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Editorial

The organic farming system in countries like India is not new and is being followed from ancient days. To understand the revival of organic farming in the present times, one must look back to the era of the Green Revolution. The Green Revolution and the subsequent phenomenal increase in grain productivity had a dramatic and far-reaching impact. The successes accomplished during the Green Revolution led to an overuse of fertilizers and pesticides, which however decreased the fertility of the soil gradually. The world of agricultural science, therefore, was compelled to opt for 'organic farming' as a holistic production management system favourable to environment and sustainable agriculture.

Organic farming is generally associated with a "back to nature" movement. In simplified form, organic farming stays away from chemical fertilizers and pesticides and seeks to increase soil fertility through feeding soil with residues such as garbage compost and sewage, manure, plant residues, food processing wastes, etc. In the present time, organic farming has developed so much that it is not merely a throwback to previous eras but an alternative modern system of production, which relies solely on biological processes to obtain high quality produce.

Organic farming involves various techniques which are eco-friendly and enhance the fertility of the soil. They are mainly: crop rotation - a technique of growing different crops in the same area according to the seasons to avoid pests and to maintain soil fertility; using green manures - plant leaves and waste material of plants; biological pest control -using living organisms to protect plants from pests instead of synthetic chemicals, and vermicomposting- a process of composting using different worms for preparation of compost with a mix of kitchen waste and other vegetable waste.

In India, there is a need to promote Organic farming in a big way by adopting strategies like branding support from the professionals to Farmer Producer Companies to brand their products like wild coffee, tribal honey, etc. for enhancing their value and organic certification which permits a farm to sell, label and symbolize their products as organic and thereby build trust among users. Retailing, packaging and labeling of organic products are also vital components in the promotion of organic products. The market of organic produce is considered as a premium market which maintains high standards. These standards are to be adhered to in the entire value chain of the product right from crop planning to production and post-production. The system requires a paradigm shift in the approach to the marketing of produce.

India has the potential to become a major organic agricultural country given the international demand for our farm products, different agro-climatic regions for the cultivation of a number of crops, the size of the domestic market and above all the long tradition of environment-friendly farming and living. Considering the current status, India has a wide scope for increasing organic practices for achieving sustainable development of agriculture.

ORGANIC FARMING FOR SUSTAINABLE AGRICULTURAL DEVELOPMENT

Dr. M. S. Deshmukh, Tanaji Namdeo Ghagare

Organic farming is one of the several approaches to meet the objectives of sustainable development of agriculture. It avoids the use of synthetic chemicals as well as genetically altered organisms and usually subscribes to the principle of sustainable farming. Organic farming is based on various laws, perspectives and certification programs, which prohibit the use of approximately all synthetic inputs, and health of the soil is recognized as the central framework of the organic farming practices.

The agriculture sector is a primary sector of the overall development of rural areas. It plays a significant role in ensuring food security, raw materials, livelihoods and providing a spur to the growth of the industrial and service sector. Therefore, the agriculture sector is the backbone of Indian economy. A large proportion of labour force still depends on agriculture. Based on Usual Principal Status Approach (UPSA), 46.1 percent of the persons were estimated to be employed under agriculture in India during 2015-16 (GoI, 2016).

The health of the individual is at greater risk than ever before because of the chemicals that we ingest into our bodies through the inorganic food we eat. Organic agriculture has positively impacted on the quality of natural resources and biodiversity. Therefore, organic agriculture provides high nutrient foods to human beings and animals for their well-being. Raising awareness, increasing market requirement, nurturing the attitude of the producer to become organic, increasing research and government supports have resulted into amazing development in organic agriculture since last two decades in the world and India. The global ranking of India in organic agriculture stood at eighth position with 1.78 million hectares of area under it in 2017. The share of organic agricultural land of India was 2.55 percent in the total world of organic agriculture. India has the highest number of organic producers in the world accounting to 30.58 percent. The area under organic farming in India, was over 17 lakh hectares and its total production was 16,75,560.70 metric tonnes in the year 2017-18. In 2016 Sikkim became the first organic state of India.

The concept of Organic Farming:

The system of organic farming is based on an intimate understanding of nature's laws and rules. In today's terminology, it is a method of a farming system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes and other biological materials along with beneficial microbes (biofertilizers). They release nutrients for increased sustainable production of crops. "Organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved." (IFOAM-2018).

Principles of Organic Agriculture:

The principles of organic farming were formulated and developed in September 2005 by IFAOM. These four principles are the roots, from which organic agriculture developed.

- **The Principle of Health:** Organic farming should sustain and enhance the health of soil, water, air, environment, animal, human and plant as one and indivisible.
- **The Principle of Ecology:** Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them on nature's laws.
- **The Principle of Fairness:** Organic practices should build on relationships that ensure fairness with regard to the common environment and life opportunities.
- **The Principle of Care:** Organic farming should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the overall environment.

Characteristics of Organic Farming:

- Protecting the long term fertility of soils by maintaining organic matter levels, encouraging soil biological activity, and careful mechanical intervention.
- Providing crop nutrients indirectly using relatively insoluble nutrient sources which are made available to the plant by the action of soil micro-organisms.
- Self-sufficiency in Nitrogen through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials including crop residues and livestock manures.
- Weed, disease and pest control by relying primarily on crop rotations, natural predators, diversity, organic manuring, resistant varieties, and limited (preferably minimal) thermal, biological and chemical intervention.
- The extensive management of livestock, paying full regard to their evolutionary adaptations, behavioral needs, and animal welfare issues with respect to nutrition, housing, health, breeding and rearing.
- Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

Sustainable Agriculture & Organic Farming:

Sustainable agriculture integrates the main goal to sustain biodiversity; enhance the quality of natural resources, economic profitability, and social equity. Organic farming provides several benefits for people and the planet. Many changes observed in the environment are long term, occurring slowly over time. Organic agriculture considers the medium and long term effect of agricultural interventions on the agro-ecosystem.

Improving Soil Fertility: Soil building practices such as crop rotations, cover crops, and organic fertilizers are central to organic practices. These practices replenish soil organic matter, feed soil life, reduce erosion, improve soil structure, and enhance nutrient cycling and water retention. The

length of time that the soil is exposed to erosive forces is decreased, soil biodiversity is increased, and nutrient losses are reduced, helping to maintain and enhance soil productivity.

Improving Water Quality: Organic farming practices, such as the application of compost manures and the use of fodder legumes and green manures within extended grain cropping rotations, can optimize soil nutrient release and plant nutrient uptake, and subsequently improve water quality. Enhanced soil structure, water infiltration, and nutrient retention also reduce the risk of groundwater pollution. In many agriculture areas, pollution of groundwater, synthetic fertilizers and pesticides are major difficulties. In some areas where pollution is a real problem, conversion to organic agriculture is highly encouraged as a restorative measure.

Energy and Climate Change: Through the use of leguminous cover crops, compost, and other organic approved materials for fertility management, organic farms often decrease the greenhouse gas emissions associated with both infield and embedded emission components. By prohibiting the use of synthetic fertilizer and pesticides, organic production avoids the CO_2 emissions associated with the production of these inputs. Additionally, many of the practices associated with certified organic production, such as diverse crop rotations, use of cover crops, and application of compost manures enhance the accumulation of carbon in soil. Organic agriculture reduces non-renewable energy use by decreasing agrochemical needs (these require high quantities of fossil fuel to be produced).

Protection of Biodiversity: Organic systems enhance biodiversity at several levels. A variety of seeds and breeds are chosen for greater resistance to diseases, climate, and pests. Producers employ diverse combinations and rotations of plants and animals to increase yields and income. The maintenance and planting of natural areas within and around organic fields and the absence of chemical inputs create suitable habitats for wildlife and important pollinators and beneficial insects. Organic farmers are both custodians and users of biodiversity at all levels.

Components of Organic Farming for Sustainable Agriculture Development:

1. Crop Rotation:

It is a systematic arrangement for the growing of various crops in a more or less regular sequence on the same land covering a period of two years and more. A mixed cropping, pasture and livestock system is desirable or even essential for the success of sustainable agriculture.

2. Crop Residue:

There is a great potential for utilization of crop residues/straw of some of the major crops. About fifty percent of the crop residues are utilized as animal fed, the rest could be very well utilized for recycling of nutrients.

3. Manure:

The organic manure is derived from biological sources like the plant, animal and human residues. Organic manure acts in many ways in augmenting crop growth, crop protection, and soil productivity. The direct effect of organic manure relates to the uptake of humic substances or its decomposition products affecting favorably the growth and yield of plants.

A) Bulky Organic Manure: Farm Yard Manure (FYM), Compost Manure, Green Manure

B) Concentrated Organic Manure: Concentrated

Figure 1.1: Components of Organic Farming

Source:http://www.agritech.tnau.ac.in/org_farm/orgfarm_introduction.html

organic manures are made from raw materials of animal or plant origin. These manures commonly used are oilcakes, blood meal, fishmeal, meat meal, and horn and hoof meal.

4. Waste:

- **Industrial Waste:** Among the industrial by-products, spent wash from distillery, molasses and press mud from industry have good manure value. This industrial waste manure can be used after proper decomposition.
- **Municipal and Sewage Waste:** Sewage sludge, particularly from industrialized cities, is contaminated with heavy metals and these pose hazards to plants, animals and human beings.

5. Biofertilizers:

Biofertilizer is microorganism's culture capable of fixing atmospheric nitrogen when suitable crops are inoculated with them. The main inputs are microorganisms, which are capable of mobilizing nutritive elements from non-usable form to usable form through a biological process.

6. Bio-Pesticide:

Bio-pesticides are natural plant products that belong to the secondary metabolites, which include thousands of alkaloids, terpenoids, phenolics, and minor secondary chemicals. These substances have usually no known function in photosynthesis, growth or other basic aspects of plant physiology. However, their biological activity against insects, nematodes, fungi, and other organisms is well documented.

7. Vermicompost:

Vermiculture has a component in biological farming, which is found to be effective in enhancing soil fertility and producing large numbers of agricultural crops. It is organic manure produced by the activity of earthworms that generally live in soil, eat biomass and excrete it in digested form. The average nutrient content of vermicompost is much higher than that of FYM.

Key Indicators of Organic Farming: World & India

According to the FiBL-IFOAM annual report 2019, 69.8 million hectares of organic agricultural land, including in-conversion areas were managed organically in 2017 worldwide. The compound growth rate of the world's organic agriculture area was 6.78 percent and that of India 9.69 percent during 2005-17. The table-1 reveals the comparative analysis of key issues of organic farming among the world and India during 2017-18. Organic agriculture practices have been carried out exponentially in the world during the last decade and now applied in 181 countries worldwide. The total area under organic agriculture was 69.8 million hectares and 1.78 million hectares in the world and India respectively. Australia is leading an expansion of organic farming area accounting 35.65 million hectares (51.07

Table 1: Key Indicators of Organic Farming: World & India (2017-18)

Sr. No	Indicator	World		India	
		Total	Top	Total	Top
(1)	(2)	(3)	(4)	(5)	(6)
1	Organic Activities	181 Countries	Liechtenstein	33 States	Sikkim
2	Organic Agricultural Land (Million Hectare)	69.8	Australia 35.6	1.78	Madhya Pradesh 0.4
3	Wild Collection Areas (Million Hectares)	42.4	Finland 11.6	4.22	Madhya Pradesh 0.54
4	Organic share to total Agricultural Land (in Percent)	1.4	Liechtenstein (37.9)	1.0	Sikkim 100.0
5	Producers (in Millions)	2.9	India 0.83	0.83	Madhya Pradesh 0.31
6	Organic Retail Sales (Million Euros)	92074	USA 40011	186	-
7	Per-capita Consumption (Euros)	12.2	Switzerland 288	0.2	-

Source: FiBL-IFOAM Annual Report 2019, http://apeda.gov.in/apedawebsite/organic/data.htm

percent) in the world. India stands at 8thrank in the world which has 1.78 million hectares and contributed 2.55 percent organic area to the world's total organic agriculture land. The share of the world's organic land to total agricultural land was 1.4 percent in 2017. The countries with the highest organic share are Liechtenstein with 37.9 percent of its agricultural and under organic practices. India has 1.0 percent (1.78 million hectares) organic share to total agriculture land. Sikkim is India's first Organic state to convert the entire state into organic practices.

There were 2.9 million organic producers actively engaged in worldwide during 2017. India has the largest number of organic producers with 0.83 million (30.62 percent). Worldwide, organic retail sales have grown in large number (92074 million Euros), but in India, organic market (186 million Euros) has not developed extensively. India's per capita consumption of organic food was 0.2 Euros as against the world's per capita consumption (12.2 Euros). In India, among all the states Madhya Pradesh has effectively implemented organic practices and schemes. Therefore, Madhya Pradesh has the highest organic area and production within the country since the last decade.

Conclusion:

The organic agriculture positively affects and sustains the quality of natural resources (soil, water, and air) and biodiversity. The application of organic farming yields better economic and environmental benefits to farmers for raising their standard of life. It is inevitable to frame and implement various policies, programmes, and strategies to promote organic agriculture in order to realize its full potential. Public awareness has transformed the initial supply driven organic movements to demand driven. The premium prices and government support for organic farming has led to the implementation of organic practices. The farmers have converted their chemical farming method to organic farming method for economic, health and environment reasons. The organic farming practices are sustainable in nature and have enhanced environmental quality and ecosystem. Organic farming is based on the principle of maximum production with high quality, without affecting the soil fertility and the environment. India has the potential to become a major organic agricultural country given the international demand for our farm products, different agro-climatic regions for the cultivation of a number of crops, the size of the domestic market and above all the long tradition of environment-friendly farming and living. Developed and developing countries have rapidly adopted organic farming practices. At the global level, every country has taken initial steps to support organic farming through implementing various programmes and policies for spreading organic practices among farmers. A strong national organic policy is the need of the hour to address the important current issues and obstacles and for promoting organic farming culture in the country. Considering the current organic status of India, it has a wide scope for increasing organic practices for the achievement of sustainable development of agriculture.

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NATURAL RESOURCE MANAGEMENT AND BIO-DIVERSITY CONSERVATION

Jitendra Pandey, Usha Pandey, Niraj Kumar and Deepa Jaiswal

Organic farming has emerged in response to questions on the environment, sustainability and human health. Driven-by the principles of circular causation, this farm practice reduces energy dependence and enhances soil fertility stability, carbon sequestration and biodiversity of microbes, plants and animals. To up-scale with ground realities, there is a pressing need for more system level and long-term studies exploring major opportunities and constraints in organic farming in the Indian context.

Driven by the continuous increase in the food demand by the rapidly growing human population under limited agricultural land, excess application of synthetic fertilizers coupled with mechanical soil disturbances led to a continuous loss of soil fertility, deterioration in food quality, increase in water pollution and generation of resistant pests. These have forced the scientists to explore possibilities for opting 'organic farming' as a holistic production management system supportive to the environment, health and agricultural sustainability. The high input production system is unsustainable, says M.S. Swaminathan; advocating towards the need for an ecologically, socially and economically sustainable production system, he named it as the 'evergreen revolution' (Kesavan and Swaminathan, 2018). Organic farming is based on the principle of circular causation with emphasis on the use of organic supplements for enhancing soil quality, minimizing food associated health risks and establishing a closed nutrient cycle to ensure the sustainability of agro-ecosystems (Pandey and Singh, 2012).

