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BIOLOGICALS FOR RESPONSIBLE FOOD PRODUCTION

The world is witnessing a transformational change in agriculture. From chemical intensive approaches, there is a clear shift towards sustainable alternatives. Biologicals have emerged as a promising input in crop care and management. The entire range from botanicals, biostimulants, natural extracts, metabolites to live organisms continue to generate interest and curiosity in the agriculture sector. Natural or organic, the days of intensive chemical treatments are gone. Agriculture is bracing for a more sustainable and biological options.

However, they come with their own set of challenges – challenges which are evolving and complex. Being live in the biological parley means they do not adhere to the conventional regulatory standards. The lab trials need not replicate on the fields with same accuracy. Guidelines for import or transport of effective live organisms across borders are evasive or non existent. The biostimulants industry is grappling with confusion in the existing guidelines. The newer players are treading with caution and scepticism. Prevalence of spurious chemicals is also a matter of concern.

So far eloquence and ambitions are driving our 'organic drive'. The intense desire of India to propel towards an organic led food production system has been able to create enough momentum among the farmers and the industry. Companies traditionally invested in chemicals are keenly seeking biological options to be added to their portfolio. But the rules are yet unclear. From a regulatory perspective, we need a clear vision and a set of guidelines that can support a sector that is constantly

innovating and evolving.

Deadlines are strategically efficient in effecting a transformational change. India needs to set a deadline – for reducing chemical inputs, for producing a certain amount of organic/ naturally produced food... a deadline that marks the beginning of a responsible food production arrangement. Then only can we inspire confidence in farmers, industry and the consumers.

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Centre Approves Cluster Farming In Five States

luster farming is the new buzzword to make Indian produce globally competitive and also to significantly increase the income of farmers. Five private firms have been authorized by the Centre to take up cluster farming of specific horticulture crops in about 50,000 hectares in five states across the country.

The initiative will serve as a pilot project to examine the benefits of cluster farming for these specific crops. The project involves investment of Rs 750 crore, including government subsidy.

The five companies were chosen for cluster farming through a bidding process. The companies which have been authorized for the project include Desai Agrifoods, FIL Industries, Sahyadri Farms, Meghalaya Basin Management Agency, and Prasad Seeds.

The project includes financial assistance up to Rs 100 crore by the Centre. The assistance shall be provided depending on the size of the project under the Cluster Development Programme (CDP), a central scheme which was launched recently. The project is being implemented through the National Horticulture Board. It involves a total outlay of Rs 2,200 crore.

This is the first initiative of its kind in the country, where the government is supporting market-led development of the entire value chain of specific horticulture crops. The total land which has been brought under the five cluster development projects is 50,000 hectares approximately, and involves about 55,000 farmers.

The banana cluster project shall be developed by Desai Agrifoods at a total



cost of 103 crore. It shall be developed at Ananthapura in Andhra Pradesh.

Sahyadri Farms has been awarded the grape cluster development project at Nasik, Maharashtra, with capital outlay of Rs 205 crore approximately. The turmeric cluster project will be developed by Meghalaya Basin Management Agency with financial outlay of Rs 52 crore approximately. It shall be developed at West Jaintia Hills.

The apple cluster project will be developed at Shopian in Kashmir by FIL Industries. The mango cluster shall be developed by Prasad Seeds at Mahabubnagar, Telangana.

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BIO-AGRICULTURE OPPORTUNITIES AND CHALLENGES IN ITS OPERATIONALIZATION

ndia's food grain production has reached all time high level of 328 million ton (Mt) in 2022-23. Indeed, India's agricultural accomplishment is a global success story.

In 1947, India's population was 330 million, food grain production at low level of merely 50 Mt, and per capita grain production of 151 kg. In 2023, India's population is 1417 million,

food grain production of 328 Mt. and per capita grain production of 231 kg. Contrary to Malthus' prediction, while India's population increased by a factor of 4.25, its food production increased by a factor of 6.55. However, the Green Revolution of the 1960s and 1970s was cereal centric (focused on rice and wheat), based on heavy inputs (fertilizers, pesticides, irrigation, monocultures),driven by subsidies (procurement) and caused severe problems of soil and environmental degradation. For example. fertilizer use in India increased from 0.5 kg/ha in 1950 to 160 kg/ha in 2020, and pesticide use in India is at 0.30 kg/ha. India's total irrigated land area of ~70 M ha uses 85% of all water withdraw in India.

Water Woes

In addition to excessive withdrawal and lower rate of renewability, water pollution is a major environmental issue in India. Eutrophication of water is caused by discharge of untreated s e w - age and unregulated small-scale industry, and agricultural runoff into surface water and seepage into ground water.

In-field burning of crop residues and use of traditional fuel sources for household uses has polluted air quality in rural and urban areas. Above all, soil degradation a major problem on all agro-ecosystems, is caused through accelerated erosion by water and wind, waterlogging, salinity/alkalinity, soil acidity, brick making because of rapid urbanization, depletion of soil organic matter content, deficiency of micronutrients, conversion to non-agricultural uses, and other complex problems. In short, agriculture has a large environmental footprint.

Major Challenges

Excessive and an indiscriminate use of inputs with long-term monoculture, practiced in conjunction with plowing and in-field burning of crop residues and flood-type irrigation, has degraded soils, contaminated water, polluted air, denuded landscape and dwindled biodiversity. The problem lies with the misuse of technology such as over-fertilization and unbalanced fertilization, indiscriminate use of pesticides, excessive and flood-based irrigation, unnecessary and inappropriate plowing, in-field burning of crop residues, and uncontrolled grazing. These practices have

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aggravated the environmental problems. Despite the great success in India's agriculture, even bigger challenges lie ahead. Important among these challenges are combatting under-nutrition (~200 million or one in seven persons), and malnutrition (children under 5 and nursing mothers) and adopting nature-positive agriculture which is simultaneously nutrition-sensitive emission negative. The goal is to reconcile the need to produce nutritious and healthy food while restoring soil health and improving the environment.

Role of Bio-Agriculture, Agroecology, Regenerative Agriculture

Because of the environmental concerns, there is a growing interest in ecological farming which can address the so called "eco-crime", and respect rights-of-soil and rights-of-nature. It is in this context that India needs a well-defined bioagriculture road map as a new growth engine of its progressive agricultural industry. Bio-agriculture should have close links to bio-food, bio-medicine and other bio-based products which are also pro-nature. Examples of bio-based product include corn cob-based biochar which can be used to remove pesticide

Table 1. Proposed Road Map for India to Produce More From Less

| Parameter | Year | | | |
|--------------------------------------|---------|---------|---------|---------|
| | 2017 | 2030 | 2050 | 2100 |
| Irrigated Area M ha, (km3) | 70(200) | 70(150) | 82(100) | 100(75) |
| Fertilizer Use (M t) | 30 | 25 | 20 | 15 |
| In-Field Burning of Residues (Mt) | 100 | 0 | 0 | 0 |
| Pesticide Use (10 ³ t) | 56 | 30 | 20 | 10 |
| Cereal Grain Yield (t/ha) | 2.1 | 2.7 | 2.8 | 4.0 |
| Post-Harvest Losses (%) | 34 | 10 | 5 | 5 |
| Organic Manure (M t/yr) | 200 | 300 | 400 | 500 |

Bio-agriculture should have close links to bio-food, biomedicine and other bio-based products which are also pronature. Examples of bio-based product include corn cob-based biochar which can be used to remove pesticide residues from water, and rice-husk based chemicals as industrial raw materials

residues from water, and rice-husk based chemicals as industrial raw materials. The goal of bio-agriculture is to produce safe and nutritious food which restores soil health and improve the environment.

Other commonly used terms are organic agriculture, regenerative agriculture, and agro-ecology.

These terms have some commonalities but differ in concepts and practices. Organic agriculture eliminates the use of chemicals (fertilizers, herbicides, pesticides) and genetically modified organisms (GMOs). Agro-ecology involves the application of ecological principles to agriculture such as high biodiversity,

FUTURE WISE

disease-suppressive soils, coupled cycling of water and other elements (N, P, S, etc.), and circular economy.

Regenerative Agriculture Is Gaining Momentum

Of all these emerging concepts, regenerative agriculture (RA) is gaining momentum. However, RA is a strategy, a concept, an ideal or an approach which encompasses a wide range of management practices or systems. Simply put, RA is inspired by eco-innovation, powered by non-carbon energy, driven by a circular economy and green infrastructure, and supported by the re-carbonization of the terrestrial biosphere (soil and vegetation) as the bedrock of sustainable development.

Some examples of RA practices include system-based conservation agriculture, cover cropping, integrated soil fertility management, integrated water management such as drip sub-irrigation, and complex farming systems which involve integration of crops with trees and livestock.

Potential And Challenges of Bio-Agriculture

Regardless of the specific terminology used, innovative agricultural practices must be based on "The Law of Return". The law, proposed by Sir Albert Howard, states that "substance we take from nature must be returned to the place from where it was taken". Sir Albert Howard also hypothesized the One Health Concept which states that " health of soil, plants, animals, and people is one and indivisible". The One Health Concept has since been expanded in scope and states that " health of soil, plants, animals, people, ecosystems and planetary processes is one and indivisible ".

How To Ensure Sustainable Management Of Soil

Sustainable management of soil must be based on the following pillars: i) replace what is removed, ii) respond wisely to what is changed, iii) predict what may happen from anthropogenic and natural perturbations, iv) produce more from less, and v)



India must adopt a "Soil Health Act" which states the rightsof-soil and makes provisions of rewarding farmers who restore soil health of their farms by rewarding them through payments for ecosystem services

save land and water for nature. Farming practices adopted under site-specific conditions must create a positive soil-ecosystem carbon budget.

Above all agricultural practices must respect rights-of-soil, and rightsof-nature. Being the essence of all life, soils must also have rights to be protected, restored, thrive, and managed judiciously.

Challenges For Policy Makers

The need to develop and implement innovative policies is more now than ever before. With land area of 2.4% and water resources of 4%, India has to support world's human population of 18% and livestock population of 31%. Furthermore, these demands must be met in an era of warming climate, shrinking soil and water resources, growing and increasingly affluent human population, and increasing global competition for producing safe, nutritious, and healthy food while restoring soil health and improving the environment. India must have a very well-defined road map to reduce use of agrochemicals, water, food waste and burning of crop residues while increasing crop yield and improving its nutritional quality.

Table 1 is merely an example of road map that can be developed for each district, state and at national level and implemented using a 5-year plan. Such a road map must be supported by regular assessment of soil health and that of water quality and renewability, biodiversity and ground cover.

Soil Health Act and Land Protection Resolution

India must adopt a "Soil Health Act" which states the rights-of-soil and makes provisions of rewarding farmers who restore soil health of their farms by rewarding them through payments for ecosystem services such as for carbon sequestration, improving quality and renewability of water, and strengthening of biodiversity. Similarly, prime farm land must be mapped and protected against urban encroachment ,conversion to non-agricultural uses, and removal of topsoil for brick making. Soil health and environmental education must be included in the curricula of kinder garden and primary schools so that children know what health soil is ,where food comes from and what is the value of clean and healthy air and water. Children must know the mantra " healthy soil=healthy food=healthy environment=healthy people=healthy planet".



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BIO-AGRICULTURE PARAMOUNT FOR SUSTAINABILITY

here is rise in the demand for bio agriculture inputs in India as it reduces the use of non-renewable energy while decreasing global warming. There is need to address the myths about lower crop yields and bring science based realities to prove that increased efficiency of sustainably farmed lands may be as productive as conventionally farmed ones.



Biofertilizers

Use of biofertilizers for nutrient management is an integral component of sustainable agriculture. Biofertilizers contain different plant associated microorganisms that enhance plant growth and improve yield and quality of the produce through supply of adequate nutrients. Bacteria, fungi and cyanobacteria (blue green algae) are considered as the potential candidates to be used as biofertilizers. Most biofertilizers belong to one of the following categories nitrogen fixing phosphate, potash and zinc solubilizing and mobilizing and plant growth promoting rhizobacteria.

Indian Council of Agricultural Research recognized the importance of Biofertilizers and started All Indian Network Project on Soil Biodiversity-Biofertilizers and have developed a large number of biofertilizers for different cereals, pulses, oilseeds and horticultural crops. In 2014, the Govt. of India initiated National Mission on Sustainable Agriculture (NMSA) where use of biofertilizers is being promoted to improve soil health.

Biopesticides

Just as biofertilizers are emerging as green alternative to chemical fertilizers,

About the **AUTHOR**

Mr Suresh K. Malhotra is former Agriculture and Horticulture Commissioner and Director, ICAR-Directorate of Knowledge Management in Agriculture, Ministry of Agriculture & Farmers Welfare biopesticides have a huge role to play in sustainable management of crop pests and pathogens. In contrast to chemical pesticides, application of ecofriendly biopesticides does not lead to development of any resistance in pest and pathogens. Still this sustainable alternative is struggling to find its place in the market over its chemical counterpart owing to technological challenges. In spite of these efforts the biopesticides represent only 4.2% of the overall pesticide market in India compared to 40% in USA and 20% each in Europe and Oceanic countries.

Biocontrol Agents

The alternate option to scale down the use and dependence on chemical insecticides is to employ biological control agents, which keep a check on pest population build-up with minimal harmful impact on the environment. The shift from the practice of non-judicious use of chemical pesticides to biocontrol agents essentiality requires active search for potential bioagents, method for their multiplication and assessment of their effectiveness for large scale use.

Biostimulants

Plant biostimulants are a new category of crop inputs for which the farmers' interest is growing as these are proving to be new tools. Biostimulants are basically organic materials that can be used for most of the crop lifecycle to increase crop yield, improve the efficiency of water usage and uptake of nutrients, and enhance crop quality. Biostimulants are differentiated from fertilizers as these are needed in miniscule quantities; while fertilizers are applied in larger dose rates and quantities. The new regulation also introduces eight categories: such as botanical extracts, including seaweed extracts, biochemicals, protein hydrolysates and amino acids, vitamins, cell free microbial products, antioxidants, anti-transpirants, humic and fulvic acid and their derivatives.

India has proven to be a pioneer country in developing biostimulant regulation in an agile manner with well-defined criteria/definition, data requirement/



There is an increase in the demand for bio agriculture for breeding nutritious, high-yielding, and less resource input-demanding crops. This, along with the surging demand for food due to the rising population in the country, is propelling the growth of the market

guidelines, and enforcement measures. Many other countries are still in the midway stage to develop biostimulant regulations. The Indian biostimulant market is projected to witness a CAGR of 16.49% during the forecasted period to reach a total market size of US \$180.95 million by 2023, increasing from US \$71.23 million in 2017.

Market Prospects

The growing awareness among the masses about the benefits of bio-fertilizers, biofuels, and bio-pesticides represents one of the key factors driving the market in India. Moreover, there is an increase in the demand for bio agriculture for breeding nutritious, high-yielding, and less resource input-demanding crops. This, along with the surging demand for food due to the rising population in the country, is propelling the growth of the market.

