

Bio-agriculture: Embracing a holistic farming approach

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Bio agriculture, also known as organic or ecological farming, refers to a system of farming that prioritizes environmental sustainability, soil health, and biodiversity while producing food that is free from synthetic chemicals. Bio-agriculture is a broad term for any agricultural land that uses organic or biodynamic farming methods, with the no use of synthetic or chemical fertilisers or any agricultural chemicals input. This agricultural practice emphasizes the use of natural resources and processes rather than synthetic pesticides, fertilizers, and genetically modified organisms. It focuses on promoting ecological balance and enhancing soil fertility through organic methods, making it a key player in the growing movement toward sustainable food systems. Bio-agricultural farming system is a good environmental management practice that shows their effect both above and below the soil surface. The demand for organic products is growing at 20-25 per cent per annum not only in India but also world widely.

In 2022, Australia was ranked first with an organic agricultural land area among all the countries *i.e.*, 35.6 million hectares, followed by Argentina *i.e.*, 3.4 million hectares, and China *i.e.*, 3 million hectares. The USA, Germany and France enjoy the largest share of market in organic produce. According to the World of Organic Agriculture Report documented in February, 2018, India has the largest number of organic producers in the world. India shared more than 30 per cent of total number of organic producers. However, when it comes to area under certified organic cultivation, India contributes only 2.59 per cent *i.e.*, 1.5 million hectares of the total area *i.e.*, 57.8 million hectares. Sikkim is the world's first fully organic state. The state government of Sikkim made a declaration in 2003 to make Sikkim 100% organic. In 2015, the entire state's agricultural land was certified organic, and in 2016, Sikkim was officially declared 100% organic.

In India, the green revolution solved the problem of food unavailability or hunger problem to the people through developing of high yielding varieties, use of inorganic fertilizers or synthetic insecticides or pesticides. Undoubtedly, green revolution solved the hunger problem in India and



provided sufficient food to Indians. The input intensive agricultural practices introduced during green revolution improved the agricultural production and productivity that endorsed the indiscriminating use of synthetic fertilizers and insecticides, pesticides. Due to lack of extension activities and less effective agriculture extension work, illiteracy of farmers about agrochemicals, industry's marketing enterprises and misleading information have made pesticide use widespread in India. This leads to existence of residues much higher than the permissible limits into food chain, resulting in serious health hazards to man, animal, soil micro flora-fauna and for our whole ecosystem.

India is the world's second largest producer of fruits and vegetables but have no more than two percent share in global exports. Occurrence of very huge percentage of pesticide residual effect higher than maximum residual levels is one of the main hurdles in increasing export. Recently, Iran and Taiwan excluded tea consignments from India presence of pesticide more than permissible limits. Failure to achieve the maximum residual level for standards are not only leading to stoppage in shipments but also in financial losses. There is a big loss to farmers and exporters from competing countries, which is detrimental to India's determinations as a top agri exporter. Further, there is awareness about food safety and people are demanding more organic or residue free food in the domestic market.

It is peak time to pursue substitute to chemical pesticides in order to attain food safety. The main aim of bio-agriculture is not only to growing high quality and nutritious produce but also significantly reducing the effect of conventional fertilizers and pesticides in the nature. Hence, there is no one better option other than biological methods, which can limit the limit the residues up to safer levels. Biopesticides have low toxicity effect, show quick degradation and maintain the ecological balance of our natural system, which is immediate prerequisite of today's time. Moreover, rising demand of organic or residue-free produce at domestic and global markets is bulging higher demand of biological inputs for plant growth and plant protection measures in India. According to market research firm IMARC 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 of 7.3% during 2023-2028. 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.

In an effort to encourage the use of bio fertilizers instead of chemical fertilizers, Government of India has launched various schemes or programmes through State Governments *i.e.*, 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 Integrated Nutrient Management (INM) and Integrated Pest management (IPM) practices such as cultural, mechanical, biological control of insect-pests to minimize the excessive use of synthetic fertilizers and pesticides, respectively.