Organic farming although yields a bit lesser (10-15%) than the conventional farming, the lower yields are compensated by lower input costs and relatively higher profit margins. Organic farming is now being practiced in over 130 countries covering a total area of ₹30.4 million hectares, 0.65% of the world's total agricultural land. India, although occupies the second place with respect to the number of certified farms (44,926), comes at 13th position for the area under organic agriculture. In India, ₹528,171 ha area is under organic farming accounting for ₹0.3% of total agricultural land. Organic farming industry in India is entirely export-oriented, running as a contract farming system under a financial agreement with the firms.

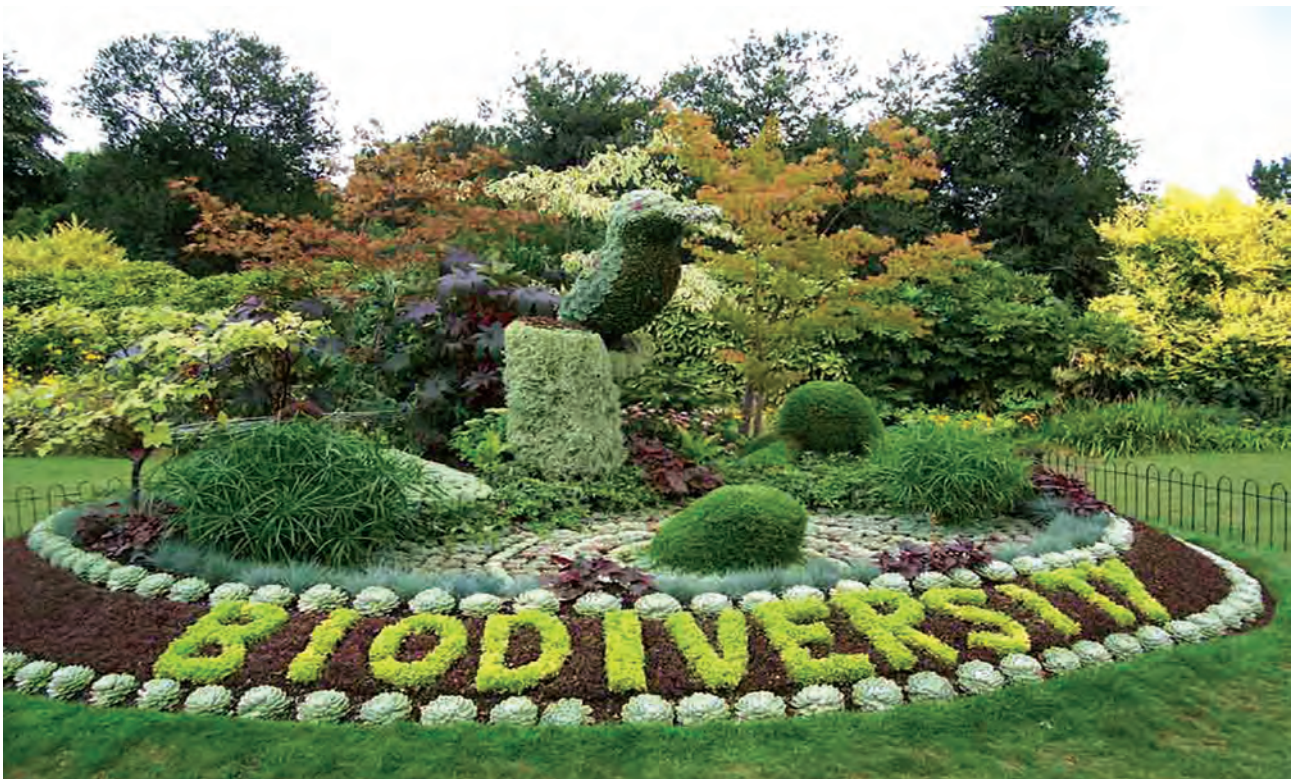
Opportunities in organic farming

A. Conservation perspectives

Organic farming practices are ecologically sustainable in terms of (1) soil fertility stability, (2) increased diversity of microbes, plants and animals, (3) increased carbon sequestration and, (4) reduced energy dependence.

(1) Soil fertility stability

The degraded soil quality is an important constraint in agricultural productivity in our country. Despite continuous use of synthetic fertilizers, driven



by soil quality degradation and nutrient mining, the agricultural productivity in India reduced from about 234.5 million tons in 2008-09 to about 218.2 million tons in 2009-10. In conventional agriculture, soil fertility declines with crop harvest. For this reason, global fertilizer use increased from ~27.4 million tons (1959-60) to 143 million tons (1989-90) and likely to reach to 208.0 million tons by the year 2020. Despite that, the world's cereal yield growth has declined from an annual average of 2.2% in the 1970s to 1.1% in the 1990s. The organic farm practices help to restore long-term soil quality. One acre of living topsoil contains ~900 pounds of earthworms, ~2,400 pounds of fungi, ~1,500 pounds of bacteria, ~133 pounds of protozoa and ~890 pounds of arthropods and algae (Pimentel *et al.,* 2005). Organic supplements are easily colonized by microorganisms that help to stabilize soil fertility via improving decomposition, nitrogen fixation and reducing the losses of nutrients. Additionally, green manures help in mobilizing nutrients, enhancing growth promoting substances, suppress soil-borne pathogens and support crops to out-compete weed and prevent soil erosion.

(2) Biodiversity Conservation

Organic farming is now seen as a potential solution towards reducing the loss of biodiversity. As organic farm practices are largely intrinsic and enhance food resource, habitat heterogeneity (management of field margins and non-crop habitats), prey-predation relationships, and reduce toxic influences (prohibited use of chemical pesticides/ inorganic fertilizers), these are expected to support species vulnerable to otherwise conventional farm practices. Although a number of caveats apply for making a generalization, promotion of biodiversity conservation has been now well accepted as an important benefit of organic management. So far, the available evidence clearly indicates that organic farming plays a significant role in preserving and conserving the biodiversity resources.

- There is clear evidence of elevated bacterial and fungal abundance and activity under the organic system. Pandey and Pandey (2009a) have reported 17-26% increase in microbial biomass and activity in organically managed experimental plots. Bacterial feeding nematodes were found to be more abundant under organic management.
- Higher earthworm abundance has been reported in organic than in conventional fields. Organic management supports more active earthworm population, number of species and more juvenile earthworms regardless of crop type.
- Organic management supports a significantly

higher number of butterflies, spiders and beetles. Higher abundance and species richness of carabids and epigeal spiders have been reported in organic farms. Also, the organically managed fields support a number of species of non-coleopteran arthropods than the conventionally managed fields.

- Studies show that organic fields support a greater number of vertebrate species (mammals and birds). Studies conducted in other countries show that small mammals such as the wood mouse (*Apodenus sylvaticus*), common shrew (*Sorex araneus*) and bank vole (*Clethrionomys glareolus*) in organic farms did appear greater in number than the conventional fields. Many species of bats actively select organically managed habitats. High abundance and diversity of invertebrates and plants in organic fields support a variety of avian community.
- Management of field margins and non-crop habitats support higher abundance and richness of weeds and non-crop flora in organically managed fields. In particular, these differences have been shown to be greater for broad-leaved weed species belonging to Fabaceae, Brassicaceae and Polygonaceae. Hedges of organic fields display significantly higher species diversity than those supported on conventional farms.
- Organic farming, by definition, reduces pollution of water bodies by pesticides and inorganic fertilizers. The overall effect is a significant increase in richness and abundance of aquatic species in waterways located downstream organic fields.

Ample evidence is now available suggesting that organic farming can play a significant role in increasing/conserving biodiversity across the landscape. Although, benefits of organic farming to biodiversity vary, the extension of organic farms can contribute to the restoration of biodiversity resources in the agricultural landscape. Because this effect varies according to the factors such as location, crop-type, species, climate and also with farm practices, there is a pressing need for more long-term, system-level studies on biodiversity responses to organic management on landscape-scale.

(3) Carbon sequestration

Knowledge of C-storage relative to flux in agro-ecosystems is essential for predictive geosphere-biosphere modeling and for reducing the excess of atmospheric CO_2 levels through C-sequestration. As per the IPCC (2007), the soil carbon sequestration is cost effective and may contribute to ~89% of total C mitigation. Our country with almost all major climatic zones and range of land usage has vast opportunities for soil C-sequestration. Conversion to agricultural land use may lead to loss of SOC pool by 60% in temperate soils and over 75% in the soils of tropics (Lal, 2010). Compared to the carbon stored in a forest, the SOC in agricultural soils can effectively benefit food production and improve agricultural sustainability. An increase of 1 ton of

soil C pool of degraded cropland may increase crop yield by about 10 to 20 kg/ha of maize, 20 to 40 kg/ha of wheat, and 0.5 to 1 kg/ha of cowpeas indicating a strong link between C-sequestration and crop production (Lal, 2010).

Further, a recent study in Punjab indicated that organic amendments significantly reduce methane emission from rice field (Khosa *et al.,* 2010). Considering the vast potential of C-sequestration and GHG emission mitigation, the government needs to encourage farmers towards the adoption of RMPs for climate change mitigation and sustained food security.

(4) Reduced energy dependence

The conventional farm systems require more overall energy inputs than do the organically managed systems. Fossil fuel energy input is required in farm machinery, transport, production of synthetic fertilizer and pesticides, etc. Synthetic fertilizers, used in conventional systems, are produced employing fossil fuel energy whereas cattle manure, legumes, etc., with very low energy needs, are used in organic practices. In a study, Pimentel *et al.* (2005) have quantified that fossil fuel inputs in organic production of corn were ~30% lower than the conventionally produced counterparts. This marks the additional benefit in terms of comparatively lesser release of CO_2 to the atmosphere and therefore helps mitigate climate change. Reduced energy use in organic farms thus not only reduce economic load but also share to solve environmental problems such as climate change.

B. Economic sustainability

The conventional mode of agriculture, which works on the principle of diminishing return, may cause long-term economic risks influencing the overall balance of trade compared to its sustainable counterpart. In a sustainability perspective of organic farming, the following issues need concern:

1. *Export orientation:* The Indian organic produce market is export-oriented. It involves hidden costs such as transport and has risks to local food security. Policies considering local demands/ markets are needed for a rational balance of trade.
2. *Market risk:* Concentrating on specific commodities is vulnerable to market risks. A disproportional sweep in the international market may lead Indian farmers to risk. As a WTO signatory, the government is bound to open its economy to the global market and thus, unable to protect the farmer's interest in this respect.
3. *Employment:* The organic farming system, being labor-intensive can help overcome rural employment.
4. *Cost-benefit analysis:* Agriculture forms the base of economic policies and poverty alleviation in many countries including India. Model estimates show that organic farming can reduce pesticide use by 50% to 65% without compromising crop yields and quality together with 50% less expenditure on the fertilizer and energy use (Pimentel *et al.,* 2005).

A study, based on 120 farmers of Shimoga and Bhadravati Talukas of Karnataka, conducted the cost-benefit analysis of organic rice production (Suresh and Kunnal, 2004). They show that although the average cost of organic cultivation per acre was lower only marginally, the net benefit increased by over 40% indicating that organic farming is beneficial in an economic perspective also. Another study by the Central Institute for Cotton Research, Nagpur indicated that the cost of organic cultivation was about 21% lower than that those under conventional farming.

Constraints in Organic Farming

A. Environmental constraints

(1) Water quality

Accumulation of heavy metals in agricultural crops depends on soil processes and properties, plant and soil physical factors, mobilization of metals, concentrations of heavy metals in soil and in irrigation water (Pandey *et al*., 2012). Wastewater irrigation has become a very common practice in many countries including India. Some countries recommend wastewater irrigation for grain crops and those grown for fodder and slaughter stocks. Wastewater is increasingly being used for irrigation in urban and peri-urban areas of the developing countries due to easy availability and scarcity of unpolluted water. Irrigation of crops with wastewater may cause heavy metal accumulation and degrade soil quality (Pandey *et al.,* 2012). The overall effect is reduced crop growth and risks to human health. For the success

of organic farming, efforts should be made to ensure the availability of contamination-free fresh waters. In this context, a massive drive to manage surface and ground waters for irrigation and other usage is essential.

(2) Atmospheric deposition

High atmospheric deposition and accumulation of heavy metals in crops and vegetables have also been reported in India (Pandey and Pandey, 2009b). It can affect human health through dietary intake and food chain associated routes. Atmospheric deposition of heavy metals has been shown to lead multifold accumulation in eggplant, tomato, spinach, carrot, amaranthus and radish and cause damage to microbial activity in organically amended soil (Pandey and Pandey, 2009b). Thus, the atmospheric deposition of heavy metals may constrain compromising organic farming with respect to its ability to stabilize soil fertility and provide toxin-free produce.

B. Resource need

Livestock resources play important role in strengthening agricultural practices for large masses in India. With the advent of technology, the livestock population in our country has declined sharply. Between 1997 and 2003, cattle population in India declined by 10.23% and those of mules, camel and donkey the declines were 20.36, 30.70% and 26.30 respectively. Improved pasture and rangelands are essential for supporting livestock and restoring C-pool, nutrient cycling and soil quality. The natural pasture cover in India is rapidly declining and the problem is more acute in dry regions.

A large part of the rural population in our country is poor and depends on animal manure for domestic fuel. This further constrains the availability of animal manure for agricultural use. In a rural household in our country, about 1500-2000 kg of cattle manure is used for domestic fuel annually. To remove this 'competitive' constraint, useful options and appropriate farm-scale management strategies are required. Lack of sufficient stock of vermicompost and biofertilizers in the local market further constrain the organic producers. Further, constraints associated with the availability of appropriate amount of biopesticides may also lead organic producers in India to risk. Additionally, most of the crop residues in our country are removed from the fields for the purpose of fodder and fuel. This has led the use of mulch farming technique towards failure. In addition, there must be some appropriate microbe-based technology for optimizing the use of natural resources to sustain agricultural production in India (Pandey and Pandey, 2017; Anandaraj, 2019). More recent studies show that the use of agricultural biostimulant may be an effective tool in making agricultural production more sustainable and resilient.

C. Certification

Problems associated with certification, for instance, a time lag of three-years (conversion stage), often constrain small landholders from

adopting organic farming. The certification is essential to authenticate organic produce and to validate the price margin in the market. The Director General of Foreign Trade (India) permits the export of organic produce if these are produced and processed under a valid certification. Lack of knowledge and access to certification discourage the small farm holders in India. To overcome these issues, training and institutional demonstration with fiscal incentives is being provided to encourage small farm holders.

D. Social acceptance

The increasing demand for organic produce is viewed as a new opportunity to aspire the economic boom with lucrative export markets. However, the majority of small farm holders depend on government incentives and are striving for a profit margin in the indigenous market. Therefore, small farm holders in our country are apprehensive towards adopting organic farming. Major issues that need to be resolved to encourage acceptance in small farm holdings include access to certification, lack of local market, cost-benefit anomalies, lack of appropriate knowledge to RMPs and non-availability of organic supplements.