Future is bright for bio-agriculture

Bio agriculture inputs derived from natural material are increasingly becoming an integral part of modern farming practices to establish sustainable farming. But efforts are needed for developing highperformance bio-agriculture products, for increased adoption of sustainable farming. Globally, the demand is for greener and safer crop protection technologies. Rising prices of synthetic inputs are also projected to remain a key factor in boosting the consumption of agricultural biologicals in the coming years.

With a rapidly rising global population, food scarcity remains a critical issue for governments around the globe. This has led to innovations, in terms of product development and promotion of eco-friendly agricultural solutions in the major agrarian economies. This, in turn, is anticipated to augment the demand for agricultural biologicals across the globe.

The number of product approvals and investments in bio-ingredients is growing rapidly, which is expected to result in intense market competition in the future. In addition, agricultural biostimulants, which are fertilizer additives derived biologically, are also gaining significance. These are used for enhancing crop productivity, growth, and health. The growth is also attributed to the constantly evolving agricultural practices in the region with respect to farming techniques, technological adaptations, and constant research & development, and government regulations promoting sustainable farming methods.

EFFCENT WATER MANAGEMENT IS A MAJOR FOCAL AREA FOR THE GOVERNMENT

Mr Franklin L Khobung, Joint Secretary, Ministry of Agriculture & Farmers' Welfare tells Agriculture Today that saving water, ensuring optimal use of resources are among the most important concerns for the government

How can sustainable management of resources help Indian agriculture?

National Mission for Sustainable Agriculture (NMSA) has been formulated for enhancing agricultural productivity, especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation. We have a range of sustainable agriculture practices for mitigation of climate challenges and adaptation to optimal resource use practices.

The focus of the government is to ensure sustainability of agriculture processes and not compromise on food security at the same time. Some of the major focus areas are soil, integrated farming systems in rain fed areas, and promotion of micro irrigation systems.

Subsequently, we can focus on many more sectors to achieve sustainable management of resources. Promotion of agro forestry is important to increase the green cover of agricultural land. Integrated horticulture development shall help the farmers make optimal use of resources and increase farmer prosperity.

With the launch of NMSA, the Ministry has revised programs and schemes to ensure conservation of resources. We have tried to include sustainable agricul-



ture in all our initiatives.

In terms of resource management what according to you are the challenges for India?

This is a very vast subject. If I have to list on priority the things that are important for Indian agriculture, water will come first. Agriculture is utilizing 80 pc of the available water resource. We have only 50 pc of net sown area under irrigation. We are taking steps to increase the area under irrigation to protect underground water resources.

50 pc of land is utilizing 80 pc of our

water resources. Hence it is extremely important for us to increase the acreage which has access to irrigation.

Water is a very valuable natural resource which has to be managed very carefully in order to meet the demand, and our future concerns. We have to promote precision agriculture for efficiency of water usage.

Then there are different challenges. These relate to finance, technology, capacity building of the farming community, lack of infrastructure.

The government has taken up several initiatives to ensure the adaptation of sustainable agriculture practices. Research and development is a major focal area. We are also developing sustainable technologies which are in tune with natural resources. We are developing healthy agricultural practices and climate resilient varieties of crops .

Equally important is the transfer of these technologies to the fields of the farmers. We are doing that by incorporating all these research findings, schemes and programs, and implementing them at field level.

Development of infrastructure is a major concern for the government. We need robust infrastructural support for ensuring sustainability. We need micro irrigation, we need conservation of water. Check dams, check walls, soil moisture conservation – all these are valuable initiatives.

We need to invest in farm ponds for storage of water. We need to invest in farm mechanization so that we can make available the latest technologies which promote sustainable agricultural practices. We need to invest in value chain of storage, refrigerated transportation so that food wastage from farm gate to market is minimized. The wastage ranges from 5 pc to 20 pc of all food produced.

Food wastage has been checked to some extent by new technology and infrastructure. If we can save this wastage, it shall be equivalent to producing so much food without any investment.

How significant is organic farming in resource management?

Capacity building and awareness of the farming community is very important. Organic farming and natural farming are among the priority areas. These cater to optimum utilization of natural resources and also address the sustainability aspect.

If we have to convince farmers not to use chemical fertilizers, it may have a direct impact on production. There is need to address this issue.

Natural farming produce must be marketed with the rate that is appropriate for the farmers. We need proper certification systems. If a consumer is going to pay 20-30 pc more for the produce, he/ she has to be sure of the source. If we have all these management systems in place, it will not be difficult to convince farmers to shift to natural or organic farming. The produce may marginally reduce, but the improved revenue will compensate for the loss.

Climate smart agriculture is an important area that is gaining traction around the world. Where does India stand?

We are doing very well in the agriculture sector as compared to the 60s and 70s.

The government has taken several initiatives to improve soil productivity. Soil health is one of the major thrusts of National Mission for Sustainable Agriculture (NMSA)

Now the big challenge for the sector is to manage the impact of climate change. Drought, cyclones etc are affecting production to a large extent. ICAR, our apex research institution, has a national program to focus on these challenges.

These teams work on continuous research for technologies which shall aid the adaptation to climate change challenges. National Innovations on Climate Resilient Agriculture (NICRA) is focusing on these aspects. They undertake work on climate smart technologies, climate smart varieties etc. It is a continuous process.

ICAR has conducted mapping of the entire area in the country in terms of vulnerability of different climatic conditions. Accordingly they have identified those districts that are vulnerable to certain climatic systems. They undertake research and develop technologies to address the climactic conditions of that area. In this way, ICAR has selected 151 districts across the counry having different climatic conditions.

How can we improve soil productivity?

The government has taken several initiatives to improve soil productivity. Soil health is one of the major thrusts of National Mission for Sustainable Agriculture (NMSA).

Through Soil health card, we take soil samples of fields across the country. The samples are tested and specific reports are given to the farmer regarding the status of the soil on his land. Accordingly, advisories are given to farmers regarding crops, the fertilizers that they should use, and in what quantity based on soil health report.

So far we have covered 20 crore farmers under the Soil Health Card Initiative.

What are so far the milestones achieved by NRM?

Natural resource management is a major focal area for National Mission for Sustainable Agriculture. We have recorded major achievements in the promotion of micro irrigation. We have covered 20 pc of micro irrigation potential areas of our country. Niti Aayog, in the review of this scheme, noted that micro irrigation schemes enable achieving 70 pc saving of water in agriculture and increase in farmers' income from 10 to 69 percent.

There is 30 to 40 pc increase in production of different crops per unit area. We have made significant achievements in the soil health card schemes. Earlier, farmers were blindly using chemical fertilizers. Now we advise them to use the inputs as per the actual requirement of soil.

We are also focusing on rain fed area development to promote integrated farming systems. These promote natural farming, organic farming. With integrated farming practices, farmers can opt for agro forestry, livestock, honey bee rearing, fisheries. All these augment the farmers' income. If the crop fails, they can fall back on alternative sources of income through livestock, horticulture, fisheries etc.

What are the future areas of focus?

In terms of resilience and sustainability, the land under irrigation is much more stable in terms of climatic emergencies like drought, heat. It is important to have access to irrigation to address these climatic emergencies. Raid fed areas most vulnerable because they are under the mercy of nature. Water management, efficient use of resources, concentrating on water production, more water available for agriculture, rain water harvesting, use of recycled water – all these and more are our key priority areas.

PRIORITIZING Atmanirbhar Krishak

he food that we produce for our survival and well-being depends, either directly or indirectly, on our soil environment, crop micro and macroclimate and their sustainability. While, it is important to ensure that the biotic world in rhizosphere and phyllosphere stays in productive harmony for meeting food security, nutritional security and protecting human health, it is also paramount for any adopted farming method to meet social and economic needs.

Post Green revolution, the following are some of the most pertinent questions that humanity faces.

1. Can we sustain our food production ecosystem, while feeding 9 billon people?

2. Can we improve farm economics without reversal of soil biodiversity loss and carbon content?

3. Can Agriculture play an important role in reducing carbon footprints and mitigating the current climate crisis?

Answers to abovementioned questions do not lie in the currently dominating chemical intensive farming practices, which rely too heavily on fossil-fuel – based fertilizers, chemicals for crop protection, mono-cropping can sustain the demand nor in natural or organic farming which often seen as a counter strategy as it has its own limitations.

The Importance Of Green Agriculture

Organic farming practices are defined by what it avoids to use – synthetic inputs. With extensive prohibitions on materials beyond the obvious Insecticides, fungicides, herbicides and synthetic nutrients, the strategy is highly limited. Furthermore, not all soils and not all cropping systems are suited to organic production. In some farming systems, there are no "natural" responses to the pests, weeds and diseases that attack certain crops. We now realize that green revolution improvements ascribed to crop genetics; biotechnology; expansion of irrigation infrastructure; the widespread use of synthetic fertilizers and pesticides with more than doubling crop yield came at a certain cost. In this backdrop, scientific breakthroughs and innovations in the field of microbiology and Biotechnology have provided important microbial tools in the hand of farmers.

A Sustainable Path Forward

Biological farming is a mid-path between chemical and organic, not as a compromise, but as a thoughtful systems approach. It has the option of using Biologicals and chemicals in combination with a preference for reduced reliance on chemicals and soluble fertilizers across the food eco- system. It takes more thought than chemical farming, but with access to the full range of microbial registered, it is a much easier for farmers now to realize the value that biology can bring to a farm.

Thus, Biological agriculture is an integrated farming system. It combines the best historical regenerative practices, honed over centuries, with the strength of the latest scientific discoveries in the field of Biologicals. It promotes natural biological processes to dramatically improve agricultural yields and reduce farm costs, reduce carbon footprints and mitigate climate crisis through Carbon sequestration.

Prioritizing Nature

Biological Agriculture works with nature. We're experiencing a biodiversity apocalypse, with 1,000,000 species at serious risk of extinction due to climate crisis and habitat loss. On top of that existing soil biodiversity is also degrading at an alarming rate, with an estimated loss of 36 billion tons of soil every year (Rodale Report on carbon sequestration).

Though all is not lost, we see a great hope in potential of regenerative agriculture practices which if implemented well, will revive top soil, enhance microbial diversity in soil, support climate mitigation efforts by drawing CO2, and induce crop resilience to the stresses, better crop yield in longer term and nutrient dense crop to address malnutrition.

Bio Agriculture commits to save soil through enhancing microbial diversity in soil, harnessing nature in preventing pest outbreaks in crops, enhance nutrient up-

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WAY TO GROW



take through better root system, building resilience against abiotic stresses, and hence a natural practice for regenerative farming system approaches.

Dynamics of Bio Agriculture

Advent of regenerative agriculture boosted curiosity of farmers as well consumers worldwide which presents before us an opportunity not only to reclaim lost soil health but to address the modern day biggest challenge of climate change by sequestering carbon di oxide from atmosphere to the soil and simultaneously curving Green House gases emission such as nitrous oxide and methane.

Agriculture by-products contributes approximately 11% of total Greenhouse gas emissions (EPA Report). Adding cover crops, reducing tillage, and other practices can help benefit soil and improve bottom line. Through, increased soil carbon sequestration and reduced GHGs from these practices can also generate registry-issued carbon credits, which are increasingly in demand by major corporations. The successful delivery of Carbon credits relies on long term data to accurately calibrate and validate models for new practices.

How Atmanirbhar Krishi Helps

Farmers' understanding of Biologicals has increased by leaps and bounds over the past two decades. We now understand about most beneficial microbial orMr Bhagchandka is passionate about traveling, cricket, scuba diving, sky diving, golf and spending time with nature

ganisms in healthy soils which have symbiotic relationships with plants and play a vital role in nutrient solubilisation, uptake and provide protection to the plants.

Biological farmers feed microbial soil life by using carbon from compost, green manures, livestock manures and crop residues. They choose crop rotations and cover crops that increase biodiversity and fix atmospheric nitrogen, providing free alternative to the most carbon-intensive input for chemical agriculture. They apply pesticides responsibly and only when necessary; we have found that improvements in trace mineral availability and soil life dramatically reduce or eliminate the need for pesticides and fungicides while incorporating carbon from crop residues and cover crops back into the soil.

Government Initiatives & Policies

With Initiatives such as PM- PRANAM for promoting alternate farming and reduced use of fertilizers, and through ATMA, GOI is continuously encouraging sustainable practices to be adopted by farmers. GOI have also launched many initiatives such as PKVY for promoting natural farming.

For discussing new innovations for sustainable farming, Ministry of Chemicals And Fertilizers organized a workshop on invigorating organic farming for sustainable food systems and Atmanirbhar Bharat on 6th March 2023 at Niti Bhawan, New Delhi. Academia, Industries, manufacturers and Associations deliberated upon diverse issues.

National Mission for Sustainable Agriculture (NMSA) has been formulated for enhancing agricultural productivity especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation.

While, the Indian government recognizes the importance of promoting sustainable agriculture, the focus remains heavily skewed towards green revolutionled farming.

Biological Innovation & Revolution

Hopefully, with efforts of IPL Biologicals and other lead players, the end result would be a diverse, healthy ecosystem that produces higher yields at lower costs. And, because biological farmers work with nature instead of fighting it, the environmental benefits are enormous.

Challenges & Future Forward

However, challenges remains to overcome lower efficacy claims especially due to sub- standard products proliferating in the market through regulations and also due to less budget spent on product development and innovations for gaining deeper insights into microbials and their usage to improve product efficacies and farming solutions.

Challenges that come our way for promoting the middle path between chemical and natural farming – are worthy to fight for all of us. Concerted efforts are needed at government, industry and academia level for furthering innovations, regulations and creating awareness amongst farmers.

BIOLOGICAL V AGRICULTURE CHALLENGES AND OPPORTUNITIES

he twentieth century saw remarkable achievements in food security, as a booming world population more than tripled from fewer than 2 billion people in 1900, to over 6 billion in 2000. It is forecast to grow to over 9 billion by 2050. This rapid population growth has been supported by equally rapid growth in food production, enabled by intensive mechanical farming methods and vast quantities of synthetic agrichemicals. Unfortunately, despite enhancing crop yields, this so-called 'green revolution' was unsuccessful in assuring long-term agricultural sustainability. In fact, it directly resulted in soil quality deterioration, and other issues related to human health, the environment and biodiversity. By the end of the last century, the excessive use of chemicals in agriculture had become a cause of major concern.



It seems that time for BioAg – the 'real green revolution' might finally have arrived. Supported by consumer demands, environmental groups, regulators and governments alike, there is at last a unanimous call for reduced chemicals in agriculture and the use of mores sustainable alternatives, such as BioAg

Calls For Reducing Chemical Load

These concerns have been reflected in highprofile initiatives such as the European Commission's (EC's) Farm to Fork Strategy, Sustainable Use Directive (2009/128/EC) and European Green Deal. The EU is preparing to remove 505 pesticides from the market by 2030 and increase organic farming from 8 to 25%. These initiatives echo public concerns for greener and safer food systems, and the

About the **AUTHOR**

Dr Minshad A. Ansari is Founder & CEO of Bionema Ltd, Swansea University, UK, and Founder & Chairman of the World BioProtection Forum World Health Organization's commitment to "minimising the adverse effects of chemicals on human health and the environment by replacing hazardous chemicals with safer alternatives, including non-chemical ones..."