Moreover, 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 encouraging the commercial production, packaging, marketing and distribution and use of biofertilizers to create a level playing field with inorganic fertilizers (National Portal of India, Niti Ayog). 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 or 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.*

Bio-farming act as alternative nutrient management practice and have a key role in organic agriculture that maintain soil health, environment, and sustainable crop production and productivity. The main barriers in acceptance and adoption of this farming system are lack of extension services, economic and marketing problem, lack of awareness infra-structural, technological, and socio-psychological problems. Being the essential components of organic or bio-farming, biofertilizers play an integral role in replacing the soil fertility by fixing atmospheric nitrogen and mobilize the fixed macro and micronutrients to increase their effectiveness and availability in the soil. The organic substances that have living microbes and exist in in the area of rhizosphere, they are involved in enhancing the supply of nutrients to plants are known as biofertilizers. Biofertilizers have a key role in organic agriculture. Organic agriculture is environment-friendly and financially profitable and has many health benefits; organic foods have great market potential, and it could be a great step for sustainable agriculture.

Biocontrol agents are the alternate option to slow down the use and requirement of synthetic insecticides, which possess a check on pest population build-up with minimum harmful impact on the natural ecosystem. This shift from the practice of non-judicious use of harmful synthetic pesticides to biocontrol agents essentially entails vigorous exploration for potential bioagents, methods for their multiplication and valuation of their efficiency for large scale use. Biological control agents are living



organisms, including parasites, predators and disease-causing fungi, bacteria and viruses. These are the natural enemies of pests, which can intervene the life cycle of insect pests in such a way that the crop damage is minimized.

Biopesticides are the organic or biological compounds that can manage agricultural pests without harming our natural ecosystem. Pests control in crop production is largely dependent on synthetic pesticides, which have deteriorate the environment since past many years till today. It is also reported that many pesticide showed resistance against some specific pests. Biopesticides certainly offer a better way to manage plant diseases and environment simultaneously. Biopesticides have wonderful potential to substitute or reduce the use of synthetic pesticides. In general, biopesticides for plant disease management and control of pests includes exploitation of natural organisms and product resultant from them. The essential oils, botanical extracts, biocontrol formulations use of nano biopesticides can be used for the control of insect-pests. Biopesticides definitely act as a potential tool and play a significant part in integrated pest management.

Concept involved in bio-farming

The concept of bio-farming is not new to human being but very old. The bio-farming efficiently using natural and easily available resources and techniques like green manure, natural waste, crop residues, live mulch, crop rotation with leguminous crops, insect-pest control by biological methods, compost and weed management *etc.* These bio-farming techniques has the potential to maintain the soil fertility for longer period, it maintains nutrient cycle without using any fertilizers or growth regulators. This economic farming process minimizing the crop failure in adverse climatic condition and it helps in maintaining the sustainability of the agriculture. This farming technique converts traditional management to organic management. Crop production is controlled by cultural and biological means. Bio-farming is modern form of agriculture and combination of science, technology and nature. It includes following methods which combine to form bio agriculture: soil management, weed management, livestock, genetic modification, crop diversity, compositing, bio-fertilizers, vermin-compost and other green manure.

The basic principles of bio-farming:

1. Soil Health and Fertility: In bio agriculture, soil is treated as a living organism. Farmers use crop rotations, composting, and the use of cover crops to maintain soil fertility naturally. This method helps to prevent soil degradation, erosion, and loss of essential nutrients that are often caused by chemical fertilizers in conventional farming.



2. Biodiversity and Ecosystem Balance: Bio agriculture encourages the diversification of crops, livestock, and other plants in farming systems. By promoting biodiversity, this approach helps to create resilient ecosystems that are less vulnerable to pests, diseases, and extreme weather conditions. Natural predators are also used to control pests, reducing the need for harmful pesticides.