Conclusion:

Indian agriculture has evolved as an ecologically sustainable approach based on natural inputs to obtain desired crop yield. The modern innovation and technology-based agriculture although increased the yield by many folds have caused a large-scale environmental degradation including the loss of biodiversity. With a large geographical area and diversity of eco-region, our country has a considerable potential to capitalize on organic farming. However, small farm holders in India are constrained by issues such as resource availability, certification, lack of local market and other factors. Therefore, an integrated effort is needed by the government and non-government organizations to remove constraints encouraging small farm holders to adopt organic farming as a solution to meet food demand while conserving the soil, water, energy and biological resources.

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STATUS, POTENTIAL AND NEW TECHNOLOGIES IN ORGANIC FARMING

Prof. A.K. Barik, R. Bera

Necessity of ecologically and economically sustainable organic farming towards crop production and mitigation of climate change is well understood. But the organic movement in the backdrop of global agriculture is insignificant despite considerable effort during the last few years. India also faces several bottlenecks with respect to growth of organic agriculture both at the production and marketing levels. Various issues have been discussed in this article regarding the major bottlenecks in organic agriculture as well as potential of sustainable growth of organic farming . New technologies / package of Practices (POP) for organic farming have also been discussed.

Food scarcity in the sixties had led to the need and initiation of green revolution. However, to augment crop production usage of chemical fertilizers in incremental dose over the years led to the deterioration of soil character, made the plants fertilizer sensitive and disturbed the pest- predator relationships, which automatically generated the necessity for application of pesticides. To further add to the dilemma crop productivity has been going downhill from the fertilizers following the 'Law of Diminishing Return'. Crop production system has become completely dependent on the external support system, at the same time input-output ratio is going low with time. Thus just after few decades of its incorporation, chemical farming has broken the equilibrium of millennia.

Hence, today successful agriculture shall only depend upon how well and fast soil depletion is checked and the soil nutrient balance shifts towards a positive balance. According the IFOAM (2009) organic agriculture has a significant role in addressing two of the world's biggest and most urgent issues – (i) Climate change and (ii) Hygienic food security. The present compulsion has initiated effort even from the government, which has formulated different subsidies, funds, incentives etc. for the incorporation of natural as well as organic inputs in the regular cultivation system. It is now understood that sole application of organic inputs can neither ensure successful organic cultivation nor enable the much desired speedy restoration of soil health. The answer can be provided only through adoption of comprehensive and scientific organic package of practice, because in order to ensure the desired results under the existing complexities the steps of organic management should work in absolute harmony with each other.

Continuous and indiscriminate use of chemical fertilizers has led to several harmful effects on the soil environment, ground and surface water reducing the productivity of soil by affecting soil health in terms of physical, chemical and biological properties. The excess/ indiscriminate use of pesticides has led to the entry of harmful compounds into food chain, death of natural enemies and development of resistance to pesticides. Enhanced use of pesticide resulted in serious health implications to man and his environment. There is now overwhelming evidence that some of these chemicals pose a potential risk to humans and other life forms and unwanted

side effects to the environment (Forget, 1993). No segment of the population is completely protected against exposure to pesticides and the potentially serious health effects, though a disproportionate burden is shouldered by the people of developing countries and by high risk groups in each country (WHO, 1990). The world-wide deaths and chronic diseases due to pesticide poisoning numbered about 1 million per year (Environews Forum, 1999).

Why Organic Farming?

Hence, enhancement and maintenance of system productivity and resource quality is essential for sustainable agriculture. It is believed that organic farming can solve many of these problems as this system is believed to maintain soil productivity and effectively control pest by enhancing natural processes and cycles in harmony with environment. Organic farming is defined as a production system which largely excludes or avoids the use of fertilizers, pesticides, growth regulators, etc. and relies mainly on organic sources to maintain soil health, supply plant nutrients and minimize insects, weeds and other pests. It was felt that organic farming may solve all these problems and has been considered as one of the best options for protecting/sustaining soil health, and is gaining lot of importance in present day agriculture.

Present Status of Organic Farming

India holds a unique position among 172 countries practicing organic agriculture: it has 6,50,000 organic producers, 699 processors, 669 exporters and 7,20,000 hectares under cultivation. But, with merely 0.4 per cent of total agricultural land under organic cultivation, the industry has a long journey ahead (Bordolo, 2016). India produced around **1.35 million MT (**2015-16) of certified organic products which includes all varieties of food products. The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc. As per the latest available cross-country statistics, in the year 2015, India ranked first in terms of the number of organic producers among over 170 countries and ninth in terms of the area under organic agriculture. India ranked 11th in organic product exports in 2015 (Mukherjee *et al*, 2017).

India is home to 30 per cent of the total organic producers in the world, but accounts for just 2.59 per cent (1.5 million hectares) of the total organic cultivation area of 57.8 million hectares. However, it has been observed that when it comes to the area under certified organic cultivation, India contributes only 2.59%, i.e., 1.5 million hectares of the total organic cultivation area of 57.8 million hectares. Thus, amongst the regions with the largest areas of organically managed agricultural land, India ranks 9th.

Emerging Challenges in Organic Farming

Organic Agriculture is not a new concept to India and traditionally Indian farmers were organic by default. But, gradually changed to chemical based cultivation since 1950's and chemicals were increasingly applied during the Green Revolution period. In this scenario, proliferation of sustainable organic farming practice or even effort

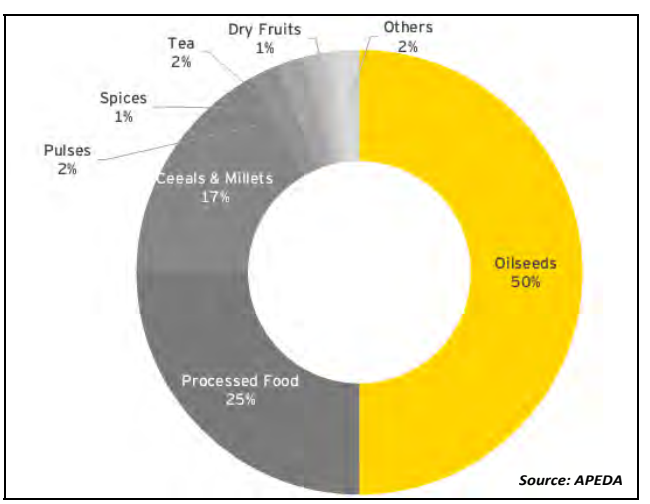

Fig 1 : Export Share of Organic products in India.

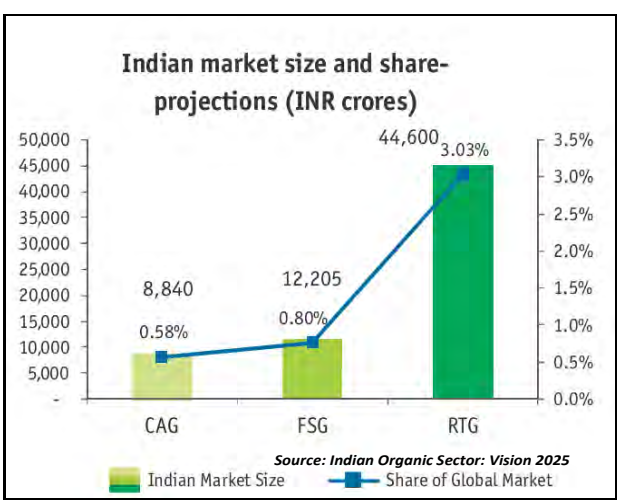

Fig 2 :India Projected Export Market in Year 2025.

towards reduction of chemical load has not been satisfactory. Lack of proper knowledge transfer has been a limiting factor towards large scale organic conversion or reduction in chemical load under conventional farming practice. At the same time farmer's participation in problem identification and solving is inadequate, consequently the technology and innovation uptake were also compromised (Hakiza *et al,* 2004). Besides this, majority of agro-research does not prioritize/ focus on dissemination of research outcome at farmers' level. There are limitations like availability of practical guidelines, communication gap with small and marginal farmers and lack of comprehensive approach for integration of technological know-how, better marketing options etc. which led to lesser farmers' participation in large scale demonstration. But above all the single most criteria which was responsible for limited progress of sustainable farming practice is lack of comprehensive and economically viable packages which can offer easy adoptability for the farming community (Maity & Tripathy, 2011).

India is poised for faster growth with the growing domestic market. Success of organic movement in India depends upon the growth of its own domestic markets. With the sizable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market (Eximbank report, 2002). With this growing demand more and more technological innovation like IRF Technology and their implementation at farmers' field will ensure economically viable organic agriculture and help in its adoption by the common farmers even without any subsidy scheme or guaranteed premium price. Considering the increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidences of being equally productive, the organic farming has emerged as an alternative system of farming which can not only address the quality and sustainability concerns, but also ensure a debt free, profitable livelihood option (Makadia and Patel, 2015**).**

New Technologies / Package of Practices in Organic Farming in India

There are few organic technologies presently in practice in large scale organic farming, among which Biodynamic Farming and Inhana Rational Farming Technology are prominent. Apart from that in most of the cases different organic inputs are used to make different organic package of practice for different crops. These combinations can be broadly divided in 4 to 5 category of POP's. These are (i) Vermi compost (soil management) + different herbal concoctions (plant management); (ii) Indigenous compost/manure (viz. FYM etc) + different herbal concoctions; (iii) Vermi/Iindigenous compost+Bio-fertilizers (soil management) + different herbal concoctions; (iv) Vermi/Indigenous compost + Biofertilizers (soil management) + different herbal concoctions/ Bio-pesticides and (v) Vermi/Indigenous compost + different herbal concoctions / Bio-pesticides.

Inhana Organic Farming (IRF) Technology – A Complete Organic Package of Practice

Taking the essence of Trophobiosis theory of F. Chaboussou (Chaboussou, 1985), a farming technology was developed by an Indian Scientist, Dr. P. Das Biswas. He termed it as Inhana Rational Farming (IRF) Technology which provides a nature receptive pathway for crop production taking into account the interrelated and integrated relationships of all the components of the ecosystem. It blends ancient Indian wisdom with scientific knowledge and ensures healthy plant and soil system which ultimately leads to a successful crop output without disrupting the ecological harmony. This farming technology has already been widely adopted in reputed tea estates in India and has shown its effectivity towards the reduction of chemical / pesticide load and management of recurrent disease problems. In the Agriculture Sector, the technology has been tried out in different crops like paddy, baby corn, green-gram, cabbage, okra, tomato, potato, brinjal etc. (Bera *et al*, 2014) and had turned out to be quite satisfactory. Thus in the backdrop of degrading soil fertility, worsening plant health leading to poor quality and productivity and prevalence of unsustainable agricultural practices, IRF Technology can become one of the weapons to contest against such adversities.

Conclusion

Organic farming is the pre-requisite for enabling wider adoptability, secured livelihoods and ensuring affordability at the consumer's end.

India has a long history of organic farming. At the same time increasing domestic market of organic food can provide the necessary support towards organic movement. Awareness, Training and dissemination programs will help to facilitate the movement but most importantly innovative organic farming technologies like Inhana Rational Farming (IRF) can popularize the practice even among the resource poor farmers by ensuring ecologically and economically sustainable organic crop production in a time bound manner. Case studies of IRF Organic POP also testify the corresponding GHG mitigation and adaptation potential, soil resource regeneration, high energy use efficiency as well as development of plant resilience; but the highlight remains its cost effectiveness and time bound results.

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MARKETING AND BRANDING OF ORGANIC FARMING

Dr. Satish Chandra Pant, Sathyendra Kumar

The Market of organic produce is considered as a premium market which has high standards. These standards are to be adhered to in the entire value chain of the product right from crop planning to production and post- production. The system requires a paradigm shift in the approach to the marketing of produce by considering farmers as well as consumers in the value chain.

Organic farming offers the promise of a future where food and farm products are produced in an ecological, sustainable and healthy manner. India's diverse agro-climatic conditions have the potential to produce all varieties of organic produce. As organic farming is an inherited trait and since ages, it is being practiced in the country. It is an added advantage to the organic producers for tapping the steadily growing market of their products.

The current position of organic farming with respect to the area covered across the country is 23.02 lakh hectares. In 2017-18, India produced around 1.70 million MT of certified organic products in all categories namely oilseeds, cotton, sugar cane, pulses, cereals, tea, coffee, millets, medicinal plants, fruits & vegetables, spices, dry fruits, etc. Madhya Pradesh is the largest producer followed by Maharashtra, Karnataka, Uttar Pradesh, and Rajasthan. In terms of commodities, Oilseeds are the single largest category followed by sugar crops, cereals and millets, fiber crops, pulses, medicinal, herbal and aromatic plants, and spices and condiments.

To strengthen organic farming, the National Programme for Organic Production (NPOP) was implemented which involves the accreditation programme for Certification Bodies, standards for organic production, promotion of organic farming, etc. The NPOP standards for production and accreditation system have been recognized by European Commission and USDA and Indian organic products duly certified by the accredited certification bodies of India are accepted by the importing countries (APEDA, 2019).

Global Organic Food Market

The global demand for Organic produce is touching new heights. The organic farmland increased substantially to 69.8 million hectares till 2017 with the engagement of 181 countries. Australia is the country with the most organic agricultural land with 35.6 million hectares followed by Argentina with 3.4 million hectares and China with 3 million hectares. The number of organic producers has grown up to 2.9 million worldwide. Indian producers are largest in number i.e. 835000 followed by Uganda and Mexico with 210352 and 210000 respectively. Organic retail sales also continued to grow, reaching another all-time high with the market size of 97 million US Dollar. The United States is the largest market for organic produce followed by Germany and France, together contributing 67% of the organic market globally (FiBL survey, 2019).

Domestic Organic Food Market

In India, the organic market is considered as a niche market segment and is still to sweep across the nation. Increasing per capita income, the growth of e-commerce, rising double income families are the major boost to the growth of the organic market. Several private players have entered this segment. Besides, all major hypermarket and supermarket chains have dedicated shelf for organic produce, which is still a small part of the overall business. The organic products market in India has been growing at a CAGR of 25 percent and it is expected to touch Rs 10,000-12,000 crore by 2020 from the current market size of Rs 4,000 crore (ASSOCHEM & EY, 2018).

Key Drivers of Marketing Organic Farming

Besides the factors like health- conscious consumers, rising double income families and urbanization several schemes are being implemented which support the production and marketing activities of organic produce in the country. The objective is to reduce the production costs and prices of the produce. Use of organic inputs like vermicompost, organic/bio-fertilizers, city compost, waste decomposer, phosphate-rich organic manure (PROM) has been promoted with the aim to reduce the costs of production in organic farming. Furthermore, assistance is being

provided to Farmer Producer Companies (FPCs)/ entrepreneurs for the development of value chains/ marketing of organic produce. Bio-villages (JaivikGaon) initiatives have been taken by many states like Bihar and Madhya Pradesh. In addition, financial assistance is being provided to farmers under various central sector.