A solution in Biological Agriculture

Biological agriculture (BioAg) or biocontrol, which includes biopesticides, biostimulants and biofertilizers, is being widely touted as that safer alternative, which could replace chemicals in agriculture. The BioAg market has been estimated at USD 12.6 billion in 2022, and it is projected to almost double, to USD 24.6 billion in 2027, according to market analysts (MarketsandMarkets, 2022). This rapid rate of growth reflects widespread and increasing demand for biological solutions as the world embraces more environmentally friendly innovations.

BioAg can be used as part of an organic approach to farming, and this is important as organic sales in the EU and UK continue to increase, reflecting consumer demand for chemical-free produce. In 2021, the EU market for organic food products increased by 12%, reaching €54.46 billion. Germany and France remain the largest organic markets in the EU, representing more than 60% of its organic market. According to available statistics, in 2021 India ranked fifth in terms of the world's organic agricultural land and first in terms of total number of producers (FIBL & IFOAM Year Book, 2020). If India is to retain its strong

GOOD EARTH

position as the second biggest producer of fruits and vegetables in the world, it must embrace more non-chemical solutions for crop pest and disease control.

This need for more farmers to use BioAg was recognised in 2022, when Indian Prime Minister Narendra Modi declared his support for organic farming to protect farmers from the impact of climate change. He has openly appealed to India's farmers to reduce the use of chemical fertilizers and pesticides, and to instead adopt organic and natural farming. Prime Minister Modi has himself identified over 100 BioAg products that could be used to support a more sustainable approach.

The Business Case For BioAg

This could be seen as a brave position by the Prime Minister of a country gaining global prominence in agrochemical production. In 2022, the country exported over \$4.9 billion of pesticides worldwide – and as government targets encourage the use of alternative solutions, a shift in India's agrochemical sector's focus could be significant.

Fortunately, India already has hundreds of companies working in the BioAg sector. As India shifts its focus to achieving food safety and nutrition security through natural and organic farming, this should be reflected in increased BioAg production and manufacturing, slowly but surely replacing the grand, polluting agrichemical giants of the past.

The developing trends for BioAg in India and other parts of the world present a welcome wealth of opportunities for companies working in this space. However, in order for this 'real green revolution' to provide longterm sustainability for agriculture, a number of challenges must be overcome. The three main challenges that have been cited by experts for the past two or three decades are innovation, formulation and regulation. Until very recently, we have made slow progress on all three challenges, but it has been exciting to see – in just the past 5 years or so – a new focus emerging. Perhaps it was a matter of waiting for our time.

Resolving Long-Standing Challenges

It has finally been recognised that in order

It is my strong belief that BioAg is the future. It might seem idealistic to consider a future in which our agriculture system uses no chemicals at all, but it is a dream worth pursuing and it seems that now – at last – that dream could be closer than ever before.

Finally, there have been continued problems with regulatory approvals of new natural and safe microbial alternatives. This has been going on for 30 years or more, and many people in industry are frustrated by the stalemate with policy makers and regulators. Current regulations in the vast majority of countries, including the EU, are still too expensive, still too slow, and still not suited to the biological entities under review. However, it is encouraging to note that recent changes in countries like Brazil have had dramatic effects on BioAg uptake, and demonstrate how the adoption of more sensible regulations can encourage more organic and natural farming. The UK is also in the process of reviewing its biopesticide regulations, post-Brexit, and we are optimistic that a more sensible approach will be adopted in this competent authority, setting the stage for far wider reaching changes in the near future.

The Time Is Now!

As we watch the solutions for these three main challenges finally unfurl, it seems that time for BioAg – the 'real green revolution' might finally have arrived. Supported by consumer demands, environmental groups, regulators and governments alike, there is at last a unanimous call for reduced chemicals in agriculture and the use of mores sustainable alternatives, such as BioAg.

It is my strong belief that BioAg is the future. It might seem idealistic to consider a future in which our agriculture system uses no chemicals at all, but it is a dream worth pursuing and it seems that now – at last – that dream could be closer than ever before.



to realise and commercialise many of the

innovations coming through academia and its spin-off enterprises, it is necessary to work with industry. Many academics have been slow to understand the value of working with industry, but some of the most brilliant scientific technologies of this century have been invented by academics, and then developed and/or commercialised via collaborations with large commercial entities. This is now being recognised much more widely, and organisations such as the World Bioprotection Forum are providing a platform to accelerate innovation by connecting industry and academia. For companies and research organisations of any size willing to collaborate, this challenge can now start to be addressed.

Formulation has been a problem with BioAg since biopesticides were commercially launched in the 1980s. It is fair to say that biological products are often more 'fragile' than conventional chemicals, so they need to be formulated in a way that ensures their survival and integrity during storage, mixing, application and on the field. Modern technologies are offering a lot of solutions for this, and it is also another example of where connections between industry and academia can help. For example, Bionema, a biotech company headquartered at Swansea University in the UK, has been working with the University of Birmingham's Engineering Department on a microencapsulation project funded by Innovate UK, with some great results. As this kind of expertise grows, the challenge of formulation for many new products can now start to be addressed.

Bio Agriculture FOOD AND NUTRITIONAL SECURITY

ndependent Bharat's first major policy document, the Industrial Policy Resolution of 1948, echoed the "national consensus" regarding how India was to proceed. This national consensus called for a mixed economy and selfreliance. Under Prime Minister Lal Bahadur Shastri, India's Green Revolution and White Revolution (Operation Flood) helped India to become self-sufficient and a world leader in agricultural products such as milk and tea.

Atmanirbhar Bharat Abhiyan - A Major Milestone

A major step towards transformation of

The study conducted by Indian Council of Agriculture Research under Network project on Soil Biodiversity-Bio-fertilizers has confirmed that yield of crop increases with the use of biofertilizers and pesticides

agriculture into sustainable enterprises was when our Hon'ble Prime Minister Shri Narendra Modi announced the 'Atmanirbhar Bharat Abhiyan' (Self-reliant India Movement) on May 12, 2020 with a special economic & comprehensive package of Rs 20 lakh crores for achieving the mission.

The mission focuses on the importance of promoting local products. The mission is also expected to complement "Make in India" initiative which intends to encourage manufacturing in India including agriculture sector which have a great potential. GOI is promoting the use of bio-fertilizers under organic farming in the country through dedicated schemes namely Paramparagat Krishi Vikas Yojana (PKVY) and Mission.

Organic Value Chain Development

About the **AUTHOR**

Mr Vipin Saini is Chief Executive Officer-Biological Agri Solutions Association of India (BASAI). The views of the author are personal for North Eastern Region (MOVCDNER) since 2015-16. Biofertilizers are also promoted through Integrated Nutrient Management (INM) and are made integral part of package of practices developed by Indian Council of Agricultural Research (ICAR) and State Agriculture Universities. In order to promote use of bio-fertilizers, ICAR has developed improved and efficient strains of biofertilizers specific to different crops and soil types under Network project on Soil Biodiversity-Bio-fertilizers. The ICAR imparts training to educate farmers on use of bio-fertilizers.

Positive Impact Of Bio-Fertilizers and Pesticides

GOI is also implementing the 'Sub-Mission on Plant Protection and Plant Quarantine' through 35 Central Integrated Pest Management Centres located in 28 States and 2 UTs with a mandate to popularize adoption of Integrated Pest Management (IPM) through training and demonstration in crops, inter-alia promotion of biological control approaches in crop protection technology with major emphasis on judicious use of chemical pesticide as a last resort, safety in use of pesticides, alternate tools for pest management viz; cultural, physical, mechanical methods of pest control as well as use of bio-pesticides and bio-control agents.

The study conducted by Indian Council of Agriculture Research under Network project on Soil Biodiversity-Biofertilizers has confirmed that yield of crop increases with the use of biofertilizers and pesticides. Under Soil Health Management (SHM), assistance upto Rs 160 lakh /unit (200MT capacity) is provided to State Governments for establishment of bio-fertilizer production unit on 60:40 sharing between GOI and State Government. To minimize use of pesticides and to augment use of bio-fertilizers Government is promoting organic farming under PKVY, MOVCDNER and various other schemes in the country.

Some Major Initiatives Of GOI

The following are some of the steps taken by government to augment use of bio/ fertilizers through various schemes, such as:

Paramparagat Krishi Vikash Yojana (PKVY): Under PKVY Government is providing assistance of RS 50,000 /ha / 3 years out of which Rs 31,000 is provided directly through DBT for procurement/ onfarm production of organic inputs including bio-fertilizers.

Mission Organic Value Chain Development for North Eastern Region (MOVCDNER): Farmers are provided Rs 32500/ha for 3 years for on-farm production/procurement of organic inputs including bio-fertilizers.

Soil Health Management (SHM): Government is providing Rs 160 lakh / unit for establishment of bio-fertilizer production unit (200MT capacity) to State Government which is shared on 60:40 ratios between Gol and State Government. 25 bio-fertilizer production units have been established under SHM.

National Mission on Oilseeds and Oil Palm (NMOOP): Financial assistance@ 50% subsidy to the tune of Rs. 300/- per ha is being provided for different components including bio-fertilizers, supply of Rhizobium culture/Phosphate Solubilising Bacteria (PSB)/ Zinc Solubilising Bacteria(ZSB)/ Azatobacter/ Mycorrhiza and vermi compost.

National Food Security Mission (NFSM): Under NFSM, financial assistance is provided for promotion of Bio-Fertilizer (Rhizobium/ PSB) @50% of the cost limited to Rs.300 per ha.

Atmanirbhar Krishi App: Technology is another component in driving the success of bio-agriculture for Aatmanirbhar Krishi and Krishak. One such initia-



tive is the Atmanirbhar Krishi App.

On 29 June 2021, the Centre launched the Atmanirbhar Krishi App in order to provide farmers with actionable agricultural information and early weather alerts. The information relevant to the



I love to read, travel and am a nature lover. My passion for sharing knowledge and undertaking various CSR activities through my Family Trust i.e. Sunrakshan Foundation and not to forget maintaining an own personal library with more than 40,000 books and study material takes most of my free time, more so as a hobby farmers curated by various government departments on the national digital platform 'KisanMitr' is now being available through the Atmanirbhar Krishi App.

With the Atmanirbhar Krishi app of the KisanMitr initiative, farmers will have in their hands, evidence-based information generated by our research organizations like IMD, ISRO, ICAR, and CGWA. This information, when used by the farmers to make decisions on cropping patterns, mechanization of small farmers' holdings or stubble burning, will ensure that decisions are made factoring in the importance of sustainability of water and environment, and judicious use of resources. An app available on a basic phone with information in a language comprehensible to farmers will also enhance inclusivity during the decisionmaking process.

In a nutshell, Bharat is on the path to achieve Aatmanirbhar in Krishi and an Aatmanirbhar Krishak, and in contributing towards maintaining food and nutritional security.

ATG WEBINAR BIO AGRICULTURE FOR SUSTAINABILITY

n Feb 20, 2023, the Agriculture Today Group hosted a webinar on Bio Agriculture for Sustainability. The webinar served as a preview to the event "BioAg India 2023" scheduled on April 27 in New Delhi.

The webinar witnessed the active and enriching participation of more than 200 guests. The discussion was graced by the presence and engaging deliberations of eminent panelists and agriculture experts viz, Dr SK Malhotra, Director DKMA – ICAR and Former Agriculture Commissioner, ICAR, Dr MH Mehta, Padmashree recipient, Dr Rajaram Tripathi, etc.

Ms Rajni Shaleen Chopra, Executive Editor, Agriculture Today initiated the discussion by welcoming the panelists and conveying her warm regards to all the participants. The discussion was moderated by Ms Anjana Nair, Group Editor, Agriculture Today Group.

Dr SK Malhotra – Director DKMA – ICAR & Former Agriculture Commissioner, GOI

Dr Malhotra said that India has successfully attained food security through green revolution. He urged that now, it is time to emphasize and focus upon food quality to achieve nutrition security. Dr Malhotra stated that in order to accomplish this, good agricultural practices should be promoted and regulatory system should come into the picture to ease the bio products business. He urged that the private sector needs to come forward and



should promote engagements and partnerships with research sector to promote and develop sustainable solutions.

Dr Malhotra advocated that microbials should be included in the bio-stimulants category. Large scale testing, agro climate zone wise planning, fast registration and identification of microbials and bio products is required, he emphasized.

Dr PVSM Gouri – Director AIOI

Dr Gouri said that many new compounds of microbial nature are being introduced in the market. Raising her concern over certification and branding of the products, she said that a regulatory system needs to be strengthened at commercial level. Dr Gouri expressed concern that many certification bodies don't know the basis on which bio stimulants should be evaluated. Packaging should embody specifications and details like crop, area, and quantity on which the product exhibits the best results, said Dr Gouri.

Addiding further on increasing the efficacy of bio products, Dr Gouri said that genetically modified organisms can be introduced.

Dr MH Mehta – Chairman, Gujarat Life Sciences

Dr Mehta said that bio inputs are extremely important and crucial to ensure viability. He stated that new generation bio inputs shall play a critical role in addressing the various challenges faced by agriculture.

Dr Mehta said that the bio-inputs industry is R&D based. Most of the units are small and medium scaled, and are flourishing. Speaking on the role and importance of India in the sector, he said the country is positioned very well to take the leadership of the sector.

Dr Mehta emphasized that by 2030, we can replace 20% of agrochemical use with bio products. He said that the bio inputs industry is a rising industry, witnessing annual growth of 17-18% annually. It is necessary to educate farmers and other stakeholders regarding the new technologies and methods to encourage the growth of the industry. Dr Mehta advocated that is essential to give a practical road map to agriculture co-operatives to accelerate the extension of the sector.

Mr RK Goyal – Director Sales & Marketing – South Asia, Verdesian Life Sciences

Mr Goyal emphasized on the requirement of easing regulations for corporates to promote bio inputs in the nation. He stated that India is a dynamic country with lots of diversity, and the largest nation to use 33million tons of urea annually. Mr Goyal added that optimization of chemicals and seeds must be encouraged for productive and profitable agriculture. He concluded his deliberation by emphasizing upon the wisdom of 'Grow More With Less'.

Dr Anand Zambre - ED, NCPAH

Dr Zambre shared his experience of learning Integrated Pest Management in Netherland. He said that in 2012, bio pesticides and other bio products were rarely available in India. He observed that in the years thereafter, the awareness for bio and organic agriculture expanded, and bio industry has witnessed a substantial growth in these years.

Sharing his perspective on bio agriculture, Dr Zambre said that integrated pest and nutrient management gives better and effective results as compared to 100 percent bio and organic practices. The webinar witnessed the active and enriching participation of more than 200 guests. The discussion was graced by the presence and engaging deliberations of eminent panelists and agriculture experts viz, Dr SK Malhotra, Director DKMA – ICAR and Former Agriculture Commissioner, ICAR, Dr MH Mehta, Padmashree recipient, Dr Rajaram Tripathi, etc.

He added that the government should emphasize upon formulation and implementation of integrated practices. To achieve sustainability, it is crucial to educate farmers. Availability of products should expand and registration should be easier, he said.

Mr Umakant Pandey – Head Agriculture, HCL Tech

Mr Pandey said that CSR initiatives of the organization are devoted towards betterment and growth of small and marginal farmers. Emphasizing upon the agenda of the conference, he said that biological and integrated practices are bringing forth hopes to ensure sustainability in the agriculture sector.