3. Avoidance of Synthetic Chemicals: One of the defining features of bio agriculture is the avoidance of synthetic pesticides, herbicides, and fertilizers. Instead, farmers rely on natural methods to manage pests and weeds. This includes crop rotation, companion planting, and the use of biological pest control methods.

4. Animal Welfare: In bio agriculture, animal husbandry is practiced with a focus on humane treatment. Livestock is typically raised in stress-free environments, with access to outdoor space and a natural diet. The use of antibiotics and growth hormones is avoided, and animals are allowed to express their natural behaviours.

5. Sustainability: Bio agriculture emphasizes long-term sustainability by working in harmony with nature. It focuses on reducing the carbon footprint of farming, conserving water, and minimizing the environmental impact of agricultural practices. This includes methods such as rainwater harvesting, energy-efficient farming techniques, and reduced dependency on fossil fuels.

Benefits of Bio-farming

- **Environmental Protection:** By eliminating synthetic chemicals and promoting biodiversity, bio agriculture reduces pollution of soil, air, and water. It also helps conserve water and reduces greenhouse gas emissions by relying on sustainable farming practices.
- **Healthier Food:** Foods produced through bio agriculture are generally considered healthier for consumers. They are free from chemical residues, and studies suggest they may contain higher levels of nutrients like antioxidants and vitamins.
- **Soil Conservation:** Through practices such as crop rotation, composting, and reduced tillage, bio agriculture helps to maintain soil structure and health. This leads to better water retention, less erosion, and improved soil biodiversity, which in turn supports better crop yields in the long run.



- **Local Economies:** Bio agriculture often supports small-scale farmers and local economies. Organic produce is frequently sold in local markets or directly to consumers, strengthening community ties and providing a more sustainable economic model for farmers.
- **Climate Change Mitigation:** Bio agriculture practices, such as agroforestry and the use of cover crops, can sequester carbon in the soil, helping to mitigate the effects of climate change. These practices also increase the resilience of agricultural systems to extreme weather events, making them more adaptable to changing climate conditions.

Challenges of Bio Agriculture

- **Lower Yield:** One of the most significant challenges of bio agriculture is the potential for lower yields compared to conventional farming. Without the use of synthetic fertilizers and pesticides, some crops may be more susceptible to pests or diseases, which can result in reduced harvests.
- **Higher Cost:** The organic certification process, combined with the labour-intensive practices involved in bio agriculture, often leads to higher production costs. This can make bio agricultural products more expensive for consumers, although the price premium is seen as a reflection of the environmental and health benefits.
- **Pest and Disease Control:** Without the use of synthetic pesticides, controlling pests and diseases can be more difficult. Bio farmers rely on natural methods such as integrated pest management, but these techniques may not always be as effective as conventional methods, requiring more labor and vigilance.
- **Knowledge and Education:** Transitioning from conventional to bio agriculture requires specialized knowledge and skills. Farmers must learn new techniques, adapt their practices, and often invest in more sustainable tools and equipment, which can be a barrier to adoption, especially for those on tight budgets.

The Future of Bio Agriculture

As consumer demand for organic and sustainably produced food increases, bio agriculture is poised to play a central role in the future of global food production. Innovations in agroecology, improved crop varieties, and advanced pest management techniques are helping to overcome some of the challenges



faced by bio agriculture. Moreover, the increasing focus on sustainability and environmental responsibility is encouraging more governments and institutions to support bio agriculture through subsidies, education programs, and research.

Conclusion

In conclusion, bio agriculture offers a promising alternative to conventional farming, with its emphasis on sustainability, soil health, and biodiversity. While it faces challenges related to yields and costs, its potential to contribute to healthier food systems and environmental protection makes it a vital part of the future of agriculture. As awareness grows and techniques improve, bio agriculture could help create a more sustainable, equitable, and resilient global food system for generations to come. The impact of bio-farming on natural resources favours connection within the agroecosystem which is essential for both production and natural conservation of our ecosystem. Biological services include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient recycling, pollination and habitats. Bio-farming methods deliver agronomic and environmental profits through structural changes and tactical management of farming system.