Technology Development- Innovative technological solutions using aquaponics, artificial intelligence, renewable energy and ICT among others are being developed by private companies for the organic food industry. Red Otter Farms a Uttarakhand based start-up has chosen aquaponics as a medium to grow organic vegetables including greens. Aquaponics is already a commercially successful method adopted by developed countries and now in India, it is successfully adopted by young entrepreneurs. It is a method of production that combines raising fish with soil- less plant production by creating a symbiotic ecosystem. The farm is growing over 20 varieties of vegetables and selling the produce to hotels and retail chains. For better market linkage, the farm has started subscription based selling and targeted households of South Delhi and Gurugram (Chowdhary Sudhir, 2019). Similarly, ecoZen Solutions, Pune based start-up is working on solar irrigation and solar-powered cold storage for fresh produce which can be utilized in remote villages where irregular power is a problem. Role of ICT and digital interventions are also addressing the challenges of traceability of organic produce, linking farmers to market and providing timely information across the value chain. Such technology drive initiatives are motivating farmers/FPOs and Agri-preneurs and promoting organic farming in a big way.

Key Challenges while promoting Organic Farming:

Low crop yield during conversion-The productivity of organic cultivation is lower than conventional practices during conversion period of 3 years and there is no premium price for the produce. Field trials of organic cotton at Nagpur witnessed that cotton yield was poor as compared to the conventional practices and from third year onwards the yields of organic cotton started rising (Narayanan, 2005).

Inadequate Quality Standards-Due to lack of awareness, the majority of the organic producers fail to produce desired quality under organic cultivation and thereby face difficulties in ensuring a continuous market. Similarly, the quality standards for biomass and other inputs need to be standardized as per the market requirements. Quality organic seeds must be made available in the market. In addition, the export demand must be taken care of in terms of quality and residues.

Policy support- Policy support is an inevitable part of organic farming. Though a number of schemes are creating an ecosystem for development of organic farming in India agriculture being a state subject, the respective State Government has to take firm decisions to promote organic farming in their states. The complexity of the organic certification system with a high cost as well as time (3 years in most cases) is one of the major challenges faced by small and marginal farmers.

Inadequate Agriculture Marketing Infra-structure: Inadequate marketing infrastructure, cold storage, and processing facilities translate to the loss of product due to spoilage. In the Himalayan states and North-Eastern states where farms are by default organic, poor road infrastructure results in delayed connectivity to markets as a result of which quality of produce suffers and prices are slashed down.

Inadequate Market Research - There is a lack of support in terms of market research as well as market- oriented training programmes related to Organic Farming in India. Majority of the farmers have only vague ideas about organic cultivation and marketing of organic produce and its benefits. So far, no fruitful work has been done in the field of fragmented and unorganized management of the entire value chain of organic produce.

Limited availability of Organic Food Products: The limited availability of organic food products in the market is also posing a serious challenge to the growth of the Indian organic food industry. There are very few retail shops in India that store and sell organic food items. Many fake organic products are also available in the markets, which are diminishing the profits of genuine vendors. In order to address the above challenges following strategies may be helpful in the promotion and branding of Organic Farming in India.

Direct Marketing: There is a need to create a win-win situation for the producer as well as the consumer. Therefore, the role of Direct Marketing is paramount. The solution exists in the direct marketing models where a producer can sell their produce directly to the consumers.

Use of Technology- Recent technology initiatives by agricultural research institutions like use of waste decomposer, use of crop residue, use of biomass of non-conventional shrubs and trees, vermicomposting for nutrient management, use of bio-agent and predators for pest and disease management, wastewater treatment and water conservation methods are needed to be promoted among stakeholders.

Promotion of High-Value Crop- In the beginning, during the conversion of conventional farm to organic farm (3 years in most cases), the lower yield can be compensated with a high value high price crop such as western vegetables, medicinal and aromatic plants, superfoods like millets, basmati rice, etc. Generally, for these products consumers are willing to pay 2-3 times higher prices hence tremendous opportunities exist in domestic as well as in the export market **(Meena *et.al.*, 2013)**.

Crop Planning and Diversity-Proper crop planning is a key factor of production as well as marketing to get profitability in organic farming. Similarly, in the case of marketing of organic produce if agri-enterprises are set up by farmers collectively or individually, it becomes imperative to do crop planning. They need to cultivate a

diverse set of produce if they hope to get a market. They also need to stagger the production so that a steady and varied supply is available over a period of time.

Contract Farming - As organic farming requires stringent quality control and conventional farmers are far behind to maintain benchmarks, therefore, Contract Farming can emerge as an option to de-risk agriculture at various stages in the value chain, provide support of input-output management to producers and create a win-win situation for both the parties. In India, there are a number of success stories on Contract Farming which have helped growers in the realization of a better price.

Collectivization of Farmers - The collectivization of producers, especially small and marginal farmers into producers' organizations are emerging as an effective way to address various challenges such as access to credit and investments, technologies, knowledge support, inputs, and market linkages. Farmer collectives/ Farmer Producer Organizations would be in a position to mobilize their capacity in terms of production as well as marketing which can improve farmers' livelihoods. This is important especially if the efforts are initiated at the farmers' end for farmer-to-farmer extension support during production processes as well as pre-production planning, the results would be in terms of better products and achieve scale at the post-production stage.

Promotion of Input Based Enterprises- Efforts are being made through various government initiatives and schemes to converse chemical-intensive farming to organic farming. The schemes are mainly confined to farmers or FPO, while organic based input enterprises can play a crucial role to generate momentum in the conversion. Therefore, input based enterprises at the local level have to be encouraged. It can expedite not only a faster spread of organic farming, but also has the potential to generate an alternate livelihood for the rural populace.

Agri-preneurs to provide market- Agri-preneurs may be encouraged and incentivized to assist farmers for better quality products and market linkage. Special emphasis on e-commerce based Agri-startups in Agri-Marketing through Agribusiness incubators, special incentives to drive the promotion and capacity building among farmers to meet expectations of e-commerce are essential.

Linking farmers to Processors and Exporters- There is a need to identify the gap between expectations of buyer and farmers capacity and fill the gap through skill training, infrastructure, and technology. Thus, farmers produce will be made more acceptable to processors and exporters. Each FPO may be provided handholding support by one professional who is good in agribusiness on a day-to-day basis.

Widespread Extension- State wise intensive campaign on Organic farming like "Bio-Village" has to be adopted by all the states. As health-conscious consumers are seeking certified organic food in their food basket thus certification process, its procedure, formalities, and practices with market linkages need to be taught to farmers/FPOs. Furthermore, while promoting organic farming, extension functionaries must ensure availability of required inputs such as biofertilizers, bio-pesticides, bio-agents which requires expertise in the field. Therefore, widespread capacity building of extension functionaries is the need of the hour in this direction. In addition, Agriculture Extension Institutions of state has to prepare customized training programmes in consultation with National Institute of Agricultural Marketing (NIAM) and National Institute of Agricultural Extension Management (MANAGE) to cater to the specific needs of organic farming in terms of promotion and sensitization.

Branding Strategies to Promote Organic Farming:

Agro Tourism- Pluck and pay model of Agri-tourism may be promoted in which urban families or tourist visit the farm, harvest fruits and vegetables of their choice and pay to farmers. Thus, farmers would get premium prices for produce and farms get recognized and always remains in the mind of the customer.

Branding through professionals- Branding support from the professionals to Farmer Producer Companies to brand their products will enhance the value of the produce. Wild coffee, tribal

honey, etc. are examples. GI tagged commodities may create better publicity and brand building of organic farms.

Organic Certification: Organic Certification permits a farm to sell, label, and symbolize their products as organic and thereby build trust among users. It helps in retailing of produce and enabling consumers to identify organic produce easily and protect them against frauds. Thus, the role of certification is crucial in terms of brand building. In India, 29 Organic certificate accreditation bodies are authorized by APEDA to certify the organic farms/ produce. Hence their role is equally important to spread awareness regarding the procedures through capacity building programmes.

Retailing, Packaging, and Labeling: Farmers/ Farmer producer organizations have to provide training to produce dressed Fruits or Vegetables by providing necessary technology, infrastructure, and market linkage. The processed or dressed produce can be sold either through their own retail outlet or through others in an attractive packaging and labeling for better branding in the market. Attractive package through organic waste would fetch a better price.

Participation in Fairs and Exhibitions: Fairs and Exhibitions such as Kisan Mela, Agri Expo, Agri Exhibitions, Agri trade show, etc. are open to a large number of people usually from diverse backgrounds and provides an opportunity to promote the product to a large set of audience. It is an effective way to reach customers and create a brand identity.

Conclusion

For the promotion of organic farming, decisions of crop selection and potential area play a crucial role. High-value crops having commercial viability, industrial use and export potential should be considered over other crops. Use of bio-inputs, use of technology and widespread extension also plays a significant role in the promotion of organic farming. The market of organic produce is considered as a premium market which has high standards. These standards are to be adhered to in the entire value chain of the product right from crop planning to production and post-production. The system requires a paradigm shift in the approach to the marketing of produce by considering farmers as well as consumers in the value chain. Stringent quality control has to follow, promotion of input enterprises and farmer to farmer extension can play a major role in the conversion process.

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BIOFERTILIZERS AND GREEN MANURING

Surender Singh, Raman Jeet Singh and Balkar Singh

To meet the local market and export demand for organic produce more number of farmers and entrepreneurs are adopting organic farming. However, the availability of organic plant nutrient source for organic farming is a great challenge. Biofertilizers and green manuring can help in meeting the nutrient demand for organic farming. Both biofertilizers and green manuring crops are not only cost-effective but also a sustainable nutrient source for maintaining soil fertility.

The need for sustainable and ecological agriculture is increasingly felt in the country. Simply stating, organic farming is a production system which favours maximum use of organic material (crop residues, animal excreta, legumes, on and off-farm organic wastes, growth regulators, biofertilizers, bio-pesticides etc.) and discourages the use of chemical agro-inputs, for maintaining soil productivity and fertility and pest management under conditions of sustainable natural resources and healthy environment.

Biofertilizers and green manures are important pillars of organic farming that support higher yield and maintain soil health. Biofertilizers is a very cost-effective solution for providing nutrients to crops in a sustainable manner, unlike chemical fertilizers which are costly and need repeated application. Similarly, green manuring utilizes lean period between two main crops and improve soil fertility by providing fixed nitrogen and improving organic matter of the soil.

Biofertilizers

Biofertilizers are products of beneficial microorganisms which increase agricultural production by way of nutrient supply especially nitrogen and phosphorus. Biofertilizers can fix atmospheric nitrogen for plant use and can mobilize unavailable phosphorous pool which can be used by plants. These biofertilizers are inexpensive, simple to use and have no problem of environmental pollution. Use of biofertilizers not only help in sustaining productivity and soil health but also in reducing subsidy burden on the government by reducing the consumption of chemical fertilizers.

Types of Biofertilizers

The concept of microbial inoculation started with legume *Rhizobium* inoculant first patented by Nobe and Hiltner in 1896. In developed countries like USA, UK, France, Australia, biofertilization is restricted to *Rhizobium*, whereas in Brazil, China and India it has been diversified and a large number of bacteria, fungi and actinomycetes have been included in this group. Biofertilizers have been broadly classified as nitrogen biofertilizers, phosphate biofertilizers and plant growth promoting biofertilizers which also includes potassium solubilizing microorganisms (Figure 1).

Nitrogen-fixing Biofertilizers:

Only a few prokaryotic microorganisms fix nitrogen directly through a biological process. The organisms that fix atmospheric nitrogen are broadly grouped as symbiotic and non-symbiotic or free-living organisms. The symbiotic nitrogen fixers undertake the fixation in the association of plants whereas non-symbiotic organisms do not require any association.

Rhizobia

Rhizobium inoculants establish a symbiotic association with pulses, leguminous oil-seed and fodder crops. Many species of family Rhizobiaceae like *Rhizobium, Mesorhizobium, Bradyrhizobium*, *Sinorhizobium* and *Azorhizobium* are known to fix N in different crops.

Azotobacter

Azotobacter is free-living nitrogen fixing bacteria and unlike Rhizobia do not require any living host to fix N. *Azotobacter chroococcum* is the most abundant species of genus Azotobacter.

Azospirillum

It is also a non-symbiotic, most abundantly found in association with the roots of millets and grasses. *Azospirillum brasilense, A. lipoferum, A. amazonense, A. halopraeferens* and *A. irakense* are most commonly used species of this genus for inoculation.

Blue Green Algae (BGA)

BGA belong to a class of prokaryotic photosynthetic microorganisms also known, as cyanobacteria are capable of fixing atmospheric nitrogen aerobically in rice fields. Most commonly found blue-green algae in Indian rice fields are *Anabaena, Nostoc, Cylindrospermum, Calothrix, Scytonema, Tolypothrix*, etc.

Phosphate, Potassium and Zinc solubilizing microorganisms

Phosphorus and Potash, both native in soil and applied as inorganic fertilizers become mostly unavailable to crops because of its low level of solubility and immobilization in the soil. A large number of autotrophic and heterotrophic soil microorganisms have the capacity to solubilize/ mobilize minerals of P and K.Similarly, Zinc is also present in soil but in an unavailable form. These microorganisms are known to dissolve P, K and Zn by the production of an organic acid.

The research on KMB and ZSB is at an early stage and only a few KMB formulations are available in the market all over the world.

Arbuscular Mycorrhizae (AM)

AM which was earlier known as VAM (Vesicular Arbuscular Mycorrhizae) is an obligate symbiont and are known to improve plant growth due to the improved mobilization of phosphorus and micronutrients such as zinc and copper and also increases absorption of water.

Plant Growth Promoting Rhizobacteria (PGPR)

PGPR is a group of beneficial bacteria that improve plant growth by the production of plant hormones, such as auxins, gibberellins and cytokinins, or by providing biologically fixed nitrogen. These PGPR also suppress the bacterial, fungal and nematode pathogens by the production of siderophores, HCN, ammonia, antibiotics, volatile metabolites, etc.

Azolla

Azolla is a free-floating water fern which in symbiotic association with *Anabaena azollae* contributes 40-60 kg N per hectare per crop. The important factor in using *Azolla* as a biofertilizer for paddy is its quick decomposition in soil and efficient availability of its nitrogen to the crop.Its application improves soil physicochemical properties apart from fertilizer use efficiency.

Biofertilizers can also be classified into two different categories based on the type of formulation

Carrier-based formulations:

For bacterial biofertilizers, the carrier may be peat, lignite, peatsoil, humus, talc. For mycorrhizal inoculants, the base material may be fine powder/ tablets/granules/root biomass mixed with the growing substrate. For the application of carrier-based formulation, the seed has to be treated with some sticky liquid like jaggery solution.

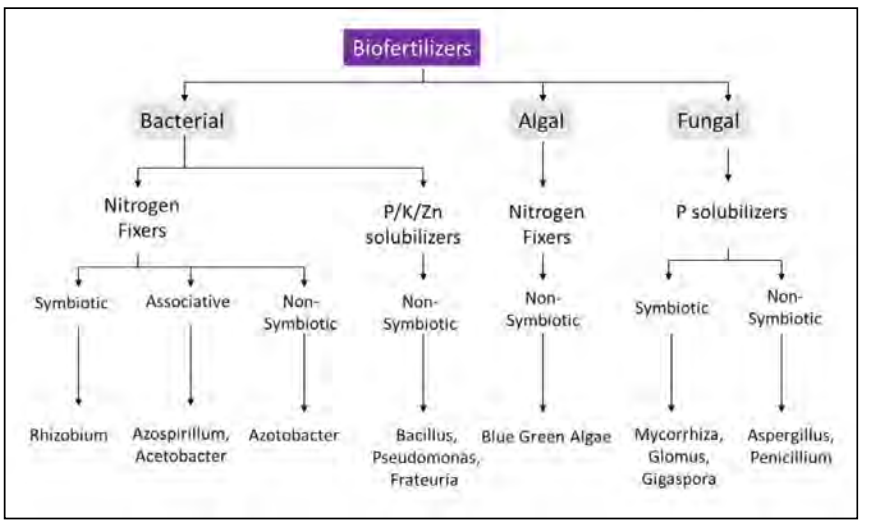

Fig.1 Classification of biofertilizers

Liquid formulations:

Liquid formulations are available for all bacterial biofertilizers. Liquid formulations are prepared by mixing bacteria with additives, stabilizers and nutrient solution that support bacterial population for a longer period. The main advantages of liquid formulations are (a) they are easy to apply as they can be directly applied to seed (b) they can be stored for a longer period (c) they require smaller space for storage compared to carrier-based formulations.