Talking about challenges faced by farmers, Mr Pandey said that the cost of bio inputs is higher. This may make their accessibility a challenge tough for small and marginal farmers. Also, the products are not yet available at the outskirts of districts, which is another reason for their inaccessibility for the farmers. Speaking about role which FPOs can play in leveraging awareness, Mr Pandey said that FPOs have the potential and the power to disseminate awareness about practices, products and technologies in their respective areas.

Mr Pandey urged that the government

should significantly emphasize upon affordability and accessibility of bio products to encourage and accelerate the growth of farmers and the promotion of organic farming in the nation.

Mr Vipin Saini – CEO, Biological Agri Solutions Association of India

Mr Saini said that agriculture is witnessing dynamic growth and advancements in agriculture technology. Nano Technology is one such example. Adding on the significance and role of India, he said that our country has the potential to emerge as a leader of the sector.

Speaking about the challenges, Mr Saini said that one set of regulations or one Act shall not suffice for the whole country. He said that different regulations, formulated region wise, are prerequisite for effective results.

Dr Rajaram Tripathi – Chairman, Central Herbal Agro Marketing Federation of India

Dr Tripathi is a pioneer in agriculture practices and has been practicing the profession since last 20 years. Discussing upon agenda, he said, there are so many ways for organic farming in the market which puzzle the farmers about reliable and effective methods. Adding further, he said, government should establish set norms for organic and natural farming to encourage farmers on adopting organic practices. Emphasizing on government's role, he said, proper funds should be allocated to the sector.

Dr Prafull Gadge – Principal Scientist & CEO – Biome Technologies Pvt Ltd

Dr Gadge spoke about the obstacles which small and medium industries are facing. He said set guidelines and regulations should be there for all biological inputs. Dr Gadge said that it is is tough to get licence for products for new industries. He added that awareness on application of biological inputs should be increased among farmers to get effective results. He urged that the government should encourage capacity building and trainings to popularize the use of biological inputs.



AATMANIRBHAR KRISHAK THROUGH SOLAR ENERGY

odern technologies as mechanization for farm operations, irrigation, processing and value addition of farm produces etc. are the major activities consuming energy in agriculture sector which is about 7 to 8% of total energy consumption of India. Agrivoltaic systems or solar farm demonstration unit offer a solution to the increasing demand for food and energy. Agrivoltaics combine crops with solar photovoltaics on the same land area to provide sustainability benefits across land and energy.

The rise in energy use has led to increase in burning of fossil fuels, which emits greenhouse gasses and responsible for disturbing the global ecosystem balance, which threatens future generations the global economy. Therefore, there is need to harness and use more renewable forms of energy from solar, wind and biomass sources, all of which are plentiful in the country.

Electricity Generation From Solar Farm Demonstration Unit (Agri-Voltaic System)

Agri-voltaic system produces food and generates photovoltic-based electric en-

ergy from a single land unit. Both the processes of photosynthesis for food production and photovoltaic for electricity generation require solar irradiation and land resources as basic resources. Therefore, in agri-voltaic system, crops are cultivated in between solar panel and below photovoltic



About the **AUTHORS**

Dr PK Gupta is Director, NHRDF, New Delhi With Dr Samarpal Singh and Mr Rakesh Kumar, Krishi Vigyan Kendra, Ujwa, New Delhi installations for simultaneous generation of food and energy.

Solar farm demonstration unit of 110 KW was established at Krishi Vigyan Kendra, (NHRDF) New Delhi under the Mukhyamantri Aaye BadhotriYojna, during 2020-21. The land area of Solar farm demonstration unit is 1500 m2 with three panels for power generation. The length of panel is 65 m and width of each panel is 3 m and inter space between two panel is 7.5 m.

The height of each panel from ground level is 3.5 m, for easy cultivation practices by farm machineries. The funding agency was NABARD and Delhi Transco Limited. The objectives of to establish here are to increase income of farmers by installation of solar plants in their agriculture land, which would enhance power production and to develop successful and profitable cropping modules for enhancing more income from single land.

The electricity is generating form its photovoltaic components as a major output. The electricity generated from the solar farm demonstration unit directly supply supplied to the local grid through net meter system. The amount of photovoltaic generation depends on the available of solar radiation.

Crop Production In Solar Farm Demonstration Unit

The cultivation of crops was started after establish the solar farm demonstration unit modules in 2021. Vegetables based cropping system was adopted between rows of Solar panel. The benefits of height of Solar panel was also taken for that the space just below of each Solar panel was also utilized for crop production.

Following bio cropping pattern were adopted in kharif season the combination of Onion (seed Production) + Tomato+ Brinjal + Bitter Gourd+ Bottle Gourd+ Spongy Gourd+ Leafy Vegetables in rabi season Onion +Cauliflower+ Cabbage + Root vegetables + Leafy Vegetables and in summer Okra (seed Production) +Bitter Gourd+Bottle Gourd+ Spongy Gourd+ Leafy Vegetables.

These crops were grown on beds and supplied irrigation by drip system. These cropping patters performed well in every season and gave good remunerative return as in table No1. The yields of these crops were affected by shading of Solar panel. The maximum yield and economics was found under open field condition as compared to under solar panel.

This reduction in the yield in every season was found due to low interception of solar radiation in solar panel area. In summer, Kharif and rabi season yield reduction was 19.01 %, 18.9% and 14.2 %, respectively due to shading effect on crops under solar panel. The maximum yield (206.70 q/acre) and net return (Rs. 183673.17/acre) was found under open

POLICY INTERVENTIONS REQUIRED

Following policy interventions may be required to establish agrivoltaic system in farmers' field.

- Loaning through banking sector for installment of agri-voltaic system need to be initiated.
- Capital investment on agri-voltaic system is quite high and therefore subsidy may be introduced to promote such system.
- Grid network should be made available to remote locations and farmers' field so that generated electricity can easily be sold to grid.
- Land use policy need to be developed so that leasing of land for installation of agri-voltaic system be easy.

field condition over cultivation of crops under solar panel .

Under solar panel, the Maximum Yield (71.25 q/acre) and net return (Rs. 54040/acre) was reported in rabi season because the crop under solar panel performed better and scoped form cold waves. However, maximum the B:C ratio (2.36) was found in Kharif season. Under open field condition, similar trend was reported in term of yield and economics.

Electricity Generation From Solar Farm Demonstration Unit And Income Per Unit Area Basis

The total electricity was generated 408789 units/ acre in the one year from February 2021 to January 2022 (table 2). The maximum electricity was generated in March month followed by November and June Months. The income Rs. 3,55644.1/ acre was generated after sale of electricity (Table1). The income from the same land by cultivation of vegetables was Rs.148750/ acre. The total income Rs.504394.1 /acre was generated from the solar farm dem-



View of Solar Demonstration Unit at Krishi Vigyan Kendra, New Delhi

onstration unit (Vegetables + Solar energy production).

In term of income from per unit land basis the combination of cultivation of crop and solar energy production is the best to enhance the income of farmer and food security.

Possible Ways To Install In Farmers' Fields

Initial investment for establishment of agrivoltaic system or farm demonstration unit is about ` 160 lakh for 1 acre. High cost of investment is a major hindrance for its adoption in farmers' field. Therefore, policy supports and guidelines are necessary for establishment of agri-voltaic system in farmers' field.

The scheme 'Kisan Urja Suraksha evam Utthan Mahabhiyan (KUSUM)' has been launched by Ministry of New and Renewable Energy, GOI. It focuses on installation of solar photovoltaic modules and solar photovoltaic pumping system.

Providing food for the world while transitioning to more land intensive energy sources is a challenge. It can be partially overcome by the dual use of land in solar farm demonstration unit.

Our preliminary modeling study showed that for vegetables crops, food yields in India may be maintained while the income of the farms deploying the proposed agrivoltaic systems could increase by over 174.6 times annually as compared to conventional farming. If this dual use of land is implemented nationwide, it can make a significant impact by generating electricity, which could meet the energy demands of people.

ORGANIC FARMING Can It Be A Game Changer?

aramparagat Krishi Vikas Yojana (PKVY) is promoted largely based on on-farm biomass recycling with major stress on biomass mulching, use of on-farm cow dung-urine formulations, periodic soil aeration and exclusion of all synthetic chemical inputs. It will reduce dependency on purchased inputs and will help to

ease

about 85% small and marginal farmers from credits burden. The PKVY programme adopted in Andhra Pradesh, Karnataka, Himachal Pradesh, Gujarat, Uttar Pradesh and Kerala have reported the effectiveness of natural farming in terms of increase in production, sustainability, saving of water use, improvement in soil health and farmland ecosystem. It is considered as a cost- effective farming practices with substantial scope for raising employment and rural development.

It is roughly estimated that around 2.5 million farmers in India are already practicing regenerative agriculture. In the next 5 years, it is expected to reach 20 lakh ha. in any form of organic farming, including natural farming, of which 12 lakh ha. are under BPKP. Organic agriculture is now practiced on 1% of the global agricultural land area and its importance continues to grow.

To strengthen economy & self-sustainability, the call for 'Atmanirbhar Bharat' is announced as a big opportunity for Agriculture and allied sectors. India has achieved the milestone of food surplus country through chemical farming and facilitating the sector to further strengthen to maintain & grow towards the vision of growing Indian economy and expanding its size to above a \$5 trillion economy.

Natural Farming (NF) here emerges as a potential agro ecological practice that promises to enhance avenue for farmer's income in addition to many other benefits like environment restoration to mitigate the climate change concerns.

Why To Move Towards Organic Farming?

The move towards organic/chemical less farming stem from the government's move to cut down on fertiliser subsidies given to the farmers. The Union government has been reducing the budget on subsidies over the years.

India has made significant mark by promoting organic farming. India's rank in terms of World's Organic Agricultural land is 9 th (1.94 million hectare area) and in terms of total number of producers was 1st (11.49 lakh farmers of producer) , total export value is 757.49 million US \$ as per 2020 data.

NITI Aayog member Dr Ramesh Chand said in an interview that India can double the acreage of chemical-free farming to 15% immediately, and to 30% by 2030, "without hurting national food security as any resultant loss in output

About the **AUTHOR**

Dr MP Thakur is Dean, RSV College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya, <u>Bemetara</u>, <u>Chhattisgarh</u>



and exports could be compensated by the reduction in fertiliser subsidies". But, it is not happening in the fields.

If a larger number of farmers were to switch to organic practices, it would require more land to be brought under agriculture. This would be additional pressure on existing natural habitats, due to habitat conversion and loss. More land diverted for organic produce would also mean that the cost of production will rise, making food less affordable for poor consumers in developing countries. Indeed, organic food is currently accessible only to high-income groups and beyond the reach of a common man.

Impact on productivity

Studies initiated by the ICAR-Indian Institute of Farming System Research (IIFSR), Modipuram at several locations in the country have clearly indicated that yield levels were drastically reduced in rice-wheat cropping system by 59% in wheat and 32% in basmati rice. Results of a three-year Natural Farming Experiment by the University of Agricultural Sciences (UAS), Dharwad indicated a yield decline of at least 30% in soybeanwheat, groundnut-sorghum and maizechickpea cropping systems. These trials have clearly established that food security will be seriously challenged along with the farmers' income if natural farming is adopted (NAAS, 2019).

NF may not be a substitute for conventional farming for large scale food For the last 20 years, GOI has promoted NF but the area under this is still limited to only 3% of the total cultivable area. It means that the acceptability of 97% Aatmanirbhar Krishak to adopt bio farming is not being realised

production. Rather, it may be promoted in low-input region of the country for small and marginal land holders (ICAR-NAARM, Hyderabad). Bio Agriculture has potential for sustainable crop production but it has limitation also particularly in tropical and sub tropical climate with changing climatic scenario where the survival of microbes is difficult and ad-



and volleyball

versely affected due to rising temperature during summer months.

Aatmanirbhar Krishi, Aatmanirbhar Krishak

If we go further encouraging Natural farming, the productivity is going to further reduce as per the multilocational trials conducted by IIFRS, Modipuram. GOI for the last 20 years through various programmes is promoting NF but the area under this is still limited to only 3% of the total cultivable area. It means that the acceptability of 97% Aatmanirbhar Krishak to adopt Bio Farming is not being realised may be due to lesser yield or unavailability of farm resources/inputs in bulk quantity and time for the larger area to be covered under NF.

Keeping in view of the above facts and figures, we have to find out mid way that Organic farming is not the paradigm for sustainable agriculture, food, nutritional and income security, but smart combinations of organic and conventional methods could contribute toward sustainable productivity increases for Aatmanirbhar Krishi and Aatmanirbhar Krishak in context to Indian as well as global agriculture. It is to be coupled with adoption of modern agricultural technology, tools, techniques of crop production & protection using farm advisory with crop, land use and weather data captured through satellite, AI, Deep learning, drone technology etc. to reap the maximum farm benefits.

THE BENEFITS AND ADVANTAGES OF **SUSTAINABLE AGRICULTURE** IN INDIA

ermaculture, regenerative agriculture, organic gardening, and companion planting are all different approaches to sustainable agriculture. While they each have their unique characteristics, they share a common goal of creating a more sustainable and ecologically responsible approach to farming and gardening. In India, these practices are increasingly gaining popularity as more people become concerned about the negative impacts of industrial agriculture on the environment and public health. Organic farmers markets provide a platform for farmers to sell their produce directly to consumers, promoting healthy eating and sustainable agriculture.

Permaculture

Permaculture is an approach to farming and gardening that seeks to mimic natural



ecosystems, creating a sustainable and self-sufficient system. It is based on three fundamental ethics: care for the earth, care for people, and fair share. The goal of permaculture is to design a system that is both productive and sustainable, using ecological principles to create a closed-loop system that minimizes waste and maximizes productivity. This is achieved through techniques such as companion planting, soil conservation, and the use of renewable energy sources.

Regenerative agriculture

Regenerative agriculture is another approach to sustainable agriculture that seeks to rebuild soil health and biodiversity. It is based on the principles of soil regeneration, biodiversity, and ecosystem restoration. Regenerative agriculture is designed to work with nature, rather than against it, by building soil health, reducing erosion, and promoting biodiversity. This is achieved through practices such as cover cropping, crop rotation, and the use of natural fertilizers.

About the **AUTHOR**

Mr Vic Gaffney is an Australian expert in permaculture, organic farmers markets, and regenerative agriculture. He has been working in the field of sustainable agriculture and food systems for over three decades.

Organic Gardening

Organic gardening is a method of growing fruits and vegetables without the use of synthetic fertilizers, pesticides, or genetically modified organisms (GMOs). It is based on the principles of sustainability, biodiversity, and natural resource conservation. Organic gardening relies on natural processes such as composting and companion planting to maintain soil fertility and pest control. Organic gardening is not only healthier for the environment, but also for those who consume the produce.

Companion Planting

Companion Planting is the practice of planting different crops together in order to improve their growth and yield. Companion plants can help to repel pests, attract beneficial insects, and improve soil fertility. For example, planting marigolds with tomatoes can help to repel nematodes, while planting beans with corn can help to fix nitrogen in the soil.

