irrigation pumps and pipes, and automatically plug the leaks.

One of the key reasons for the shrinking ground water level is the cropping pattern, which is skewed toward crops that use more water. Rice and sugarcane crops together consume more than 60% of water available for irrigation. India also lacks a proper structure on support prices and subsidies to discourage farmers from growing water-intensive crops.

Global Examples

There are many examples from around the world of increases in yield when farmers have replaced synthetic chemicals and shifted to sustainable/organic methods.

223,000 farmers in southern Brazil using green manures and cover crops of legumes and livestock integration have doubled yields of maize and wheat to 4-5 tons/hectare.

45,000 farmers in Guatemala and Honduras used regenerative technologies to triple maize yields to 2-2.5 tons/ha and diversify their upland farms, which has led to local economic growth.

200,000 farmers across Kenya as part of sustainable agriculture programs have more than doubled their maize yields to about 2.5 to 3.3 tons/ha and substantially improved vegetable production through the dry seasons.

100,000 small coffee farmers in Mexico have adopted fully organic production methods and increased yields by half.

A million wetland rice farmers in Bangladesh, China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Vietnam have shifted to sustainable agriculture, where group-based farmer field schools have enabled farmers to learn alternatives to pesticides and increase their yields by about 10 percent.

In Madhya Pradesh, India, average cotton yields on farms participating in the Maikaal Bio-Cotton Project are 20 percent

higher than on neighbouring conventional farms.

In Madagascar, SRI (System of Rice Intensification) has increased yields from the usual 2-3 tons per hectare to yields of 6, 8 or 10 tons per hectare.

In Tigray, Ethiopia, a move away from intensive agrochemical usage in favor of composting has produced an increase in yields and in the range of crops it is possible to grow.

In the highlands of Bolivia, the use of bonemeal and phosphate rock and intercropping with nitrogen-fixing lupin species have significantly contributed to increases in potato yields.

It is wrong to say that the organic farming is very less productive and cannot feed the world population. The scientists in India should give more attention and undertake intensive research on organic farming.

Electronic Negotiable Warehouse Receipt

A new era on economic and social front of agriculture is gaining ground. This is the Electronic Negotiable Warehouse Receipt, a powerful financial tool, of WDRA.

This will be a wonderful IT enabled electronic platform. It will take care of the financial problems of farmers by enabling them to sell their farm produce online. The consumers will benefit by getting the produce in competitive rates.

Land Holdings

Small land holdings make it impossible to apply modern inputs, adopt scientific methods for improving the soil, conserving water, protecting plants, and introducing mechanized processes. Land consolidation can increase crop sustainable growth and increase the production.

Issues That Need Focus

Therefore, land ownership regulations shall be made on priority. A cap on land ownership ought to be put in place. Farms should be of a minimum size. Solving the water logging and soil erosion problems is important. It is advisable to cultivate wasteland by arid and semiarid crops research and development.

Another very important factor is the failure or inadequacy of rain and irrigated water, causing fluctuations in yields because more than half of the gross cultivated area is rained. Better irrigation infrastructure is vital.

Soil degradation is a major issue that contributes to the loss of soil fertility. The primary kind of deterioration brought on by deforestation and unreliable agricultural methods like shifting cropping is soil erosion. Other causes of soil fertility loss include poor management and repetitive use, which increases salt, alkalinity, and acidity and therefore, shall be monitored for increase in crop production and crop growth.

Farmers should employ methods like crop rotation, fertilizer use, and pesticide application. Farmers that use new technologies need to be supported. It will be helpful to conduct further research on the crops, seeds, and fertilizers.

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AND DEDICATION OF
INDIAN FARMERS**



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