Some biofertilizers are crop specific like *Rhizobium, Acetobacter* and Blue-green algae while others can be used for all crops (Table 1)

Benefits of applications of different biofertilizers

Biofertilizers help in different ways to increase the crop yields some of which are:

1. Biofertilizers provide various nutrients to plants like N, P, K, etc. either by fixing the elemental form (N) or by solubilizing the unavailable nutrients like P, K and Zinc. VAM (AM) fungi benefit plants by mobilizing the nutrients from a larger root area. Azolla not only fixes N but also add organic matter to the soil.
2. Biofertilizers not only provide nutrients to plants but also protect plants from plant diseases as they secrete many antibiotic compounds which suppress the growth of disease-causing pathogens.

Fig. 2. Liquid biofertilizer formulations

3. Besides providing nutrients and suppressing diseases, biofertilizers also secrete some plant growth promoting hormones like auxins and gibberellic acid which makes plant healthy.
4. Many biofertilizers like VAM and PGPR also help plants in avoiding water stress by secreting some polysaccharide which helps in soil aggregation and conserving moisture for longer times.
5. Once the biofertilizers are established in the field after 2-3 years of continuous application, the dose of biofertilizers may be reduced

The average increase in yield of some common crops with anticipated benefits in terms of nutrients supplied is provided in Table 2.

Availability of inoculants: *Rhizobium, Azotobacter, Azospirillum* and PSB inoculants of popular brands of various companies and

Table 1.Major biofertilizers and target crops

Biofertiliser	Target crop
Nitrogen Fixing Biofertilizers	
Rhizobium	Pulses
Azotobacter	Wheat, maize, cotton, mustard and vegetables (Potato, onion, tomato, brinjal and others)
Azospirillum	Cereal crops like wheat, maize, millets, sorghum, barley; and sugarcane.
Acetobacter	Sugarcane
Blue green algae (BGA), Azolla	Rice
PGPR and Phosphate/Potassium/Zinc solubilizing microorganisms	All
Arbuscular mycorrhiza	Field crops, nursery-raised crops and orchard trees

Table 2.Crop response to biofertilizers

Biofertilizer	Anticipated benefits	Average increase in crop yields
Rhizobium	20-60 kg N	15-40%
Azotobacter	15-20 kg N	10-30%
Azospirillum	20 kg N	15-30%
BGA	25-30 kg N	10-20%
Azolla	3kg/t	10-20%
PSB	25 kg P_2O_5	10-20%
VAM	Availability of P, Zn, Fe etc.	10-20%

corporations (IFFCO, NFL, Kribhco) are generally available on their agency shops, seed, pesticide and fertilizer retail shops in the market. All State Agriculture Departments, research institutes like IARI, NCOF and agricultural universities also make them available during the season. Many private companies are also coming up in the production of biofertilizers, especially liquid inoculants.

Method of application of Biofertilizers:

The success of any biofertilizer organism depends on how close the organism is applied to seed, seedling or other planting material. Nearer the organism and planting material, the results in all probability would be positive. Seed application with bacterial inoculant is the most common practice of inoculation. Seeds should be sown as soon as possible after treating with cultures or inoculants to take the full benefit of the same.

Quality control of Biofertilizers in India

For effective management of Quality Control Regime, many important biofertilizers (*Rhizobium, Azotobacter, Azospirillum,* KMB, ZSB, and PSB) have been included under "The Fertilizer (Control) Order 1985" since March 2006 and standards have been set by the government to ensure the quality of these bio-fertilizers. Earlier under the Bureau of Indian Standards (BIS) product certification marks scheme licenses were granted to manufacturers for affixing BIS Mark on their products conforming to Indian Standards. Expiry period of 6 months for carrier-based formulations and 12 months for liquid formulations has been set under FCO.

Constraints

Biofertilizers are the most important source of nutrients in organic farming but farmers are not able to practice crop inoculation due to various reasons. Some of the difficulties faced by the government and extension agencies in popularizing the biofertilizers especially for organic farming are

1. The foremost constraint in the popularization of biofertilizers in the country is the timely supply of cultures in remote corners of the country where organic agriculture is practiced.
2. Lack of knowledge of the farmers about these biofertilizers and proper measures taken by the extension departments in demonstrating the benefits of inoculants to farmers.
3. Though mechanisms exist under Fertilizer Control Order (FCO 1985) to looks after the

Fig. 3.Green manuring practice (sunnhemp) for soil fertility improvement

quality control of biofertilizers, the persons involved in the quality control are not versed with the proper tools and techniques of handling biofertilizer samples.

Green Manuring:

Green manuring–a practice of ancient origin- can be defined as a practice of ploughing or turning into the soil undecomposed green plant tissues grown *in-situ* or cut and brought in for incorporation for the purpose of improving physical structure as well as the fertility of the soil. In another way, green manuring is the practice of growing lush plants on the site into which you want to incorporate organic matter, then turning into the soil while it is still fresh (Fig. 3). The plant material used in this way is called green manure. Green manuring is usually done in the lean period available between the two main crops. However, it can be practiced in between crop rows also *eg. in-situ* green manuring of Sunnhemp/ Sesbaniain between maize rows (Fig. 4).

Fig. 4.In-situ green manuring practice (sunnhemp) for soil erosion control

Kind of green manuring:

Green manuring can be broadly divided into two classes based on the basis of the cultivation method.

1. ***In-situ* green manuring:** Green manure crops are grown in the desired field and buried in the same field for green manuring. An ideal *in-situ* green manure crop should be fast growing with minimum nutrient and water requirements. Nitrogen-fixing legumes which produce heavy tender growth early in its life cycle are most

Table 3. Common legume crops for in-situ green manuring

S. No.	Common Name	Botanical Name	Growing Season
1.	Dhaincha	*Sesbania aculeata*	Zaid/Kharif
		Sesbania rostrata	Zaid/Kharif
2.	Sunhemp	*Crotalaria juncea*	Zaid/Kharif
3.	Mung	*Vigna radiata*	Zaid/Kharif
4.	Cowpea	*Vigna unguiculata*	Kharif
5.	Guar	*Cyamopsis tetragonoloba*	Kharif
6.	Senji	*Melilotus alba*	Rabi
7.	Berseem	*Trifolium alexandrium*	Rabi
8.	Khesari	*Lathyrus sativus*	Rabi

suitable for green manuring. The species commonly used for green manuring are given in Table 3.

Green leaf manuring:

In green leaf manuring, leaves and tender green twigs are grown in separate fields, bunds or wastelands and incorporated in the soil of some other field. The species commonly used for green leaf manuring are given in Table 4.

Table 4. Common shrubs/trees used for green leaf manuring

S. No	Common name	Botanical name
1.	Subabool	*Leucaena leucocephala*
2.	Glyricidia	*Glyricidia maculeata*
3.	Wild dhaincha	*Sesbania speciosa*
4.	Karanj	*Pongamia glabra*

Time of sowing of the green manure crop

Normally the green manure crops are sown in between the main crops. In north India, Dhaincha is sown as green manure crop after wheat harvesting and buried in soil one month prior to rice transplanting. Some farmer also takes pulse crop in between wheat harvesting and rice transplantation and bury the legume crop like moong as green manure. In some parts, green manure crops are grown immediately after the monsoon rains. No special soil preparation required for the sowing of green manure crops and the seed of the green manure crop is broadcasted preferably with higher seed rate followed by tillage. Majority of the green manure crops are buried deep in the soil after 6 to 8 weeks (flowering stage) after sowing. In principle, the green manure crop should be buried in soil at least 15-20 days prior to sowing/transplanting of next crop so that the crop is properly degraded before sowing of next crop to avoid nutrient immobilization during the degradation process.

Advantages of the Green manuring:

Following are some of the advantages of the green manuring-

1. Following degradation, it adds organic matter to the soil which helps in maintaining the activity of the beneficial soil microorganisms.
2. The green manuring crops improve the physical structure of the soil by increasing humus and organic matter content of the soil. Increase in organic matter also improves the water holding capacity of soil thus reducing the run-off and soil erosion.
3. Leguminous green manuring crops like dhaincha, add nitrogen to the soil for the succeeding crop besides increasing the availability of nutrients like phosphorus, potassium, calcium, magnesium and iron.

Disadvantages of the green manuring under organic farming:

Following are some of the disadvantages of green manuring-

1. If not properly decomposed, the green manure crop may hamper the germination and growth of subsequent crops by immobilization of plant nutrients. Decomposition is not proper especially under rainfed conditions in the absence of good rainfall.
2. An increase of diseases, insects and nematodes is possible if the green manure crop is not properly decomposed before sowing of next crop.

Conclusion:

Biofertilizers and green manuring are important sources of nutrients and organic matter respectively for sustaining the crop yields, especially under organic farming practice. Though both biofertilizers and green manuring are old and established technologies many farmers are not aware of the benefits of these technologies. Extension workers should train more farmers about the proper use of biofertilizers for maximum benefits. Timely availability of quality biofertilizers and green manure crop seeds can help in meeting the demands of organic producers especially in distant areas.

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CHANGING SCENARIO OF ORGANIC FARMING

Suraj Prakash Ghulati

Organic Farming is based on the traditional system of Indian agriculture. Organic Farming sustains/enhances the health of soil, plant, animal, and humans. It is based on using ecological systems and cycles and helps sustain them. It protects health and well-being of present and future generations, and the environment. World scenario for organic farming is very robust. India has the maximum number of Organic Farmers. A paradigm shift is required in our approach to organic farming.

The FAO's Codex Alimentarius Commission (June 1999) states: "Organic Agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity."

Organic Farming is basically farming without the use of chemicals.

Traditional System

Organic Farming is based on the traditional system of Indian Agriculture. Hundreds of manuscripts since ancient times have been written on or contain chapters on Organic Farming.

To illustrate:

Rig Veda(7000 Bc); Arthshastra (After 326 Bc); Birhat Samhita (6th Century); Vrikash Auyurveda(6th Century) Sarngadhara Paddhati (13th Century); Babarnama (15th Century); Jahangir's Memoirs(16th Century); Dara Shikoh's Book on Agriculture(17th Century).

These manuscripts cover the entire gamut of agriculture including prediction and measurement of rainfall; soil improvement; Non-chemical fertilizers and pest control, seeds preservation, growth promotion of plants, better farming implements, etc.

Why Organic Farming?

Organic Farming is basically farming without the use of chemicals. In India- after Power-Agriculture (19%) is the second highest emitter of greenhouse gases.

A. Organic Farming is totally environmental friendly:

Karp et al (1995) reviewed 24 case studies indicating the types of environmental damage seen as a result of conventional agriculture

activity in developing countries. These include soil erosion, sediment damage, floods, over irrigation, agrochemical damage, soil compaction, deforestation, wetlands drainage, and air pollution.

The environmental costs of conventional agriculture are substantial, and the evidence for significant environmental amelioration via conversion to organic agriculture is overwhelming. A review of over 300 published reports showed that out of 18 environmental impacts, organic farming systems performed significantly better in 12 and performed worse in none (Romesh et al., 2005).

B. Organic Farming reduces the carbon emission by 40 to 60 percent compared to farming with chemical fertilizers and pesticides:

Farm comparisons in Europe have shown nitrate-leaching rates on organic farms are 40-57 lower per hectare and carbon dioxide emissions are 40-60 percent lower per hectare than conventional systems.

(Source: "Environmental and resource use impacts or Organic Farming on Europe," by Stolze, Piorr, Haring and Dabbert, 2000.)

In addition, organic systems showed significant ability to absorb and retain carbon, raising the possibility that agricultural practices might play a role in reducing the impact of global warming.

(Source: The Rodale Institute Farming Systems Trial. The first 15 years, by Cass Peterson, Laurie E. Drink water, and Peggy Wagoner, the Rodale Institute 1999.)

In order to grow 1 kg of rice, we leave a carbon footprint of 902 gram (due to the swamp effect of methane emission from standing water). The technological inputs of SRI reduce this substantially if not completely eliminate the requirement of standing water.

(Source: Climate Change Vulnerability & Adaption Experiences from Rajasthan & Andhra Pradesh-SRI The system of Rice Intensification Case Study India Swiss Agency for Development and Cooperation SDC-2009)

C. Organic Farming does not pollute the environment with chemicals hence it preserves the biodiversity of animal, plant, insects and micro-organism species:

Organic agriculture maintains diversity in wildlife habitats. Studies made by Ingrisch, Wasner and Gluck (1989); ZSwingel (1987); Frieban (1988); Ries (1998) Plakolm (1989); Elsen (1989), etc. have shown that there are an abundance and diversity of wildlife in organic farms compared to conventional ones.

"Organic fields accommodate a greater variety of plants, animals and microorganisms."

(Source: FiBL Dossier: Organic Farming enhances soil fertility and biodiversity, August 2000.)

Adoption of organic farming improved the soil ecology and environment in Andhra Pradesh as under:

"Villages are also seeing an increase in sustainable soil and water management practices that benefit the entire community." It adds, "Further, Farmer-friendly insects and birds are coming back to the field as they are no longer targeted by broad-spectrum pesticides."

(Source: The World Bank 2009 Learning Note on "Ecologically Sound, Economically Sound. Community Managed Sustainable Agricultural in India" by T Vijay Kumar, Madhavi Pillai et al.)

D. Conserves water and enhances moisture retention in fields:

According to a report documenting 15 years of finding from

The Rodale Institute's long-term Farming System Trial:-

1. "Organically managed soils achieve better physical structure. Soils in the organic system gradually became looser and more porous, and absorbed and held water better than conventionally managed soils."
2. "Water is able to percolate into the organically managed soils at a faster rate. During rainstorms, more water will be absorbed into the soil and less will run over the surface and out of the field."

(Source: The Rodale Institute Farming Systems Trial the First 15 Years by Cass Petersen, Laurie E. Drinkwater and Peggy Wagoner, the Rodale Institute 1999.)

E. Organic Farming ensures sustainable soil health and reduces soil erosion:

Organic Farming enhances soil fertility and biodiversity. According to the 16-page field trial report:-

1. "Fertilization in organic systems has a positive effect on the content of organic matter and helps to avoid soil acidification. Organic soil management improves soil structure by increasing soil activity, thus reducing the risk of erosion."
2. "Organic soil management improves soil structure by increasing soil activity, thus reducing the risk of erosion."
3. "Organic Management promotes the development of earthworms and above ground anthropods, thus improving the growth conditions of the crop. More abundant predators help to control harmful organisms (Pests)."
4. "Organic crops profit from root symbioses and are better above to exploit the soil."
5. "Organic fields accommodate a greater variety of plants, animals, and microorganisms."