Organic farmers markets provide a platform for farmers to sell their produce directly to consumers. Farmers markets also promote community involvement and provide opportunities for education and outreach on sustainable agriculture practices.

Implementing sustainable farming practices such as permaculture, regenerative agriculture, organic gardening, hugelkultur, biodynamic agriculture, Demeter food standards, companion planting, composting, vermiculture, and organic farmers markets can bring mul-



tifarious and sustainable benefits to India.

Increased crop yield: Permaculture and regenerative agriculture are sustainable farming practices that focus on building healthy soil, increasing biodiversity, and improving ecosystem health. These practices can lead to increased crop yield and higher quality produce.

Reduced environmental impact: Organic gardening, biodynamic agriculture, and Demeter food standards emphasize using natural methods to grow crops without synthetic fertilizers, pesticides, and herbicides. This approach can reduce the environmental impact of agriculture and promote the health of soil, water, and air.

Cost savings: Hugelkultur is a technique that involves building raised beds using logs and other organic matter. These beds act as self-sustaining ecosystems, retaining moisture and nutrients and reducing the need for external inputs. This can lead to cost savings for farmers.



Mr Gaffney is the founder of 'Permaculture India' which is a national network of communitybased food projects, and the 'Organic Farmer's Market' in New Delhi

Biodiversity conservation: Companion planting is a technique that involves planting different crops together to support each other's growth and health. This practice can also increase biodiversity on farms and protect against pests and diseases.

Improved soil health: Composting and vermiculture involve converting organic waste into nutrient-rich soil amendments. These practices can improve soil health, increase soil fertility and reduce the need for synthetic fertilizers.

Economic opportunities: Organic farmers markets can provide small farmers with access to a niche market that values sustainable farming practices. This can create economic opportunities for small and marginal farmers who may struggle to compete in conventional markets.

Implementing these sustainable farming practices can bring several benefits to India, including increased crop yields, reduced environmental impact, cost savings, biodiversity conservation, improved soil health, and economic opportunities.

By addressing these issues with the sincere support of national and state governmental agencies, smart policy and implementation initiatives, targeted education and capacity building of the primary stakeholders, India as a whole will benefit greatly in measurable improvements in the health of the consumers, and the productivity and wealth of the farmers.

tête-à-tête with Anjana

INNOVATIVE SOLUTIONS Key to sustainable farming

arain Bayer

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The small and marginal farmers in India and many parts of the globe face multiple challenges. Lack of access to good quality crop inputs and agronomy insights, frequently changing weather patterns, increasing instances of soil degradation, water scarcity, and labour shortages are adversely impacting the productivity of small farm holders.

Even a good produce is no guarantee of a good income as access to markets and getting the right price for their produce is a challenge. It is exactly these challenges that Bayer is trying to address through its innovation efforts across the entire crop value chain.

Mr. D Narain, President, Bayer South Asia and Global Head of Smallholder Farming in conversation with Anjana Nair, Group Editor, Agriculture Today elaborates on the unique trends existing in India and Bayer's initiatives in India.

Mr. D Narain President, Bayer South Asia and Global Head of Smallholder Farming

In what ways we can make smallholder farming more remunerative?

Smallholder farmers normally have landholdings of less than two hectares. One of the ways to help them reap the benefits of scale is to bring them together into collectives.

These farmer collectives, similar to Farmer Producer Organizations (FPOs) in India, have the opportunity to help farmers acquire inputs collectively, share knowledge, use mechanized tools, and access markets as one unit. The Indian government has set an ambitious target of creating and promoting 10,000+ FPOs and Bayer is collaborating with several existing FPOs and also helping establish new FPOs in targeted areas.

Bayer's Crop Science Division in India already supports more than 20 million farmers in the country through its portfolio of innovative chemical & biological crop protection solutions, seeds & traits, and digital technologies & services. Additionally, Bayer's global model of Better Life Farming (BLF) which is a last-mile based partnership based ecosystem for clusters of 500-1000 farmers has already established more than BLF 1600 centres across the country and are run by rural Agri-entrepreneurs.

In addition, rural micro-entrepreneurship models like 'Sahbhaagi', run by Bayer, empower farmers, women, and rural youth to become an advisor to smallholder growers. Bayer's Bay G.A.P. Service Program helps farmers get certified and connected to the value chains tête-à-tête with Anjana





for both domestic markets and exports. With a number of Food Chain managers in 44 countries, we aim to cultivate new opportunities for smallholder farmers worldwide. By sharing collective insights, goals, and resources, we contribute to tangible initiatives that improve the livelihoods of smallholder farmers.

India will continue to be a major manufacturing hub, a knowledge hub as well a key market for Bayer's cutting-edge products and innovative ideas, which boost farm productivity and rural incomes.

Can Sustainable farming help reduce the stress on smallholder farmers? What are Bayer's initiatives on Sustainable farming?

Through innovative solutions that promote sustainable, low-emission, and resilient farming, we can help reduce the stress of smallholder farmers. For example, the excessive usage of groundwater for rice cultivation has become an endemic problem in many North Indian states. Farmers need to adopt methods and crops that conserve water. This means reviewing traditional agriculture practices and adopting a holistic rice crop management system along with a drive to plant the right seed varieties including expanding hybridization.

To reduce stress on water resources and promote sustainable farming, Bayer has piloted the Direct Acres project in Punjab and Haryana, scaling it up to 2000 acres in 2022. The objective of Direct Acres is to ensure successful Direct seeded rice cultivation. Bayer is also collaborating with institutions like IRRI to scale up Direct Seeded Rice (DSR) in Eastern UP, Bihar, and Orissa. Participating farmers also have the opportunity to earn additional income through the Bayer carbon project.

Bayer aims to collaboratively lead the transition to DSR in millions of hectares leveraging innovation in genetics, weed management, and mechanization. Bayer is also helping farmers to use climatefriendly methods, such as reducing plowing and using digital solutions, to reduce CO2 emissions. Solutions like better weed control, being offered by Bayer, can reduce the need for farmers to till their soil, thereby decreasing soil disruption caused by excessive tillage. With a number of women Agri-entrepreneurs running our BLF centers, it has become a crucial driver of gender equity in many rural communities as well!

Likewise, the use of digital tools and precision agriculture techniques and the usage of drones in agriculture being pioneered by Bayer in India, not only helps reduce the usage of water and crop protection products but also leads to a judicious and even spraying of crop protection products.

In the final analysis, all these actions have the potential to generate sustain-

I feel that there is an opportunity for co-existence for all forms of farming. All farming methods that ensure no disruption in the food supply and fulfill the needs of the people, should be encouraged.

able farm incomes while at the same time delivering significant improvements to drive water efficiencies, soil health, and reduce environmental emissions!

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The government currently places a lot of emphasis on organic and natural farming. What is your take on this?

Over the past many decades, India has successfully managed to continuously improve farm productivity and grow enough food to feed its growing population. I feel that there is an opportunity for co-existence for all forms of farming. All farming methods that ensure no disruption in the food supply and fulfill the needs of the people, should be encouraged.

Whatever farm practices are adopted, they have to be economical and remunerative for farmers and sustainable for the planet and the economy. Productivity and farmer profitability will ultimately drive what farming practices will be adopted by farmers.

How significant is India as a market for Bayer?

With over 125 years of legacy in India, Bayer remains committed to supporting the country and its people by ensuring food security, health security, Nutrition, and livelihoods. India continues to be a very significant market for all three business divisions of Bayer – Crop Science, Pharmaceuticals & Consumer Health.

India is home to the largest population of smallholder farmers in the world and Bayer is supporting more than 20 million farmers to increase productivity, enhance the use of technology in farming and promote sustainable farming to help conserve precious resources.

Bayer runs some of the most advanced seed breeding centres, seed processing units as well as manufacturing facilities for crop protection products in India. In fact, Bayer is not only Making in India but is also Making in India for the World.

Bayer's unit in Vapi is a core manufacturing site for the company globally and the single largest synthetic pyrethroids production facility in the world. Located in Gujarat, it is fully backward integrated with production starting from basic chemicals to active ingredients and intermediates for application in crop protection, animal health as well as home



tête-à-tête with Anjana

and garden applications.

India is also a key market for innovation and digital tools employed by Bayer worldwide. But even more importantly, Bayer is partnering with multiple startups in India to bring innovation, digitization, and technology to agriculture. India is home to multiple centers of excellence in Bayer servicing global functions related to IT, Finance, and Global Business Services

What are the market trends that you have been observing in India and how is it different from the rest of the world?

India enjoys many advantages and is a very unique market. I would like to highlight a couple of trends that are unique to India and will be crucial in transforming the Indian agricultural market:

 India is home to most of the major crops in the world and is self-sufficient in meeting the food security of its citizens

• India is a unique smallholder market with more than 86% of farmers in the country and hence requires uniquely tailored solutions

 India represents one of the largest markets for food products in the world but at the same time it is one of the biggest exporters of food products

 With nearly half of the country's population still dependent on agriculture and allied activities, India presents a great opportunity to transform the rural landscape through transformative measures

 India has a significant opportunity for innovation and digitization in the agriculture sector. Digital public infrastructure for agriculture will enable inclusive solutions through relevant information services, improved access to inputs, credit, and insurance, help for crop estimation, market intelligence, and support for the Agritech industry.

What are the future plans for Bayer in India?

Bayer remains fully committed to, enhancing farmer incomes and delivering on its vision of 'Health for all, Hunger for none,' in



India. We will continue to work on technology that will drive resilience among crops, increase output per acre while reducing carbon emissions, encourage efficient use of natural resources, and create partnerships to help build scale among smallholders. Bayer also aims to further boost rural entrepreneurship and capacity building among Indian farmers through a rapid expansion of rural entrepreneurship models including focusing on empowering more women and rural youth.

Forward Farms

Another initiative that has great potential is 'Forward Farms'. In Forward Farms, Bayer partners with independent farmers to show how tailored solutions, modern tools and practices, proactive stewardship measures, and partnerships are enabling farmers to run successful businesses while providing enough food for a growing world, and in a way that preserves the environment. The first such farm has already been set up in India by Bayer and we are looking to expand this initiative across the country

Digitization and mechanization are important focus areas for Bayer in India. We work with farmers to identify opportunities tailored to each field through data-driven insights and products that help them make the most of every piece of farmland. India will continue to be a major manufacturing hub, a knowledge hub as well a key market for Bayer's cutting-edge products and innovative ideas, which boost farm productivity and rural incomes.

BIOSTIMULANTS & PLANT GROWTH REGULATORS Essential inputs in bio agriculture

atest agriculture technologies provide high yielding varieties, ensure nutritional sufficiency and effectively control pest incidences in order to further increase the global food grain production. In spite of employing these technologies, the yield levels of various crops have reached a plateau.

This is resulting in gradual enhancement in the cost of food production. The enhancement of yield gap is also a growing concern that indirectly shows the gradual reduction in the metabolic efficiency of the crops to reach biological potential in terms of growth and yield.

Impact Of Climate Change

One of the major reasons for this reduced metabolic efficiency of the crops is due to their susceptibility to physiological stress caused by the ill effects of climate change. The various studies on the impact of climate change on Agriculture reports that, instances of yield reduction, reduced nutritive value of the harvests and crop failures are becoming frequent.

Plant Bio Stimulants and Plant

Growth Regulators

Why are crops that are managed scientifically through balanced nutrition and timely protection from pests & diseases succumbing to the ill effects of climate change?

Even though the soil is fertilized as per soil test data, crops are sprayed with latest pest control molecules; the capability of the crops in the uptake, translocation and assimilation is decided by the Enzymatic and Hormonal balances within the plant system.

These Phytohormones (growth factors) plays a major role in the activation of various metabolic pathways that result in uptake, translocation (mobility) and assimilation of nutrient elements in to economically important substances called the Yield. Instances of deficiencies of these growth factors will result in the inability of the crops to reach the biological potential in terms of growth, yield and its quality.

Indiscriminate Use Of Synthetic Agro Inputs

The ignorance of plant physiology has resulted in the indiscriminate use of synthetic agro inputs to increase the yield.

About the **AUTHORS**

Mr Narayanan is Director Marketing, Greenstar Fertilizers Limited, Chennai Ms B Jayanthi is Chief Research Officer, Agripro International Pvt Ltd, Chennai

The Food and Agriculture Organisation (FAO) has reported the average change in the world temperature.

It is reported that from the month of October to mid-March, the world temperature change during 2020 to 2022 is to the tune of 1 Deg Centigrade. This change in temperature during October to March also effects the intensity and spread of normal monsoon affecting the growth and yield of rain-fed crops of Asian and African regions.

These unscientific practices have resulted in the deposit of hazardous chemicals in the soil and ground water sources. As a result the soil biology is altered where in the nutrient fixing, cycling and releasing microbes have become in efficient; making the soil less Productive even when they seems fertile in a soil test laboratory.

Biologically synthesized Bio stimulants (PBs) and Plant Growth Regulators (PGR) play a vital role in ensuring enzymatic and hormonal balances in the plant system. The inclusion of PBs and PGR in the crop production process is one of the essential tools to reverse the current situation of Yield Plateauing and to reduce the Yield Gap.

The requirement of PBs and PGR to stimulate the essential metabolic pathways is plants is very small as they work efficiently at very low concentrations. As a result the investment per unit area of land is relatively small and the benefits are multi-fold in terms of quantity of harvest made and value of the harvest due to superior quality parameters.

Benefits of Biologically Synthesized PBs and PGR

- Improves the soil biology and promotes the development and growth of beneficial microbes.
- Improves the uptake & use efficiency of water and nutrients; thereby reducing the requirement of synthetic agro inputs.



- Stimulates natural defence mechanism on the crops to tide over pest epidemics.
- Under best agricultural practices, PBs and PGR will ensure a bumper yield with nutritious harvests.
- Bounce back quickly to normalcy from the ill effects of climate change by effective scavenging of free radicals.
- The bioactive substances like L Amino acids function as carriers of micro nutrients to bring about bio fortification of the yield.
- Imparts overall resilience to the crops to march towards A Climate Smart Agriculture Production system.

The formulations that are manufactured through biological ways through enzymatic intervention process is known to contain bio active substances which are the potent active substances in the PBs and PGRs.

The recent notification of the Government of India on Bio stimulants has identified Botanical extracts, including seaweed extracts, Bio –chemicals, Protein Hydrolysates & amino acids, Vitamins, Cell free Microbial products, Antioxidants, Anti-transpirants, Humic & fulvic acid and their derivations. This has opened up new opportunities for combating the impact of Climate Change in Indian Agriculture, ensuring a Climate Resilient Farming Practices.

Significant contribution of PBs and PGR for Bio Agriculture

- Regular use ensures rejuvenation of soil biology and hastens detoxification process.
- Regular use makes the soil fertile and productive enough to meet the ever increasing demand of food with superior quality of produce.
- Enhances the utilization of applied nutrients and water; thereby reduces the dose of synthetic agro chemicals to sustain and increase the yield.
- Ensures superior quality foods with bio fortification of mineral nutrients & vitamins.
- Reduces the impact on Environment with respect to greenhouse gas emissions.
- Creates a biologically active ecosystem for recycling of crop residues and carbon sequestration to enhance carbon sink.