(Source: FiBL Dossier: Organic Farming enhances soil fertility and bio-diversity, August 2000.)

F. Organic Farming reduces the use of non-renewable energy:

1. Organic Farming requires lesser number of ploughing and as such, it saves non-renewable energy.
2. Organically grown crops use less fossil energy than conventional crops, according to findings from a 21 – year field trial initiated by the Research Institute of Organic Agriculture (FiBL) in Switzerland. Begun in 1978 in Therwil, Switzerland, the DOK trial compares the consequences of organic, biodynamic and conventional farming systems in a randomized pilot trial.

(Source: FiBL Dossier: Organic Farming enhances soil fertility and bio-diversity, August 2000.)

Thus Organic Farming is vital for the nation's future strategy to reduce its Carbon Footprints.

G. Organic Farming is a healthier option:

Organic Farming is the healthiest option in the food chain:

A review made by Heaton (2001) indicated that in 43% cases, organic food was having higher nutrients, in 45% cases equal and in 11% cases lower

nutrients comparatively higher polyphenol and vitamin C content in the organically grown tea and potato respectively.

The World Bank 2009 Learning Note on "Ecologically Sound, Economically Sound. Community Managed Sustainable Agricultural in India" by T. Vijay Kumar, Madhavi Pillai et al. states about positive impacts on health, "Farmers report a noticeable drop in pesticide-related health problems. Women who have traditionally performed the task of spraying the crops and suffered numerous health problems due to the resultant high exposure to pesticide are now strong advocates of the NPM/CMSA movement. A quick survey of three districts has shown that the number of cases of hospitalization due to pesticide poisoning has reduced from 242 cases per year before the adoption of NPM to 146 cases per year, a 40 per cent drop.

Farmers who have adopted non-pesticide management agriculture have been totally free of pesticide-related hospitalization"

According to an international report from Journal of Applied Nutrition, 1993, the organically grown food averaged 63% higher in calcium, 78% higher in chromium, 73% higher in iron, 118% higher in magnesium, 178% higher in molybdenum, 91% higher in phosphorous, 125% higher in potassium and 60% higher in zinc. The organically raised food averaged 29% lower in mercury then chemically grown food. This will help reduce malnutrition among women and children.

H. Organic products taste better:

According to Yadav (2010), flavoring ingredients, oils and other taste giving components have been found to be higher in organic products. As per the report, high yields achieved today in some fruit and vegetable crops with higher chemical fertilizers and other inputs under conventional farming have likely come at the expense of crop nutritional and organoleptic quality (Theuer, 2006).

I. Climatic Changes Risk Management:

Organic Agriculture is better able to withstand drought and flood conditions. Plants are healthier. The soil porosity increases and it is better able to retain moisture. It has been found in Andhra Pradesh that organically produced plants are able to withstand better the adverse climatic effect of drought and excessive rainfall.

(Source: The World Bank 2009 Learning note on "Ecologically Sound, Economically Sound. Community Managed Sustainable Agricultural in India" by T. Vijay Kumar, Madhavi Pillai et al.)

J. Increased Livelihood:

The Andhra Pradesh experiment points out, "village communities have begun to benefit from jobs and enterprises catering to inputs for sustainable agriculture and by providing services like quality control and procurement of CMSA produce.

At least 2000 jobs have been created in villages through the establishment of shops for supply of bio-pesticides and organic nutrients, seed banks and agricultural implements hiring centers. In addition, about 5400 small and marginal farmers are generating. Additional income through the operation of vermicomposting units."

(Source: The World Bank 2009 Learning Note on "Ecologically Sound, Economically Sound. Community Managed Sustainable Agricultural in India" by T. Vijay Kumar, Madhavi Pillai et al.)

World Scenario:

Organic Agriculture is one the fastest growing agribusiness sectors in the world, our export items are rice, wheat, tea, spices, coffee, pulses, fruits and vegetables, cashew nuts, oilseeds, cotton, and medicinal herbs.

In 2017 there were three million organic producers worldwide. India had the highest number of producers (835,200), followed by Uganda (210352) and Mexico (210,000), This is a 20 percent increase over the previous year.

A total of 69.8 million hectares of land worldwide was organically managed. This was an unprecedented increase of 20% or 11.7 million hectares over 2016. Australia leads (35.6 million hectares) followed by Argentina (3.4 million hectares) and China (3 million hectares). Now Oceania (35.9 million hectares) leads nearly half with Europe second largest 21 percent (14.6 million hectares).

In fourteen countries over 10 percent of the land is now organic while globally 1.4 percent of the land is organic, the share ranges from Lichestentien (37.9 percent) to nil in some countries. In fourteen countries over ten percent of the land is organic.

India has the largest number of organic producers (835,000) certified. This is 30 percent of the total production worldwide, area wise.

However India is only 2.59 percent, 1.5 million hectares of the total area of 57.8 million hectares, China has around 50 percent of the total organic cultivable land in Asia and India 30 percent.

Tech Sci Research reports that the Global Organic Market in 2016 was $110.25 trillion and anticipated to develop at a CAGR of 16.5 % through 2017-2022 to reach $262.85 trillion by 2022. Thus there is tremendous scope for India to increase its organic produce for fruits in the export market.

According to APEDA, India produced around 1.35 million tonnes(mt) of certified organic products in 2015-16, out of this we exported 263,687 tonnes worth 218 million dollars, this increased to 515 million dollars worth in 2017-18.

Further, it is estimated that the overall market of 4000 crores would reach 10000-12000 crores by 2020.

Organic products are mainly exported to the following countries-(in order of market)

1. Europe: Netherlands, United Kingdom, Germany, Belgium, Sweden, Switzerland
2. France, Italy, Spain;
3. Americas: USA, Canada;
4. Middle East: Saudi Arabia, UAE;
5. Asia: Japan, Singapore;
6. Australia;
7. Africa: South Africa

Oilseeds are 500 percent of India's export followed by processed food products at 25 percent.

Status of organic agriculture in India:

India has a unique climate, ranging from the frozen areas to the hot climate of the equatorial region. This ensures that a large number of agri produce like tea, coffee, spices, vegetables and fruits are available throughout the year, wheat and rice is grown twice a year and cotton once. All these have huge export and domestic potential for organic produce.

Domestic Market:

The domestic market is organized by producers, aggregators, wholesalers/traders, Special farmer markets and supermarkets, restaurants and hotels.

The metro cities and all 'B' class cities have potential clients, even in small towns, all are becoming more aware of the benefit of organic produce.

The growing affluence of the middle class in the country has given a big impetus to the demand for Organic produce. Earlier only the rich were interested. Now the middle class is well aware of organic produce and want the best for their children and themselves.

Changing role of organic agriculture in the rural economy – a Paradigm shift

Out of the 145727 crore farmer holdings in India, the marginal (less than 1 hectare) holdings are 99885 with average size 0.38 hectares and the small (1.0 to 2.0 hectare) are 25777 crore with average size 1.41 hectares.

These two comprise a total of 76.21 percent of the total holding.

(Source: Agriculture census 2015-16 (Phase -1) Department of Agriculture Cooperation & Farmers Welfare.)

These holdings are primarily in rainfed areas, these farmers are the most distressed section of the farming community yet they together produce over 40% of our agri production. The climatic changes affect them the most and they also cannot afford

the costly chemical inputs of hybrid seeds, chemical fertilizers, and pesticides.

What these farmers require is some technology which reduces their cost, increases production and is locally available. This is where organic farming can come to their rescue. The basic protocol of organic farming developed in the country envisages the use of easily available botanical and organic inputs. In fact this protocol developed by us makes use of in farm available inputs and thus easily available.

These farmers basically follow the tribal and rural technology and all that they require is the knowledge and training in additional inputs like soil preparation with Amrit Paani and compost, vermicompost, growth promotion and pest control with Panchgavya mixture as foliar sprays with botanical material available in the farm.

About 100,000 farmers in Nalanda district of Bihar were trained in System of Rice Intensification (SRI) and System of Crop Intensification (SCI) in 2008. After one year the average increase in overall yield was 86%. However, a few educated young farmers started innovating with traditional methods of nitrogen-fixing, green manuring, crop rotation, etc, and broke national records in rice, wheat, potato, and onion. By 2011, they were close to a world record and in 2012 they set a new world record in each. This extraordinary achievement became world news compelling former World Bank President and Nobel laureate Joseph Steiglitz to visit Nalanda in January 2013. Table 1 gives a summary.

Table 1 Comparative yield in four main crops (MT/Ha) (2012)

Crop	China	India	USA	NALANDA FARMERS
Rice (dry)	6.69	3.53	7.92	19.5
Wheat	4.84	2.99	2.94	15.5
Potato	16.28	22.72	42.17	109.0
Onion	21.69	16.1	56.2	70.0

Thus, some farmers in Nalanda achieved over five times yield increase in rice, wheat, potato and onion as compared to average Indian yield and at least three times more than the best China has achieved. The seeds were non- GMO, hybrids from foreign and local firms. A French company ECOCERT certified that the produce was organic. Seven years ago these farmers were struggling to survive.

SRI (System of Rice Intensification)

Under this system, the requirement of seed is only one-eighth(1/8) and the requirement of water is reduced to twenty percent.

No standing water is required. This eliminates the swamp effect of rice cultivation and consequent methane gas emissions. The yield is also increased by 96% in Uttarakhand as per The System of Rice Intensification Case Study, India Swiss Agency for Development and Cooperation SDC-2009.

Farmers in Bihar, Tripura, Tamil Nadu, Jharkhand, Chattisgarh, West Bengal, Orissa & Kerala are now extensively adopting this technology with very beneficial results including an increase in production.

In Andhra Pradesh, the government has introduced and trained the farmers in this system of rice cultivation in all the districts of the states with excellent result.

Our small & marginal farmers can easily achieve a 50 percent increase in production (if not more) if they are imparted the knowhow.

The beneficial effect of SRI methods have been documented in 46 countries worldwide and validated in 35 countries.

The future of Organic Farming in India is not only the certified niche market for domestic and export market but mass production of organic agriculture as the norm, with its huge impact on malnutrition, health, production and upsurge in the rural economy.

We have the technology and the farmers to adopt it. What is required is a paradigm shift in our approach and understanding of what organic farming can do to change the agricultural scenario of India – not only the farmers in the hill areas and the north east but also the small and marginal farmers of the rest of the country. What a positive difference it will make in the GDP of the rural areas.

The need of the hour is a Mission Mode on Organic Farming to be achieved within a limited time frame.

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TECHNOLOGICAL INNOVATIONS IN ORGANIC FARMING

Dr. Y.S. Shivay, Dr. Dinesh Kumar

Organic farming seems to be a viable alternative because it enlivens the soil, strengthens the natural resource base and sustains biological production at different levels. The export market can also be tapped by the prospective farmers by growing organic crops. If organic agriculture is given the consideration on its merits, it has the potential to transform agriculture as the main tool for nature conservation.

During the past several decades, agricultural development mainly focused on short-term gains in productivity and profitability, which has caused severe damage to soil fertility, health, and environment. These changes prompted us for a change in farming practices. Organic farming of selected commodities appears to be an excellent alternative in certain farming situations. There is sound evidence that productivity of organic systems can be brought to the level of conventional systems or even higher by adopting proper package of practices like adoption of proper crop rotations which include legumes, diversified nutrient management practices, efficient soil and water management practices, proper weed management and effective control of insect pests and diseases through available tools and approaches.

The concept of organic farming is not new in India as it has existed here before the introduction of modern methods of farming. It is actually based on the minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. The International Federation of Organic Agriculture Movements (IFOAM) has defined it as *a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.*

Organic farming helps in improvement of crop quality and reduces environmental pollution. It brightens the prospects of export of organic food items. Organic farming has demonstrated its ability not only to produce safer commodities for consumers but also to produce biodiversity at all levels. The organically produced food items are better in quality aspects as compared to that produced by synthetic chemicals. They are good in taste, flavour, essential nutrients, etc. and at the same time, they are free from harmful or toxic chemicals. Organic farming seems to be a viable alternative because it enlivens the soil, strengthens the natural resource base and sustains biological production at different levels. The export market can also be tapped by the prospective farmers by growing organic crops. If organic agriculture is given the consideration on its merits, it has the potential to transform agriculture as the main tool for nature conservation.

New Technological Innovations for Organic Cultivation

A good organic farm mimics the biodiversity of nature through practices like intercropping, companion planting, the establishment of beneficial habitats, crop rotation, etc. Farms with a diverse mix of crops have a better chance of supporting beneficial organisms that assist in pollination and pest management. Furthermore, organic cultivation should also encourage diversity among enterprises. Good organic operations integrate the various enterprises of which they are comprised like crop husbandry, dairy, poultry, fishery, piggery, sericulture, etc. The enterprise diversification helps in achieving sustainability in production, especially by minimizing the risks involved in conventional farming. Crop rotations, green manures, animal manures, composting, natural fertilizers (e.g. greens and gypsum, rock phosphate, etc.) and bio-fertilizers are practical ways to supply plant nutrients under organic crops. In organic crops, the pest breaks are relatively rare and short-lived due to the presence of natural predators, parasites, and disease agents that quickly reduce the pest numbers to a moderate level.

Crop rotations

The organic crop rotation followed should be remunerative and sustainable. The Network Project on Organic Farming of ICAR have identified the following important cropping systems, which were found economically better or at par with conventional systems at different experimental stations in the country:

- Soybean–Berseem/ Mustard/ chickpea at Raipur, Chhattisgarh
- Tomato/ Cabbage–cauliflower–pea and maize–garlic at Bajaura, Himachal Pradesh
- Rice-wheat/ potato/ mustard/ lentil at Ranchi, Jharkhand
- Groundnut–rabi sorghum, soybean–durum wheat, potato–chickpea, chili + cotton and maize–chickpea at Dharwad, Karnataka
- Soybean–durum wheat/ mustard/ chickpea/ isabgol at Bhopal, M.P.
- Rice–durum wheat/ berseem, rice–potato–okra and rice–garlic, sorghum–berseem, maize–berseem–maize + cowpea and sorghum + cluster bean–oats–cowpea at Ludhiana, Punjab
- Maize–cotton, chilies–onion and brinjal–sunflower at Coimbatore
- Sorghum–pea–okra at Modipuram, Uttar Pradesh

Nutrient Management

The inclusion of legumes in crop rotations:

The benefits of good crop rotation are increased organic matter, nitrogen supply and improved structure of the soil. These effects are observed especially with deep-rooted legumes or crops capable of bringing plant nutrients from the lower layers of soil and leaving them as crop residues in the upper layers. Nutrients so fetched can be utilized by shallow-rooted crops. Deep-rooted crops also contribute to increased permeability of soil at lower depth to air and water. The other benefits of crop rotations are keeping the soil under crop cover for most of the year, control of run-off, soil erosion and efficient use of fertilizers.

Practices like planned crop rotations, green manuring, composting, intercropping, companion cropping, mulching, etc. are commonly followed on organic farms due to their benefits on soil health. Supplemented fertilization through chemicals like powdered rock phosphate, green sand, gypsum, dolomite, etc. can be followed to supply plant nutrients. Crop rotations to optimize nitrogen fixation, efficient management of crop residues and exploration of the soil by developing rooting systems and management methods that limit nutrient losses is an efficient approach that improves soil fertility and crop production.