ORGANIC ATMANIRBHAR KRISHAK BREAKTHROUGH FOR ONE CROP TRANSITION

cientific and practicing farm community has been deeply apprehensive about eliminating the chemical fertilizer as well as crop care chemicals completely without affecting the yields. We see advocacy of natural farming and cow-based Prakrutik farming as transitional methods for chemical free farming.

So far, 3-5 year transition period is recommended causing the farm community to accept lower yields and higher damage to the crops during this transition period. Market is limited for the higher priced (organic) food. This has been a major stumbling block in strategic needs Vs actual implementation.

A Key Stumbling Block

One of the key stumbling blocks is crop protection without the chemicals (technical pesticides). 40 years of observations in organic farms have shown that disease and pest infestations have been substantially lower compared to chemical farms.

Nitrate from Urea and Ammonium (fertilizers like DAP) act like a super magnate to attract insects and pathogens from the microbial world because it requires them as key input for their own protein synthesis. This confirms the observation and mechanism that higher the use of chemical fertilizers, higher the vulnerability of crops to diseases and pest attack.

> The challenge is to replace the water-soluble chemical nutrients mechanism with the metabolites and nutrients availability through microbial activity. Zydex has achieved a major breakthrough in creating Zytonic Technology Platform which enables the farmers to immediately convert farm soils which are soft and porous.

> > This impacts improvement in gas exchange (aeration), water holding capacity and enables the plant roots (white roots) to create much larger rhizosphere. The enabling conditions of oxygen, water can increase the microbial activ-

About the **AUTHORS**

Dr Ajay Ranka is CMD, Zydex Group. Dr Shailendra Singh is COO, Zydex Agro Solutions ity and with the large volume of the rhizosphere a substantial increase in the natural mining of nutrients and microbial metabolites can now compete to equal or exceed the chemical nutrient supply mechanism.

Bringing In The Forest Mechanism

Zydex has built a complete platform of inoculating high quality microbial species like My co, NPK and make sure that we have high population of effective microbial population and maintain their activity at highest level to ensure that the plant growth and the yields are actually better without depending on chemical route. We are bringing in the forest mechanism and make it very efficient in our farms through the new generation of the range of bio-fertilizers (www.zydexindustries. com).

The new generation of bio-fertilizers have ensured higher yields when 100% chemical fertilizers are replaced giving a new hope to the farm sustainability. These bio-fertilizer formulations can make the soil soft and porous, improving aeration and moisture retention along with boosting the friendly biology population and its activity. This results in substantially large and dense root zone with high level of nitrogen fixing by the Rhizobium and Azotobacter family in the rhizosphere.

The Potassium and Phosphorus solubilizing bacteria also function more efficiently and actively in the large rhizosphere with the optimum availability of Oxygen and water and release the insoluble Phosphorus and Potassium from the soils resulting in higher crop yields without using chemical fertilizers.

Growth And Protection

Stress of temperature and lack of maintaining perfect moisture conditions in the air/in the soil are the key problems faced by the Indian farmers. Growing under adverse conditions of high temperature and imperfect weather has now been enabled by a new technological breakthrough from Zydex to enhance crop resistance through bio-protection.

It enables absorbing dew water (night condensation) on the leaf surface and now maintain healthy and beneficial microbes



Sustainable bio-agriculture will need to focus on efficient use of animal population and new generation of biological technology bio-digestion, bio-fertilizers and natural pesticides. This will also ensure safe and healthy food for all

on the standing crop canopy to resist pathogenic fungal/ bacterial attack along with reduced vulnerability to insects and pests. This works well as a bio-foliar eliminating the need of chemical fertilizer for growth due to enhanced photosynthesis activity (The absorbed dew has higher concentration of dissolved carbon-di-oxide).

Fungal Based Bio-Digestion Technology

Zydex has innovated fungal based biodigestion technology (Zytonic Godhan) to enhance the conversion of biomass to stable organic matter (SOM) and increase the speed of bio-digestion. Zytonic® Godhan, allows the farmer to accelerate the fungal bio-digestion on the surface without repeated turning and repeated watering (reducing the labour input), in 30-60 days with higher organic residue. The resulting manure is high quality (brownish black), fungal dominated, free flowing, smell free and becomes available at the local farm level.

The field application of such completely bio-digested fungal rich manure has shown to eliminate the white grubs, reduce weed population by bio-digesting weed seeds in manure. It also helps in almost eliminating the fungal pathogenic attacks on the roots and control the menace of root attacking nematodes, demonstrating that the healthy rhizosphere is effective to protect the plant. It is also cheaper, ecofriendly using local resources leading to sustainable agriculture. Most important benefit is enhancing soil fertility. The field experience in Bihar, UP, Haryana, Punjab, Rajasthan, MP, Gujarat and Maharashtra have shown excellent consistency and >95% success rate.

The Challenges Of Residual Pesticides

Indian farmers are also facing the challenges of residual pesticides impacting the export worthiness of many economically attractive crops. The effective management of insects can be achieved by moving to repellent approach for harmful insects.

By using Zytonic Neem (A specialized Neem based formulation with enhanced stability on crop surface) harmful insects will not feed on crops and they will also be naturally controlled by increased population of beneficial insects maintaining ecological balance and reducing cost of farmers making them profitable.

Our Innovations Your Edge To Lead!



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- Skill development programs for universities & colleges
- Industry oriented Courses
- Hands on training sessions based on industry needs
- Placement Assistance



For Academia

For Corporate



Agrochemicals Manufacturing Workshop

- Manufacturing of Biostimulants, Organic Fertilizers & Pesticides Bio Fertilizers & Bio Pesticides, Adjuvants
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- Regulatory Guidelines
- Marketing Assistance
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Cultivating the Future

Shaping India's Bio-Agriculture Landscape by Harnessing Digital and New Media Technologies

he emergence of Industry 4.0 and Agriculture Revolution 3.0 presents a unique opportunity for India to transform its agricultural landscape. Industry 4.0 refers to the fourth industrial revolution, characterized by the integration of digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics, into traditional industries.

Agriculture Revolution 3.0, on the other hand, focuses on the development and adoption of advanced bio-agricultural practices, including precision farming, organic farming, and genetically modified organisms (GMOs), to enhance productivity, sustainability, and resource efficiency.

By harnessing the power of digital and new media technologies, India can revolutionize its domestic bio-agricultural sector, enabling farmers to optimize resource utilization, minimize environmental impact, and increase crop yields.

These innovations can help India position itself as a global leader in sustainable agriculture by sharing its knowledge and expertise with other nations, fostering international collaboration, and contributing to the global effort to combat climate change and ensure food security.

Gains Made By Digital India Mission

The Government of India's has been one of the pioneers in mainstreaming the use of digital and new media technologies and enhancing the capacities of central and state government agencies through Digital India Mission.

GOI has formulated guidelines such as the India Enterprise Architecture (IndEA) to ensure seamless data exchange and interoperability among various digital platforms; India Digital Ecosystem for Agriculture (IDEA) focuses on creating an enabling environment for the development and adoption of digital solutions for agriculture sector.

Agristack initiative aims to create a comprehensive digital repository of agricultural data, and startup promotion programs to provide financial support,

About the **AUTHOR**

Mr Vikas Kanungo is Senior Consultant with the Digital Development Global Practice of The World Bank and is the founding partner of DT4T Advisors LLP mentorship, and access to resources for agri-tech startups. These efforts, in tandem with the innovative use of digital and Agritech technologies can lay the groundwork for a digitally empowered agricultural sector that can effectively embrace the Agriculture 3.0 revolution, positioning India as a global leader in sustainable agriculture.

Let us explore various digital and new media technologies that can be harnessed to drive India's bio-agricultural sector forward and their potential applications in enhancing agricultural productivity, sustainability, and global



World Bank's "Sustainable Agriculture in Ukraine" project and the FAO's "AgriTech Solutions for Smallholders" initiative in Africa are some of the examples that demonstrate the power of precision agriculture in boosting productivity and sustainability

competitiveness.

Precision Agriculture & Decision Support Systems

Precision agriculture uses advanced technologies like IoT, AI, and Big Data to collect and analyze farm data for better decisionmaking. By utilizing sensors, drones, and satellite imagery, farmers can monitor crop health, soil quality, and other environmental factors in real-time, enabling them to make informed decisions on irrigation, fertilization, and pest management.

This data-driven approach reduces resource wastage, increases crop yield, and minimizes environmental impact. On the supply side, these technologies can help government make evidence based policies and programs that can provide long term sustainability and just intime support to farmers' activities.

The World Bank's "Sustainable Agriculture in Ukraine" project and the FAO's "AgriTech Solutions for Smallholders" initiative in Africa are some of the examples that demonstrate the power of precision agriculture in boosting productivity and sustainability.

By providing farmers with satellitebased monitoring systems and tools like mobile apps and remote sensing, these projects have enabled data-driven decision-making in crop management and resource optimization, significantly improving agricultural productivity and increasing income for smallholder farmers.



Blockchain based Systems and Traceability Solutions

Blockchain technology can be utilized very effectively to create transparent and secure supply chain systems, enabling end-to-end traceability of agricultural produce. By implementing blockchain, stakeholders can ensure the authenticity of bio-agricultural products, promote fair trade practices, and empower consumers to make informed decisions.

Additionally, application of these systems can ensure more resilient and transparent warehousing and logistic solution for formers, buyers and even the financing institutions. There are very successful use cases of leveraging Blockchain based Warehouse Receipt System in the World Bank funded project SMART in Maharashtra and Blockchain for Agricultural Supply Chains" project in Kenya.

Robotics and Automation

Robotics and automation technologies can improve efficiency in the bio-agricultural sector. Autonomous tractors, drones, and robotic harvesters can optimize field operations, reduce the need for manual labor, and minimize crop losses. Furthermore, these technologies can help farmers work in challenging weather conditions, thereby increasing overall productivity.

The World Bank's "Innovative Agricultural Solutions" project in Armenia has supported the adoption of robotics and automation technologies in the country's agricultural sector. Similarly, the FAO's "Agricultural Mechanization Strategy" aims to promote the use of robotics and automation to enhance agricultural productivity worldwide.

The role of new media in disseminating knowledge and fostering collaboration cannot be overstated. Through digital platforms, webinars, and social media channels, India can create a robust ecosystem for sharing the latest developments in bio-agriculture and AgriTech, connecting farmers, researchers, and entrepreneurs.

Meeting SDGs

By adopting more sustainable agricultural practices, India can contribute significantly to global objectives, including SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 15 (Life on Land).

In doing so, India can serve as an exemplary model for other nations, showcasing the transformative impact of sustainable agriculture and the advantages of a proactive, cooperative approach to addressing the pressing challenges of our time.

It is imperative for the government, private sector, and all relevant stakeholders to collaborate and foster a favourable environment that encourages the development and adoption of cutting-edge agricultural technologies and practices.

AGTECH TRENDS THE FUTURE OF FOOD

lobal population hit 8 billion very recently. How can we cope up with increasing demand for food, at the same time maintain food sustainability and establish global food security? It requires a new way of thinking and development of novel disruptive technologies in agri-foodtech sector which is a entering a global food transition. Climate change, consumer preferences for healthy and sustainable foods, shift in the agriculture market landscape will drive the future of global agri-foodtech landscape.

Agri-Foodtech Trends

Agri-foodtech trends that are forecasted to shape the future of agriculture and food are listed below. These technologies and innovations should help produce more with less environmental impact and should include water use efficiency, increase demand for global protein, optimized, efficient and shorter agri-food

About the **AUTHOR**

Mr Vasudevan Balaji is a globally recognized agrifoodtech thought leader with a passion for innovation and disruptive technologies enabled by helping startups to acheive sustainable food production and security SynBio advancements potentially lead to disruptions across industries in the form of product substitution, process improvements and new inputs supply chain, advanced food traceability methods, emission regulation, smart farming with Al/ML, broad band connectivity, effective de-carbonization, adaptability to crop pandemic, soil health, regenerative agriculture, bio-pesticides, sensors and connective technologies

Crop Improvement/Biotechnology – Genomics, GMO, Gene Editing, Chromosome editing, Mini-chromosome technology, Precision Breeding/NBTs TILLING, Speed breeding, and Molecular breeding

Crop Protection – RNA & Protein based biopesticides, Microbial consortiumbased biologicals, NPP, IPM/IRM, Nano protection, Bee vectoring technologies

Crop Enhancement – Biofertilizers, Nanofertilizers, Biostimulants, Microbiome diversity

Food Security - Alternate proteins (Plant based, Cell based & Fermentation based), Food loss reduction, Post-harvest loss reduction, Shelf-life extension, Food waste recycling, Food storage infrastructure, Upcycling

Food Sustainability - Reducing and offsetting carbon emissions, Decarbonization, Soil health

Soil diagnostics, Regenerative agriculture, Plant-based biodegradable materials and packaging, Soil microbiome enrichment, Circular bio-economy, Food and ag waste management

Digital/Smart/Precision Farming -Indoor/Vertical farming, CEA, Automation, Robotics/Al/ML, Big data and predictive Analysis, Data platform, Sensors, Farm and resource management, Digital agronomy tools, Disease and stress sensing & diagnostics, Water management technology

Supply Chain/Farm to Fork – Automation, Traceability using microbial barcodes, Advanced equipments, Crop storage facilities, Climate controlled transportation, Block-chain in distribution, Harvest refining tech, Market Places.

Emerging Agri-food Technologies

Emerging agri-foodtech offer a growing range of opportunities and methods to transform our food and agriculture systems to achieve FAST (food and agricultural sustainable transformation) and realize the FAO SDG goal of achieving zero hunger. Progress across these innovation areas has been driven by the development of several cutting-edge and innovative technologies, including but not limited to:

• CRISPR and Gene Editing • Chromosome Editing • Speed Breeding • Synthetic Biology

Cellular Agriculture (Alterntaive Proteins - Cultivated Meat, Precision Fermentation, Plant Proteins)

Nanotechnology • GMO • Biological Crop Protection • Biofertilizers • Biostimulants and Crop Enhancement • RNA & Peptide Based Biopesticides • Precision Agriculture • PHL Reduction and Shelf-Life Extension Technologies • Upcycling • Soil Health and Soil Diagnostics • AI/ML/IOT • AgDrones • 3D Printing • Vertical Farming • Closed Ecological Systems • Floating Farms • Agricultural Robots Aquaponics • Engineered Minichromosomes
 Harvest Quality Vision Bee Vectoring
 Bioplastics/Biopolymers Laser Scarecrows
 Algae Feedstock Climate Controlled Transportation • Traceability - microbial barcodes • Crop & food storage facilities.

Disruptive Agri-Food Technologies

I am excited about the development of all novel and disruptive agri-food technologies that are listed above and beyond. It is not just one or two technologies will solve the global food security and production problem. It is amalgam of technologies and innovations when applied effectively can provide a solution to elimination or reduction of food insecurity. I am personally excited about Synthetic Biology in particular because of the future it promises for human existence.

SynBio is going to disrupt all major industries in the next 5 -10 plus years- food, agriculture, materials, medicine, processing, animal feeds, meat and aquaculture,





Mr Balaji likes to read science books, follow trends in technology, teach and mentor students

fashion, textiles, chemicals, mining, fuel, electricity, construction, machinery. Mckinsey in 2019 published that Bio-economy/Life Science Revolution will dominate next 3-5 decades comparable what digital tech in the past 2-3 decades. SynBio will lead the pack in life science transformation capped at \$4 trillion. Eric Schmidt from Schmidt Futures bets on synbio and said if he has to start all over again, he would invest in synbio tech and not google like internet based digital tech. Synthetic biology industry has seen investment in excess of \$12 billion over past decade and Synbio market was \$6.9B in 2019 and projected to reach \$700B by 2040.

Synthetic Biology Is The Way Ahead

SynBio has evolved into a mammoth industry by itself in the past decade with the advent of biological tools like DNA/gene synthesis, NGS/WGS, precision fermentation, strain engineering, pathway or metabolic engineering, CRISPR-Cas9/multiplex gene editing, RNAi, gene drives, regulated promoters, gene synthesis, DNA has a storage and for computing, Cell free manufacturing, bio-cement, biomaterials like PFA replacing plastics. Key mile stones are - Impossible Food Bleeding Burger with Leg hemoglobin from soybean in Yeast. Perfect Day - Cow free Whey protein, Medicago-Covid vaccine using Plant Molecular farming, Pivot Bio - Proven for corn and sorghum with engineered bacteria for nitrogen fixation, Egg-free egg protein by EVERY COMPANY, Cell cultured chicken by GoodMeat/Just Egg, Cell cultured milk proteins, Plant based dairy protein Casein by Nobel Foods and Miruku. Nature Fynds fungal protein, Mycelium based leather from MycoWorks, Bolt Threads spider silk protein from yeast, Mori silk protein for food waste reduction, Elemental enzymes protein-based biocontrol flagellin, Air protein using Co2 and bacteria- Solar foods & Air protein, Sweetener from Stevia from JoyWell foods, Co2 to organic acids/ chemicals.

Plant synbio is fast catching up with microbial counterpart. This includes cell based cotton, cell based coffee, cell based chocolate, cell based wood Seeds with animal proteins, dairy proteins improved proteins, vaccines in seeds for animals, growth factors and therapeutics etc.



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Bio Agriculture Atmanirbhar Krishi | Atmanirbhar Krishak

hrough National Program for Organic Production (NPOP), the Agricultural and Processed Food Products Export Development Authority (APE-DA) has further established standards for accreditation of Certification Bodies, to support organic production, promote organic farming and market organic products. The introduction of other schemes such as Capital Investment Subsidv Scheme (CISS) under Soil Health Management Scheme, National Mission on Oilseeds and Oil Palm (NMOOP) and National Food Securit y Mission (NFSM) have also contributed to increased adoption of organic cultivation in the country.

As a step towards Atmanirbhar Krishi, across organic farming, the government has launched dedicated programmes, namely Mission Organic Value Chain Development for North-East Region (MOVCDNER) and Paramparagat Krishi Vikas Yojana (PKVY). To support building "Atmanirbhar Krishak", about 40,000 clusters (acreage of seven lakh ha) and 160 Farmer Producer Organizations (FPOs) with collective acreage of around 80,000 ha have been brought under the folds of PKVY and MOVCD respectively. The Agriculture Export Policy 2018 was formulated by the government to give a boost to agri exports from India.

Challenges Galore

Despite significant developments and policy initiatives, there is a plethora of challenges related to the adoption of organic cultivation across post-harvest and processing infrastructure, marketing, certification process and lack of awareness among the buying trends in key importing countries, among others.

Firstly, there is an opportunity cost for conversion from conventional to organic farming as there is a potential reduction in yield which makes it less remunerative for farmers, a large majority of whom are small and marginal farmers. The schemes are designed to provide financial support to farmer collectives. However, a large majority of farmers are not part of any collectives or producer organisations/ companies (FPO/ FPCs), which limits them from availing it.

Secondly, organic cultivation requires availability of quality organic inputs such as compost, bio fertilisers, organic fertilisers and manure, crop rotation, etc. While the input costs are comparatively higher compared to those in conventional farming, there are also infrastructure constraints which make adoption of organic cultivation difficult for most small and marginal farmers.

Problems Faced By Small And Marginal Farmers

Thirdly, the organic certification process is fraught with several complexities and the high costs make it a deterrent for most small and marginal farmers. Despite the government subsidising farmers under the Participatory Guarantee System (PGS), which is a self-certification process and reduces requirement of thirdparty verifications, the farmers are denied access to export facilities. This deprives them of a premium price for their produce. Also, the third-party certification for exports made mandatory by APEDA lacks global recognition.

Fourthly, there are constraints related to infrastructure in terms of shortage

About the **AUTHOR**

Mr Soumyak Biswas is Partner, Management Consulting, BDO India LLP



of storage infrastructure in the form of pack houses. This leads to post-harvest losses for organic produce and a dearth of testing infrastructure. These factors combined with poor market linkage initiatives, are resulting in low price realisation. Lastly, there is a lack of awareness regarding requirements related to quality compliance and standards pertaining to organic production in the buying countries.

Calibrated Approach Required

Growing demand for organic produce in the global markets and rising environmental concerns associated with conventional farming have promoted policymakers to play a proactive role in embracing bio agriculture. However, a calibrated approach is required in adopting such practices, to avoid circumstances as were created in the case of Sri Lanka, where the move to convert from conventional to organic farming boomeranged to a food security crisis. It is true that bio agriculture has positive impacts on the producer, consumer and environment, however, given the structural issues of the Indian agriculture sector, some of the following measures may be needed to accelerate adoption of bio farming with minimum hassles.

Expediting the implementation of PM PRANAM Scheme would help in driving wider adoption of natural farming even in states which are not currently producing a large quantum of organic products. This will fast-track creation of assets related to the technological adoption of alternate fertilisers and alternate fertiliser production units at the village, block and district levels. Funds from this grant may be used to incentivise and encourage farmers, farmer collectives (SHG/FPO/FPCs), and panchayats that play a proactive role in reduction of fertiliser usage.

Convergence Of Existing Schemes

Driving convergence of some of the existing schemes in agriculture for organic production would streamline the process of receiving assistance for farmers involved in organic production, specifically related to cultivation and infrastructure creation at farm gate levels. Benefits available to agriculture crops may be extended to several plantation crops which are grown organically and command a premium in domestic and export markets.

Focussing on training and awarenesscreation would lead to improved adoption. Central- and state-run universities may be mandated to conduct training sessions to impart knowledge to farmers and encourage them to apply GAP through sustainable agricultural methods such as integrated pest management, integrated nutrient management, conservation agriculture, etc. Creation of regional centres of excellence in organic farm management can spur adoption of such practices. Sustained campaigns related to benefits of organic food products vis-à-vis conventionally-produced items can have a lasting impact on the farmers.

Streamlining the certification process would result in improved production. Also, there is a need to relook at the costs of certification for organic production. Given the compliance requirements vary across importing nations, it is high time to formulate a standard list of compliances for the major export items which would help reduce rejection in consignments.

Lastly, driving technology adoption would play a key role in ensuring traceability and quality assurance of products through e-way bills from the farmer collectives (SHGs/ FPOs/ FPCs) and digital transactions, specifically for organic produce. Further, promoting innovation across the value chain would also assist in easier adoption of bio agriculture across the country.

MAKING ORGANIC FARMING SUCCED The Do's And Don'ts

t is said that everything happens at an appropriate time. PM Modi ji in his first address as the Prime Minister in 2014 mentioned about the importance of organic agriculture and organic food. It took him eight years to initiate the first step towards sustainable agriculture. Probably he underestimated the power of chemi-culture and the depth of the pockets of the agro-chemical industry.

Fake Chemicals Sold to Farmers

The farmers have no clue of the monetary powers of chemi-culture. Even in small villages there are shops selling agrochemicals. In most cases, more than 70 percent to 80 percent agriculture inputs are either substandard or fake. Perhaps because of deliberate negligence or possibly because of under the table deals, banned chemicals are sold to farmers.

Most of the time, the same salt-based chemical under different brands is recom-



mended or sold by the shopkeepers. This increases the dose of the same chemical to three to four times. It is very difficult to explain all the problems faced by the farmers. Due to the failure of crops, purchase of crops being below MSP, it becomes necessary for the farmers to buy the chemicals on loan and with interest.

Farmers Need Training For FPOs

The government has started the FPO program, but no training has been pro-



About the **AUTHOR**

Harpal Singh Grewal, Founder Heavenly Farms vided to farmers about how to start, manage and operate an FPO. Consequently most of the FPOs either fail, or the management goes into the hands of traders.

Unless this problem is addressed with immediate effect, this project is liable to defame the government. It may even be presented as a big scandal by the opposition during the coming elections.

The government seems to be facing the dilemma of reduction of yields, which may lead to further problems. Due to double mindedness and confusions of various kinds, the Finance Ministry has not given the equal status to organic agriculture.

There is no budget provided for research and development. No specific infrastructure has been built and the budget has not been allocated. It is very important to provide proper budget for all the above points. It is equally important to provide proper training to the agriculture scientists, agriculture extension officers and farmers. Farmers are facing multiple problems. There are no checks and balances provided for chemical residue testing labs. There is no uniform code of conduct for drawing, testing and calculating.

The Challenges We Face

No protocols have been fixed. No training has been given to the inspection agency staff. The Food Law Amendment 2011 has not been implemented till date. There is a complete vacuum in the field of organic seeds and organic seed law.

Farmers cannot be driven on the basis of emotion to go ahead and jump into the most unorganized, under-privileged and unsupported project called organic agriculture. This is not going to work.

Instead of providing cash as Kisan Samman Yojana, the budget should be diverted to Kisan Samman Samasya Samadhan Fund. This should address the problem of poor infrastructure. Why does the government want the farmer to take all the risks? When the time comes to get the reward in terms of incentivized sales income, fake organic is being exported with the help of the government agen-



The organic farmers who have practiced this type of farming for 20 year or more should be regarded as model farmers. Their experience should be validated scientifically and it should be recommended to the farmers

cies. This causes a great loss to farmers and also to the consumers. Meanwhile, the culprits go scot free.

Wisdom In Following Experienced Organic Farmers

I have repeatedly urged the authorities to implement total transparency and total traceability up to the farmer's bank account. Otherwise the farmers shall



Mr Grewal is highly fond of classical music and is fond of sharing the treasure of treasured classical compositions with his friends.

slowly either stop doing organic farming, or they shall start compromising with the process. The result shall be the crash of organic concept due to complete loss of faith in organic food.

Till now we have only lost partial faith in everything that is labeled organic. But due to the faulty policies, confusion, lack of funds, lack of experience, lack of research and development, lack of implementation of Food Law Amendment 2011, lack of Organic Seed Law etc, we shall face many more problems. It is not possible to practice organic or natural farming alongside other chemical free farming practices.

The organic farmers who have practiced this type of farming for 20 year or more should be regarded as model farmers. Their experience should be validated scientifically and it should be recommended to the farmers. Each state agricultural university must identify the trusted and established organic farmers in their areas. Those farmers must be given due recognition. Their practices should be adopted. They should be awarded monetarily and given due academic recognition at university level. This practice will immensely help the large mass of farmers and provide them access to training and the right practices. It shall save the money and the time of the nation, and all farmers shall be encouraged to adopt the correct practices.

FARMING 4.0

HARNESSING TECH POWER FOR ATMANIRBHAR KRISHI

ndia is one of the world's largest importers of agricultural inputs and products, including agrochemicals, seeds, and produce.

Agrochemicals: India is a major importer of agrochemicals, which include pesticides, herbicides, and fertilizers from China, USA, Belgium, and Germany. In 2020, India imported agrochemicals worth \$4.8 billion, which is an increase of 18% compared to the previous year. Most notably we are heavily reliant on imports for meeting the fertilizer demand needing large imports in Nitrogen fertilizers (Urea), Phosphatic fertilizers, Potassic fertilizers. To make farming and farmers self-reliant, the Indian government needs to take several initiatives. One such initiative is reducing the fertilizer subsidy load, which has environmental consequences, such as soil acidification, water pollution, and greenhouse gas emissions. Instead, the government could focus on promoting sustainable practices and subsidizing the use of alternative fertilizers through programs like Paramparagat Krishi Vikas Yojana and provide financial assistance.

Food and allied imports: India also imports various fruits, vegetables, and other food products. In 2020, India imported produce worth \$1.6 billion, which is a 4% increase compared to the previous year.

Harvesting Innovation: The Next Generation of Sustainable Ag Inputs

Cutting edge Biotechnology for next generation of Biologicals would have a crucial role to play in each of the sectors mentioned above. Biotechnology can provide innovative solutions to address the challenges faced by Indian agriculture, including climate change, soil degradation, pest and disease outbreaks, and water scarcity.

Peptides: Peptides are short chains of amino acids that can disrupt the membranes of insects or interfere with their physiological processes, leading to insect death. They are effective against a wide range of pests and have low toxicity to non-target organisms.

Semiochemicals: Semiochemicals are chemical compounds that are used by insects for communication. They can be used to disrupt mating behavior, attract predators or parasitoids, or repel pests from crops.

Signaling molecules: Signaling molecules are compounds that are involved in regulating various physiological processes in insects. They can be used to disrupt the growth and development of pests, leading to their death.

Microbial extracts: Microbial extracts are derived from microorganisms such as bacteria, fungi, or actinomycetes. They can be used as bioinsecticides, biofungicides, or herbicides, and are effective against a wide range of pests and diseases.

Cell-free extracts: Cell-free extracts are derived from microbial cultures and contain bioactive compounds such as enzymes, peptides, or secondary me-

About the **AUTHOR**

Dr Renuka Karandikar is the founder and CEO of Bioprime, a company that is revolutionizing the world of agriculture with cutting-edge biological solutions tabolites. They can be used as bioinsecticides, biofungicides, or herbicides, and are effective against a wide range of pests and diseases.

Siderophores: Siderophores are small molecules that are produced by microorganisms to scavenge iron from the environment. They can be used as biocontrol agents by interfering with the iron metabolism of plant pathogens, leading to their death.

Quorum quenching: Quorum quenching is the disruption of quorum sensing, a process by which bacteria communicate with each other to regulate various physiological processes. It can be used to disrupt the growth and development of plant pathogens, leading to their death.

Essential oils: Essential oils are volatile compounds that are derived from plant materials. They have been used as natural insecticides, fungicides, and herbicides, and are effective against a wide range of pests and diseases.

Botanical extracts: Botanical extracts are derived from plant materials and contain bioactive compounds such as alkaloids, flavonoids, or terpenoids. They have been used as natural insecticides, fungicides, and herbicides, and are effective against a wide range of pests and diseases.

RNAi technology: RNAi technology involves the use of small interfering RNAs (siRNAs) to silence specific genes in pests. It can be used to disrupt the growth and development of pests, leading to their death.

Aptamers: These are single-stranded DNA or RNA molecules that can bind to specific targets, including proteins, with high affinity and specificity. They can be designed to target specific insect or weed proteins, and can be used as natural alternatives to chemical pesticides.