The inclusion of legumes has been found beneficial in almost all cropping systems across the globe. Extensive research has been conducted to evolve methodologies to measure nitrogen fixation in annual, forage and tree legume species and exploit these benefits in cropping/farming systems. Including legumes into various cropping systems can lower the demand for nutrients for associated as well as the succeeding crops. However, more research is needed to obtain quantitative information on the effects of grain legumes on nitrogen economies of the organic cropping system.

Crop residues

In recent years with the development of rice-wheat cropping system and mechanization of agriculture, rice, and wheat straw, especially, the rice straw has become surplus and is mostly burned

on the field. Research is on and the data have been generated which show that incorporation of rice and/or wheat straw may or may not increase the crop yield but it does improve soil fertility. Addition of crop residues into the soil also enhances biological activities in soil. Thus, in the long–run crop residue helps in giving sustained production and improves soil fertility.

Green Manuring

The practice of green manuring for improving soil fertility and supplying a part of the nutrient requirement of a crop is age-old. Depending on the crop grown the N contribution by green manure crops varies from 60–280 kg/ha. Leguminous green manures can fix large quantities of atmospheric N_2 which generally can accumulate about 100 kg N/ha in 50–55 days but can reach up to more than 200 kg N/ha. The problem with green manure crops is that they compete with cash crops for space, time, water and other inputs.

Bulky organic manures

Manures like farmyard manure, composts, vermicomposts, green manures, and press mud, etc. containing a small proportion of plant nutrients and a greater proportion of organic matter are considered as bulky organic manures. Before the introduction of high-yielding varieties (HYVs) of crops, organic manures were the main nutrient sources in Indian agriculture. The use of organic manures not only provides plant nutrients but also improves soil physical, chemical, and biological properties. Although the cattle population has increased in recent years, the availability of organic manures has not increased substantially in the country. Alternative use of cattle dung as fuel is the major constraint in increasing availability of organic manures in India. The plant nutrient supply from the use of organic manures can be increased by developing biogas plants and agro-forestry for providing alternative sources of fuel to the villagers, the addition of crop residues, recycling of city and urban wastes and adding nutrient value through proper composting.

Biofertilizers

Biofertilizers are low-cost agricultural inputs, which are environment-friendly and used as seed and soil inoculation. Some biofertilizers fix atmospheric Nitrogen and while others increase the availability and uptake of nutrients. The biofertilizers increase crop yields tremendously.

Weed management

Weeds compete with the main crop for water, nutrients, air and light. They remove a lot of nutrients from the soil. They are also alternate host plants for different insect pests and disease-causing microorganisms. Therefore, weed control is very essential to maintain soil fertility and soil productivity in organic systems. Chemical herbicides are not permitted in organic farming. Therefore, cultural methods such as tillage combined with irrigation timings, seeding rates and cultivate selection, use of weed-free seeds, cropping systems, use of animals, flooding, mulching, composting, hoeing, hand weeding, farmers' care, and straw disposal, etc. can be adapted to manage weeds. A number of fungal and bacterial pathogens parasitizing different weeds can be utilized for the purpose. Two mycoherbicides have been registered in the USA for commercial use for weed control. One of soil-borne fungus is *Phytophthora palmivora* against strangler vine *(Morrenella odorata)* and the other formulation is of *Collectotrichum gloeosproides* against selective control of northern jointvich *(Aeschynomene viriginalaca).* Organic manures such as FYM or composts, if used, should not have any viable weed seeds.

Insect-pests and disease management

Biological control is often considered a default benefit of the soil fertility practices of organic farming. Sanitation can take on many forms such as deep ploughing of crop residues, destruction of nearby weed habitats, cleaning of accumulated weed seeds from the farm implements, sterilizing pruning tools, etc. The pesticides permitted in organic farming fall predominantly in several classes viz. Botanicals (rotenone, neem, pyrethrum, etc.), biologicals (*Bacillus thuringiensis*), pheromones, and minerals (clay based materials like *surround*), etc. *Scialabba (1998) have suggested the following practices to control the insect-pests in organic farming:*

- Manipulation of crop rotations, to minimize survival of crop-specific pests (in the form of, for example, insect eggs, fungi) which can infect the next crop
- Strip cropping, to moderate spreading of pests over large areas
- Manipulation of pH-level or moisture level of the soil (in irrigated areas)

- Manipulation of planting dates, to plant at a time which is most optimal for the crop, or least beneficial for the pest
- Adjustment of seeding rates, to achieve an optimal rate given the need to crowd out weeds or avoid insects
- Use of appropriate plant varieties and livestock breeds for local conditions
- Use of stock burying programmes, which minimize the import of diseases onto the farm
- Limiting field size, which aids in weed management by livestock
- Biological control methods, to encourage natural enemies of pests by providing habitat (for example hedges) or by breeding and releasing them in areas where they are required
- Trapping insects, possibly with the use of lures such as pheromones
- Biological pesticides (for example, derris dust, pyrethrum, rotenone) of which the active ingredient is short-lasting, and which may be produced locally.

The important insect-pests management strategies under organic farming are:

Use of botanicals

Extracts obtained from plants like neem *(Azadirachta indica),* Pongamia *(Pongamia glabra),* Tulsi *(Ocimum sanctum),* sorghum, marigold, and bougainvillea have been found quite effective against a number of diseases and insect pests. Many neem based formulations are available in the market and have shown satisfactory results against insect-pests of agricultural, horticultural, vegetable crops, household pests, locusts, grasshoppers, caterpillars, stem borers, pod borers, beetle, jassids, aphids, mealybugs, whiteflies, planthoppers, fruit flies and mosquitoes. Neem oil at 2% and neem seed kernel extract (NSKE) at 5% have proved effective against major pests of rice, sucking pests of cotton and vegetables. Neem cake applied at 250 kg/ha at last ploughing before sowing has been found effective against cotton stem weevil and soil insects of many other crops.

Biological control

Management of pests and disease-causing agents utilizing, parasitoids, predators and microbial agents *like* viruses, bacteria, and fungi is termed as biological control. Several pathogens including viruses such as nuclear polyhedrosis virus (NPV) and granuosis virus (GV), bacteria like *Bacillus thurienglensis, Veticillium* and protozoan like *Schizogregrine* cause diseases in insects and destroys them. Similarly, several insect parasitoids (parasites thriving on insects) are also known in nature. *Trichogramma* is an egg parasitoid of several pests. Selective microbial pesticides offer particular promise, of which strains of *Bacillus thuringiensis* is an example.

Trap cropping

Crops that are grown to attract insects or other organisms like nematodes to protect target crops from pest attack (examples in Table 1). This is achieved by either preventing the pests from reaching the crop or concentrating them in a certain part of the field where they can be effectively destroyed/ controlled. It could be an important strategy under organic farming systems.

Table 1. List of successful examples of trap crops

Main Crop	Trap Crop	Pests Controlled
Tobacco/ cotton/ groundnut	Castor	Tobacco caterpillar
Maize	Sorghum	Shootfly, stem borer
Cotton	Onion/Garlic	Thrips in cotton

Planting dates and crop duration

Planting dates should be so adjusted that the susceptible stage of crop synchronizes with the most inactive period or the lowest pest population (see Table 2). The plantings should also be based on information about pest monitoring, as the data varies with location.

Planting density

Plant nutrient status, interplant spacing, canopy structure, etc. affect insect behavior in searching for food, shelter and oviposition site. It also affects the population of natural enemies.

Destruction of alternate host plants

Many insects use a wide range of cultivated plants especially weeds as alternate hosts for offseason carry-over of the population. The density

Table 2. The significance of planting dates on pest population and damage

Host Plant	Insect	Response
Rice	Leaf folder	Early planted rice (up to the 3rd week of June) suppressed the population
Rice	BPH (Brown Plant Hopper)	Planting in end of July in *Kharif* and early in *Rabi* escapes attack in Andhra Pradesh
Sorghum	Leafhopper	Delayed sowing increases the incidence
Tomato Chillies	Thrips	Late planted crop severely affected by thrips and leaf curl virus

of weeds around the crop can alter the proportion of harmful and beneficial insects that are present, and increase or decrease crop damage. Destruction of off-types and volunteer plants, thinning and topping, pruning and defoliation and summer ploughing are other cultural methods to reduce pest load in the field.

Crop rotations

Sustainable systems of agricultural production are seen in areas where proper mixtures of crops and varieties are used. Monocultures and overlapping crop seasons are more prone to a severe outbreak of pests and diseases. Growing rice after groundnut in garden land in puddled condition eliminates white grub.

Organic manures

Application of press mud in groundnut @ 12.5 t/ha had been found to reduce the damage by leaf miner. The incidence of leafhopper in rice was low in *Azospirillum* combined with farmyard manure. Application of organic manure lowered the rice gall midge incidence.

Use of pest-resistant or tolerant varieties

Host plant resistance forms are an important component of the non-chemical method of pest management. Several resistant varieties of crops have been evolved against major pests, through intensive breeding programmes. The varieties which are resistant to the insect-pests and diseases should be used in organic farming.

Mechanical method

Mechanical destruction: Hand picking of caterpillars; hooking of rhinoceros beetle adult with the iron hook; sieving and winnowing for stored-product insect control; shaking plants to dislodge caseworm in rice.

Mechanical exclusion: Wrapping of fruits against pomegranate fruit borer; banding with grease – against mango mealybug; trenching – for larvae of the red hairy caterpillar; tin barrier – around coconut tree trunk to prevent rat damage; rat proof structure in storage godowns.

Using appliances: Light trap for stem borer of rice; yellow sticky traps for attracting aphids and jassids; fish meal trap for sorghum shoot fly; methyl eugenol trap for fruit flies; probe trap for stored product insects; pheromone trap for various adult insects

Conclusion:

Organic production systems largely exclude the use of synthetic chemicals and fertilizers. It is a sustainable system because it enlivens the soil, strengthens the natural resource base and sustains biological production. The area and value of organic crops are increasing year after year in India. There are growing concerns in India for promoting organic farming. Export of organic products has become a foreign exchange earner. Further, the growing export market can be tapped by prospective farmers by way of growing organic crops. Under organic production systems, the management of crops is quite different than the conventional ones. Special attention is required to increase the productivity of organic systems. Practices like the adoption of suitable crop rotations, efficient nutrient management through organic sources of nutrients and biofertilizers, timely management of insect pests, diseases and weeds using botanicals / bio-pesticides and cultural practices need to be followed to get maximum economic yields and returns.

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WOMEN IN ORGANIC FARMING: AGENTS OF CHANGE

Sameera Saurabh

Multi-cropping and organic fertilisers have transformed the practice of traditional subsistence agriculture into a dependable livelihood option for more than 2000 tribal farmers applying natural farming on more than 1200 hectares of land. The tribal women prefer growing food crops rather than cash crops because their priority is to meet their family's nutritional requirements. They have formed groups bringing together landholders and the landless poor on the basis of equal sharing: patches of land are leased out for organic farming.

Organic farming is a production system which excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, genetically modified organisms and livestock food additives. It relies upon crop rotations, use of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral bearing rocks to maintain soil productivity and to supply plant nutrients to control insects, weeds and other pests.

India is home to 30 percent of the total organic producers in the world but accounts for just 2.59 percent (1.5 million hectares) of the total organic cultivation area of 57.8 million hectares, according to the World of Organic Agriculture 2018 report. At the same time, most organic farmers are struggling due to rising input costs and limited markets, says a study by the Associated Chambers of Commerce and Industry of India (ASSOCHAM) and global consultancy firm Ernst & Young. Farmers also complained of low productivity during the transition from conventional chemical farming to organic farming.

According to reports by the National Sample Survey Office (NSSO), the agrarian sector nearly employs 80% of women workers. Despite such high numbers, both the sector and the macroeconomic policy framework are yet to recognise them as farmers. Moreover, 81% of the female agricultural labourers belong to SC, ST and OBC communities (ILO, 2010). The largest share of casual and landless labourers also comes from these social groups.

Women are at the centre of implementing the objectives of organic farming initiatives. Women become critical agents of change in these local communities by strengthening livelihoods, ensuring a steady supply of quality seeds for cultivation and increasing the availability and access to pesticide-free food for consumption.

Indian tribal women of the Sundargarh district of eastern India's Odisha state have chosen to produce safe and nutritious food, achieving food security and a better livelihood through organic farming. This is in respect to their age-old agrarian tradition. Thousands of hectares of farmland in the district have never consumed any fertiliser that is either synthetic or inorganic in nature. Members of the Oliva Women Farmers Collective have received several accolades for growing about 12 crops – brinjal, chilly, onion, tomato, cowpea, watermelon, beans, bitter gourd, ladies finger, sunflower, pumpkin, and leafy vegetables – in a single season by dedicating a row to each crop.

The model of zero budget natural farming entails producing crops at zero or near zero cost. Farmers prepare organic fertilisers using cow dung, cow urine, jaggery (a type of brown sugar made in India) and lentil powder, as well as organic pesticides using the leaves of neem (Azadirachta indica), Karanja (Pongamia pinnata) and calotropis along with garlic, jaggery, cow dung and cow urine in different compositions. The farmers use molasses-rich mahua (a tropical tree) instead of jaggery as the former is available in the vicinity and nearby forest.

Multi-cropping and organic fertilisers have transformed the practice of traditional subsistence agriculture into a dependable livelihood option for more than 2000 tribal

farmers applying natural farming on more than 1200 hectares of land. The tribal women prefer growing food crops rather than cash crops because their priority is to meet their family's nutritional requirements. They have formed groups bringing together landholders and the landless poor on the basis of equal sharing: patches of land are leased out for organic farming.

Janadhanya, an association of women farmers in Karnataka seeks to protect agro-biodiversity and promotes organic farming and market linkages for farmer produce to advance sustainable rural livelihoods. Representatives from a cluster of five to seven villages are nominated to be the Board of Directors of Janadhanya. They make decisions, monitor and evaluate the activities of the groups and the federation, and ensure that members receive information and services.

The association also facilitates linkages between government agricultural departments and other institutions, builds capacities of Community Resource Persons to support the village communities in livelihoods, and quality assures the farmer produce through a decentralised organic farming certification, the Participatory Guarantee System.

From Janadhanya's network of 3,000 women across 17 villages, 694 have formed smaller Producer Groups (PG). The 21 groups operate Seed Banks, process grains, and produce organic inputs and vegetable seeds; mill edible oil, make vermicompost, vermiwash, and cattle feed. Groups of 10-15 women farmers in Ramanagara district, Karnataka, owning anywhere between 0.5-1.5 acres of land, have come together to conserve and produce indigenous seeds, cultivate and process grains, and compose organic inputs. Women farmers in Jandhanya's network villages are no longer just low-wage labourers or confined to their homes. They are farmers and producers, leading the revival and adoption of locally sustainable agricultural practices. They make decisions, their opinions are heard, and they create employment for other women in their communities. The effectiveness of these Community Seed Banks led the Government of Karnataka to establish such SBs all through the state.