From Lab to Field: Strategies for Mass Adoption of Bio-based Pesticides

To achieve mass adoption of biologicals in agriculture and realize the full potential





Dr Renuka is an amateur painter with love for nature and rural landscapes. She always travels with a small watercolour box and paper pad. She is an avid reader and collector of signed copies of books

in promoting sustainable and environmentally friendly agricultural practices, several technological advancements are needed:

Formulation and delivery systems: One of the challenges with biologicals is that they are often living organisms or naturally derived molecules, which makes them more sensitive to environmental conditions such as temperature, humidity, and UV radiation. Therefore, there is a need for new and improved formulation and delivery systems that can protect the biologicals during storage, transportation, and application.

Standardization and quality control: Biologicals are often produced through fermentation or extraction, which can result in variability in their composition and effectiveness. As they are sourced from plants, algae, fungi etc they are prone to seasonal, age, regional variations. Therefore, there is a need for standardization and quality control measures to ensure consistent and reliable performance.

Mechanisms of action: While the mode of action of only some biologicals is well understood, for most it remains unclear. Understanding the mechanisms of action of biologicals can help to optimize their use and improve their efficacy. A standardized "clinical trial" like process definition is needed to ensure competence.

Integrated pest management: There is a need for greater integration of biologicals into IPM programs, which will require the development of decision support tools and other resources. Developing IMP programs, education and awareness is need of the hour.

Cost-effectiveness: One of the main barriers to the adoption of biologicals is their higher cost compared to traditional chemical inputs. Therefore, there is a need for research to identify cost-effective production methods and delivery systems that can reduce the cost of biologicals.

BIO AGRICULTURE DELIVERING SAFE FOOD ENHANCING EXPORT

he green revolution in India led to food security through high yielding varieties, inorganic fertilizers, and chemical pesticides. Undoubtedly, green revolution delivered India food sufficiency but also has brought negative implications with it.

The input intensive and intensive production practices introduced during green revolution increased agricultural productivity that promoted indiscriminate use of chemical fertilizers and pesticides. Due to less effective agriculture extension, illiteracy of farmers about agrochemicals, industry's marketing initiatives and misleading information from traders have made pesticide use rampant in India. This is leading to existence



of residues much higher than the permissible limits into food chain, resulting in serious health hazards to man and surrounding ecology.

Exceeding Maximum Residue Level Norms – The Impact

Though India ranks world's second largest producer of fruits and vegetables, have no more than two percent share in global exports. Occurrence of pesticide residues higher than maximum residue levels is one of the major hurdles in increasing export. Re-About the cently Iran and Taiwan re-AUTHOR jected tea consignments **Dr Prafull Gadge is** from India. Grapes, chil-**Principal Scientist &** lies, okra, mangoes and **CEO, Biome Technologies** aromatic, long-grain Pvt Ltd, Ahmednagar basmati rice etc. have also faced rejections and even ban in markets such as the Bhutan, EU, US, Saudi Arabia and Japan due to residues

higher than maximum residue level.

Failure to accomplish maximum residue level norms are not only leading to stoppage in shipments, and financial losses but also loss of market share to farmers and exporters from competing countries; detrimental to India's ambitions as a leading agri exporter. Further, growing awareness about food safety after covid is demanding organic or residue free products in the domestic market. The action of Kerala High court on Sabarimala's batch of payasam that contained pesticide-laced cardamom seeds has already alarmed about the same.

The Gains Of Bio-Agriculture

It is high time to seek alternative to chemical pesticides in order to achieve food safety. Bio-agriculture is not only growing high-quality and nutritious produce but also significantly reducing amounts of conventional fertilizers and pesticides in the environment. Hence, none other than biologicals are better option to chemical pesticides or in combination to limit the residues up to safer levels.

Biopesticides have low toxicity, quick degradation and maintain the ecological balance, which is immediate need of time. Furthermore, escalating demand of organic or residue-free produce at domestic and global markets is projecting higher demand of biological inputs for plant growth and plant protection in India. According to market research firm IMA-RC Group, the Indian bio agriculture market size reached INR 62,249 Million in 2022 and expected to reach INR 97,147 Million by 2028, exhibiting a growth rate (CAGR) of 7.3% during 2023-2028.

In an attempt to encourage use of bio fertilizers instead of chemical fertilizers Government of India has launched various schemes/ programmes to through State Governments, viz: Paramparagat Krishi Vikas Yojana (PKVY), Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), National Mission on Oilseeds and Oil Palm (NMOOP), National Food Security Mission (NFSM), along with the INM-IPM i.e. Integrated Nutrient Management (INM) and Integrated Pest management (IPM) practices such as including cultural, mechanical, biological control of pests to control excess use of fertilizers and pesticides respectively.

GOI Push to Bio-Agriculture

Furthermore, task force has been constituted under the chairpersonship of Prof. Ramesh Chand, Member, NITI Aayog in July 2021 on production and promotion of biofertilizers and organic fertilizers to suggest mechanism and policy support for



I am an amateur astronomer and nature photographer. Being beneath the stars helps to understand and connect self with science

encouraging the commercial production, packaging, marketing and distribution and use of biofertilizers to create a level playing field with inorganic fertilizers. As a part of this under Capital Investment Subsidy Scheme, Government of India encouraging the production of bio-fertilizers by providing 100% assistance to State Government Agencies and 25% of the assistance cost is provided for individuals/ private agencies for setting up state of art liquid/ carrier-based Biofertilizer units through the National Bank for Agriculture and Rural



Development.

Biologicals have some limitations such as slower acting, less shelf life, limited field persistence and target specificity etc., However, increased research and development in public and private sector have started delivering effective solutions for these challenges. Easing out of regulations for manufacturing license, required time and licensing cost for entrepreneurs and spreading awareness among the farmers for wise application of biopesticides may further increase the share of biologicals in the conventional practices.

Agro-Chemicals Literacy: Leading The Farmers Towards Food Safety

In Maharashtra, hundreds of farmers are being trained for agro-chemicals literacy and effective application of biologicals for sustainable yield and plant protection. Use of Biologicals have not only yielded quality residue free grapes but also reduced production cost to 3 lakhs to 1.25 lakhs per acre for Mr. Ganesh Salgar, farmer from Solapur district.

Similarly, Mr. Shewale brothers from Marathwada region have found Bio Agriculture profitable for their 150 acres of farm comprising fifteen plus crops. Mr. Ajit Gholap and Mr. Sagar Varpe near Pune are profiting from biologicals in their tomato, brinjal and vegetables production, which are commonly considered difficult in terms of protection. List a few, Progressive farmers from "Maitri Vicharanchi" which is a 400 plus farmer-tofarmer extension - self help group has been trained under Agrochemicals Literacy Movement and are effectively using biologicals to deliver safe produce with reduced production cost.

Under guidance and leadership of respected Prime Minister and Union Agriculture Minister, the present Indian agriculture ecosystem offers investment opportunities with favorable policies and incentives for Bio Agriculture, which is a win-win situation for farmers, consumers, exporters and input manufactures. So let's build Healthy India with the help of Bio-Ag!

MOO DID IT!

THE MAN WHO HAS MADE COW-BASED FARMING A SUCCESS MODEL FOR FARMERS

r Ramesh Bhai Ruparelia has proved that if a man wants, he can even extract water from the barren land. He just needs to have courage and dedication.

A villager become great saviour for gaumata, his love become passion and gradually passion become life goal.

Long time ago, Rameshbhai was impoverished. He had strong passion for promoting traditional farming of Gauadharit Agriculture. He managed to find a small field and planted onion using only Gau-mutra, gobar, and other natural fertilizers. The results were remarkable. He got an extraordinary yield that surpassed all of his expectations. Slowly, Rameshbhia moved ahead with his ability and hard work.

Desi Gaupalan Expert

Today, Rameshbhai Rupareliya is highly acclaimed as a Desi Gaupalan expert. For more than 10 years, he is in the business of cow welfare, activities for cow development and also in creating entrepreneurs. His success is mainly due to the fact that he also engages in cow-based farming, having taken bumper crop year after year.

He developed his own Gaushala, "The Gir Gau Jatan Sansthan". He man-

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चरक संग्रित

and the second

ufactures over 200 Cow based products and operates an efficient direct-to-customer model. Rameshbhai started giving proper training and practical experiments to a number of trainees, so that this mission of cow entreprenuership mission won't stop.

Bhoomi samvardhan ensures good agriculture. Cow samvardhan not only provides for diary requirements but also enables a farmer to undertake organic farming.

Gir Gua Jatan Sansthan

Ramesh Bhai's Firm 'Gir Gua Jatan Sansthan" is a leading manufacturer of a wide

-



array of products ranging from Ghee, Buttermilk, Bilona Mathni, Anaerobic Compost bags, Spices, Nutritional Powders, Soaps, and even Chyawanprash. Their products are well known for their superior quality and have been widely appreciated by customers all around the country.

With its innovative approach to production and commitment to delivering high-quality products on time, by the grace and blessings of Gaumata his firm has quickly become one of the top players in the market. He always says 'Vande gaumataram'... and praises Gaumata for all her divinity.

Who can think that an untrained simple villager will one day become a ideal for all cow lovers and organic farming? A good tree does not grow from a good seed alone, it requires the right soil and top-notch fertilizers.

Ramesh Bhai has not taken any sort of formal training. All his accomplishments and achievements have come thanks to his experiments and experience. People say "necessity is the mother of invention." It is not that he did not make any mistakes. But by learning from those mistakes, he climbed the ladder of success. His talent for picking up new skills quickly and his enthusiasm to learn Ramesh Bhai's Firm 'Gir Gua Jatan Sansthan'' is a leading manufacturer of a wide array of products ranging from Ghee, Buttermilk, Bilona Mathni, Anaerobic Compost bags, Spices, Nutritional Powders, Soaps, and even Chyawanprash

independently have proven to be invaluable assets in his professional career.

Videos To Train Youths

Ramesh Bhai is a man of impeccable character and his words carry great weight. He has been known to create insightful and educational videos on YouTube for new or developing Gaupalaks, which has had a powerful impact on people. These videos have increased people's faith in Ramesh Bhai and the products he prepares.

Ramesh Bhai has established an efficient and effective E-commerce platform called "gircowcare.org" from which he can easily sell his products. Customers can also purchase directly from the Gaushala. Offline or campus purchases are available as an option.

Recognition For Purity Of Products

Ramesh Bhai's name has become a mark of purity. He is known to always use the highest quality ingredients and to label his product as organic. This is a testament to his commitment to provide customers with the best possible products and an allnatural experience free from any artificial additives or chemicals.

Rameshbhai's firm is certified and has the necessary documentation to validate that its products meet the required standards. This certification ensures that customers can trust their products and services. These include certification from Food Safety & Standards Authority of India (FSSAI); Gujarat Organic Products Certification Agency (GOPCA); Agricultural and Processed Food Products Export Development Authority (APEDA) and Ministry of Micro, Small, and Medium Enterprises (MSME)-UDHYAM Certificate.

Ramesh Bhai is exporting his goods to many countries such as USA, UK, UAE, Canada, Australia, New Zealand and various other countries around the world.

FOOD AND HEALTH

BIOPESTICIDES THE CHANGING TIMES

iopesticides are pesticides drawn from natural sources like plants, bacteria, and fungi. They are frequently considered to be more environmentally friendly and long-lasting than traditional chemical pesticides. In India, biopesticides have a tiny market share, accounting for about 3-4% of the total pesticide market. However, as people become more aware of the benefits and potential of biopesticides, demand for them is increasing. They must minimize the negative impact of chemical pesticides on the environment and human health.

Biopesticides' global market share has steadily grown in recent years, and it is now estimated to be around 5-6% of the total pesticide market. Several factors, including growing concerns about food safety and environmental sustainability, as well as changes in regulatory policies and customer preferences, are driving demand for biopesticides.

Both biological and chemical control methods have benefits and drawbacks, and which one to use depends on the circumstance and the type of pest or disease being controlled. Biological control methods, such as the use of biopesticides, are widely viewed as being more environmentally friendly and long-term sustainable. Because they are frequently

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pest or disease specific, they have little impact on beneficial organisms and leave no chemical residues on crops.

Analysis Of Pest Control Methods

Biological pest control methods may be slower acting and less effective in certain circumstances. They may also require more specialized knowledge and tools to implement, making them more expensive and difficult to scale up.

Chemical control techniques are frequently more effective in controlling pests quickly, but can have detrimental impacts on the ecosystem and human health if not used properly. They can also cause bugs to develop resistance and harm useful species. Furthermore, the use of chemical herbicides can leave residues on products and in the ecology, which can have long-term repercussions for human health and the environment.

In general, a mix of biological and chemical pest and disease management methods may be most successful in cultivation. Integrated pest management is a comprehensive strategy to insect and disease control that includes biological, chemical, cultural, and physical control approaches. The goal of this technique is to decrease pesticide use while maintaining crop yields and preserving the ecosystem and human health.

Greener and safer farming pesticides, such as neonicotinoid insecticides and glyphosate herbicides, are now available. These chemicals have been thoroughly evaluated, and their toxicity/safety has been found to be similar to that of biopesticides in many cases. No chemical, however, is completely safe, and all chemicals must be used responsibly to minimize their effect on the ecosystem and human health.

Neonicotinoid Insecticides, Biopesticides

Neonicotinoid insecticides are a form of systemic insecticide used to manage a wide range of insect pests in agriculture. Traditional pesticides are believed to be less selective and harmful to species other than the target. Glyphosate pesticides are Biopesticides have limitations. They may be less effective at managing bugs than traditional chemical insecticides and may require more frequent applications. They may also be more expensive than conventional pesticides



extensively used in agriculture to manage weeds and, when used properly, are regarded reasonably safe and environmentally benign.

Bio-based chemicals, such as biopesticides, plant-based compounds, and microbes, are now available in addition to these chemicals. These pesticides are frequently regarded as more environmentally benign and safer than conventional chemical pesticides. They are obtained from natural sources, and their mode of action is frequently more selective, resulting in little impact on non-target species.

It is essential to note, however, that biopesticides have limitations. They may be less effective at managing bugs than traditional chemical insecticides and may require more frequent applications. They may also be more expensive than conventional pesticides, making them inaccessible to small-scale farms.

Supportive R&D Climate Needed

The R&D climate in India is usually regarded as strong, with a growing number of public and commercial research organizations dedicated to farming research and development. The government has also taken several measures to support agricultural research and development, such as the establishment of research institutions and funding for research initiatives.

However, several obstacles must be overcome in order to create a more supportive R&D climate in India. These include a dearth of research funding, access to modern research centers and tools, and a qualified researcher and scientist shortage.

Furthermore, greater collaboration among various stakeholders, such as researchers, farmers, and lawmakers, is required to guarantee that research is concentrated on the most urgent problems.

Conducive Policy Climate

The policy climate for developing innovative commodities in India can be difficult, with a variety of regulation barriers that can stymie the development and commercialization of new products. One of the main obstacles is the long and complex licensing process for new goods, which can take several years and needs comprehensive data on safety and efficacy.

Another problem is the lack of a welldefined regulatory framework for biopesticide research and commercialization. This makes navigating the regulatory environment and obtaining funding difficult for companies and academics.

To handle these issues, greater collaboration among government, industry, and academic organizations is needed to create a more supportive policy climate for the creation of novel products. This could include simplifying the product licensing process, creating a clear policy structure for bio-based product development and commercialization, and boosting funding support for agricultural research and development.









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