Bhimdanga village in Odisha, eastern India : Empowering women farmers to manage their own seed enterprises enables them to become decision-makers in the community. This is significant, given that according to the 2011 census, 68.5% of women work in agriculture. Traditionally, women have been the custodians of seeds. The short-grained kalajira is one of the key scented rice varieties of India and gives a high yield in a short timespan. When cooked, the rice has a heady fragrance, earning it the market name of "white baby Basmati." Over the last two years, six seedbanks have been established in five villages in Odisha with 72 men and women conserving 50 varieties of fibre and food crops seeds. Traditionally, Odisha is not a cotton growing state but over the last two decades, small and marginal farmers have started growing the cash crop. Conserving organic cotton seeds that are suited to the soil and as a climate adaptation measure is a priority for smallholders.

Pitchandikulam Bio-Resource Centre (PBRC) is working with twenty-seven women's self-help groups (SHGs) within the Kazhuveli bioregion and along the Coromandel Coast. These groups allow women to have a safe space to address pressing issues, to attend useful training sessions and to play an active role in the development of the community. As a result of receiving training in these groups, community members are beginning to utilise organic farming methods on their own land and to grow crops with success. Plantation of TDEF species in their villages and setting up indigenous nurseries as income-generating activities help to conserve the biodiversity of the region. Pitchandikulam helps these groups to access government and micro-credit schemes which are of great benefit to SHGs and communities in general. Women's Centre has been recently constructed at Nadukuppam Field, which enables woman's SHGs to meet independently in a safe, stimulating environment. It provides them with the opportunity to expand their horizons and interact with other women and sections of the community – as well as being a hub of information and knowledge. The Centre and its activities encourage women to implement sustainable practices in the village and farming community.

Organic farming is a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity is hence important. Many studies have shown that organic farming methods can produce even higher yields than conventional methods. A significant difference in soil health indicators such as nitrogen mineralization potential and microbial abundance and diversity, which were higher in the organic farms can also be seen. The increased soil health in organic farms also resulted in considerably lower insect and disease incidence. The emphasis on small-scale integrated farming systems has the potential to revitalize rural areas and their economies.

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HEALTH AND ENVIRONMENTAL BENEFITS OF ORGANIC FARMING

A. Subba Rao

Organic farming increases soil organic matter, which in turn enhances the soil's ability to absorb and store carbon, cycle nutrients and absorb and store water. Increased soil organic matter contributes to greater soil resilience under the influence of different environmental stresses like drought and flooding. Organic farming is receiving world-wide attention in terms of animal and human health, prosperity, benefits to soil and water quality, to birds and bees in the ecosystem and ability of organic farming to mitigate damage from global climate change.

One of the basic principles of organic farming is that Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystem-healthy soils produce healthy crops that in turn foster the health of animals and people (IFOAM, 2005).

Organic produce consumers tend to be more concerned about the negative health effects of pesticides and genetically modified organisms than other consumer groups and they also believe that organic produce is more nutritious compared to food produced under conventional agriculture.

Health Benefits of Organic Farming

In organic farming no harmful pesticides, fungicides, herbicides or chemical fertilizers which are known to cause some human health hazards, are used. Studies showed that organic foods are more nutritious and higher in antioxidants because they are grown on more nutrient-rich, nutrient balanced and healthy soils. Eating organically grown fruits and vegetables could increase body antioxidant intake by around 20-40%. Organic farming ensures that foodgrains, fruits, and vegetables are not subjected to any artificial and harmful human interventions or genetic modifications. Diseases, pests and weeds are managed through good soil health for natural plant resistance, selection for stronger plants, crop rotations, natural predators and beneficial insects.

Plant secondary compounds like polyphenols and antioxidants in fruits and vegetables likely to have a positive effect on animal and human health but the mechanism(s) which explain these effects

are still not clear but research in this direction is currently going on. The work done at Indian Institute of Soil Science, Bhopal has shown that pomegranate fruit quality parameters such as sugars, total soluble sugars (TSS) and ascorbic acid content increased significantly with the application of Integrated, nutrient management (INM), organic and inorganic management systems. The maximum TSS was recorded in cattle manure treatment, organically managed. Higher accumulation of ascorbic acid was recorded in INM treatment, followed by organic and inorganic treatments and was the lowest in control (Table1)

A decade of research at the Indian Institute of Soil Science Bhopal showed that the application of various organic manures resulted in the improvement of seed/grain quality of soybean, chickpea and wheat grains also there was improvement in the dehydrogenase and phosphatase enzyme activity, microbial biomass and organic carbon content in the soil (Singh etal 2008). Tryptophan content in the wheat grain which limiting Amino-acid in cereal was recorded the highest where cattle manure+poultry

manure+vermicompost combination of organic manures was applied compared to other combinations of organic manures and control (Table2).

Application of different organic manure combinations increased the protein and sulphur -containing amino acids (methionine and cysteine content) in chickpea seeds. Similar results were obtained in the case of soybean crop also (Table 3).

It is also claimed that organic farming results in nutrient-dense foods in the form of increased concentrations of major and micronutrients in the grains/seeds of crop plants. There have been experimental and human experiences that due to balanced nutrient supply through organic sources, the quality of production increases in terms of aroma, essential oil content, texture, taste and shelf- life (Sharma 2008).

Unlike conventional farming, antibiotics or hormones are not used in raising organic livestock. Organic livestock production systems have higher animal welfare standards which lower the levels of pathogens present in milk and meat.

As on today evidence without dispute (conclusive) is not available to support the perceptions regarding health benefits of organic foods over the conventional foods. So well planned researches are required to arrive at valid and acceptable conclusions on the health benefits of organic food.

Environmental benefits of organic farming

Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations and the environment (IFOAM2005)

Conventional agriculture relies mostly on synthetic fertilizers, especially nitrogenous fertilizers. Half to two-thirds of this nitrogen finds its way into rivers and water bodies, affecting both freshwater and marine environments. The most dramatic result is the dead zone, for example, in the Gulf of Mexico which interferes with fishing. There are 146 dead zones around the world and nitrogen fertilizer run-off from agricultural lands is largely responsible for most of these.

Organic farming avoids the use of heavy pesticide and herbicide typical of conventional

Table 1: Effect of different nutrient sources on pomegranate quality parameters

Treatments	TSS (%)	Sugar (%\	Acidity (%)	Vitamin C mg/100g	Carotene mg/100g	Tannin (%)
Control	15.5	10.4	0.31	16.0	2.10	0.48
Vermicompost	16.8	11.7	0.26	17.5	2.29	0.42
Phosphocompost	16.7	12.0	0.24	17.7	2.25	0.41
Cattle dung manure	17.4	12.5	0.25	17.8	2.37	0.40
RDF (400:250:200 g NPK plant^{-1})	16.5	11.5	0.27	17.4	2.29	0.47
50% RDF+ 50% CDM	17.3	12.6	0.25	17.9	2.48	0.40
CD (P=0.05)	0.09	0.11	NS	0.12	NS	NS

Table 2: Effect of various organic manures combinations on wheat grain quality

Treatment	Mineral (%)	Protein (%)	Tryptophan (g /16 g N)	Methionine (g /16 g N)
Cattle dung manure + poultry manure	1.55	12.14	1.30	1.58
Cattle dung manure + vermicompost	1.55	11.61	1.32	1.53
Poultry manure + vermicompost	1.58	11.90	1.34	1.57
Cattle dung manure + vermicompost+ poultry manure	1.54	11.74	1.39	1.59
Control	1.50	11.31	1.28	1.52
CD (0.05)	NS	0.20	NS	NS

Table 3. Chickpea seed yield and quality under organic farming

Treatment	Mineral (%)	Protein (%)	Cysteine (g /16 g N)	Methionine (g /16 g N)
Cattle dung manure + poultry manure	2.7	19.9	1.44	1.67
Cattle dung manure + vermicompost	2.8	19.3	1.46	1.66
Poultry manure + vermicompost	2.8	19.3	1.47	1.69
Cattle dung manure + vermicompost+ poultry manure	2.8	20.1	1.52	1.73
Control	2.7	18.2	1.34	1.46
CD (0.05)	NS	0.42	0.08	0.09

agriculture. Often the water and fish samples from the rivers and streams in the intensively cultivated agricultural areas contain one or more pesticide and herbicide residues which are harmful to animal and human health.

Organic farming practices improve soil health and water quality in agricultural areas. Using biological means of nutrient supply i.e., through composts, animal manures and legumes in a rotation and as cover crops build soil organic matter under organic farming. Building more organic matter in soil increases soil water retention and supports more active soil microbial communities that fix nitrogen and retain in soil organic matter and also transform it into non-leachable gaseous forms.

Organic farming fosters above and below ground soil biodiversity. Studies comparing the impacts of organic and conventional farms on such things as plants, soil microbes, earthworms , spiders, butterflies, beetles, birds and mammal in majority cases demonstrated the abundance and richness of species in organic farms compared to conventional ones.

A review of over 300 publications showed that out of 18 environmental impact indicators studied (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residue, CO_2, NO_2 CH_4, NH_3, nutrient use, water use and energy use), organic farming systems performed significantly better in 12 and performed worse in none (Stolze et al 2000).

Global climate change is manifesting in increasing frequency of costly droughts, floods, heat waves and major storms. The disturbed environment/climate is affecting crop production and water availability, causing hunger, malnutrition and social unrest. Under organic farming, the primary strategy to mitigate climate change is to increase carbon sequestration in soil through more use of organic manures and other organic inputs and avoidance of fertilizers and pesticides. It is desired to generate information on carbon sequestration and emissions of greenhouse gases under organic farming, especially in long continued organic farming experiments.

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ROLE OF NABARD IN ORGANIC FARMING

Dibakar Lenka

With increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidence of being equally productive, the organic farming has emerged as an alternative system of farming which not only addresses the quality and sustainability concerns, but also ensures a debt-free, profitable livelihood option. The capital investment subsidy scheme for commercial production units of organic/ biological inputs is being implemented in collaboration with NABARD which aims at promotion of organic farming in the country by making available the organic inputs and increasing the agricultural productivity while maintaining the soil health and environmental safety.

Pollution free environment is essential for sustaining the life of all living beings on the earth. While technology induction is required for feeding the surging population, the excessive use of chemical fertilizers, pesticides, and weedicides in agriculture has caused environmental imbalance and is causing problems to all living beings on the earth. So Eco- friendly farming is the need of the hour for sustainability.

Eco-friendly farming is farming of integration of biological, cultural and natural inputs including integrated disease and pest management practices. It not only advocates for stopping or restricting the use of pesticides, but also emphasizes the need for farming which should create an ecological balance and a micro environment suitable for health and growth of soil micro-flora, plants, animals, farm workers and finally the vast population which consumes the farm produce. So it combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all.

Impact on the Economy:

Many farmers are turning to organic or "low input" farming as a strategy for economic survival.

During the past 20 years, farmers have shown steadily increasing interest in organic farming. Many farmers who adopted organic farming methods early in this period were motivated by reasons relating to the health and safety of their families, consumers, and livestock, and by idealistic convictions about soil and land stewardship. More recently, as costs of chemicals and credit have increased and commodity prices have stagnated, thousands of conventional farmers have begun to search for ways to decrease input costs. "Low input farming" is the new, socially-acceptable term for organic farming, and economic survival is the motivation for many young farmers.

Conventional Vs. Organic Farming:

There are solid bases of studies that suggest organic is equal to or more profitable than conventional farming. Part of that competitive edge comes from the premium price – driven by consumer demand – which organic farmers can get for their products. One of the most persistent myths the studies consistently debunk is that organic systems are incapable of reaching the same yields as conventional systems. After a transitional period of 3 to 5 years, organic systems can produce up to 95 percent of conventional yields. Additionally, organic farming is less dependent on fossil fuels, expensive inputs, and annual loans, making it less vulnerable to financial market fluctuations. Organic is a low-waste system that emphasizes quality over quantity, meaning it uses less land for the same profit. Conventional crop subsidies exacerbate the problem, incentivizing farmers to grow more than they can sell, which causes excess pollution, overuse of resources, and food waste.

Natural Capital- A new concept of Economy

The capital is defined as money, machinery, tools, or other physical assets that help increase an entity's wealth. In the case of a farmer, capital means tractors, greenhouses, or hand tools – things that can be used again and again to facilitate profit and growth. Natural capital is a new branch of economics that would like to recognize the ways we benefit from natural systems as a form of capital. Natural capital includes a mind-boggling array of ecosystem services and resources provided by the natural world, some of which we are yet to discover. Think of trees making oxygen and capturing pollutants from the air, wetlands filtering water, insects pollinating plants, and the incredible biodiversity of a place like the Amazon rainforest generating new medicines. Mother Nature does a lot for us, and the natural capital movement would like to quantify those values in order to more easily incorporate them into the traditional economic schemes that do not account for them.

Organic Farming & Natural Capital

As discussed, organic farming can stand its ground under traditional economic evaluations, but when we also start to incorporate natural capital values, organic becomes the clear winner for long-term profitability. Let us consider a few examples of how organic farming utilizes and increases various natural capital functions:

- Adding organic matter to the soil each year (a foundational organic practice) increases the soil's ability to store carbon dioxide.
- Organic matter in the soil also increases the soil's water holding capacity, reducing pressure on water resources and making organic farms more resilient to drought. Since water costs money, drought tolerant farming systems mean cheaper food production over time.
- Biodiversity on organic farms offers myriad financial benefits. A diverse crop system means a succession of blooms that can feed insect populations (and provide them with habitat) year-round. These beneficial insects help to keep down populations of harmful insects, reducing or eliminating the need for pesticides, and providing pollination services to increase harvest yields.
- Genetic diversity on organic vegetable and seed farms acts as a well-endowed gene bank for potential new varieties that will be resilient against future environmental changes, insect populations, and diseases – a service that is essential to global food security with tasty food.

Natural capital is a relatively new field of study, and economists and scientists are just beginning to unpack the ways we can attribute values to it within agricultural systems. As we learn more about the economics of natural capital and organic agriculture, we will convince more farmers to make the switch, increasing the world's profits of biodiversity, nutritious food, and healthy ecosystems, farm by farm.

Future prospects

The movement started with the developed world is gradually picking up in developing countries. But demand is still concentrated in developed and most affluent countries. Local demand for organic food is growing. India is poised for faster growth with a growing domestic market. The success of the organic movement in India depends upon the growth of its own domestic markets. India has traditionally been a country of organic agriculture, but the growth of modern scientific, input-intensive agriculture has pushed it to the wall. But with the

increasing awareness about the safety and quality of foods, long term sustainability of the system and accumulating evidence of being equally productive, the organic farming has emerged as an alternative system of farming which not only addresses the quality and sustainability concerns but also ensures a debt-free, profitable livelihood option. An environmentally sustainable system of agriculture like organic farming will be able to maintain a stable resource balance, avoid overexploitation of renewable resource, conserving inherent soil nutritional quality and soil health, and biodiversity. It will lead us to sustainable agriculture and create a sustainable lifestyle for generations to come.

NABARD and Organic Farming:

NABARD Consultancy services for Organic Farming:

Nabcons has the know-how on cultivation practices under organic farming through alternate Eco-friendly Technologies like Biofertilizers, Bio-pesticides, Neem formulations, Bio-fuels, etc.

Production of Organic Manures:

- Systems for On-Farm Waste management
- Off-Farm and Agro-industry Wastes like Sugar factory Press mud, Coir pith, etc.
- City solid waste
- Vermicomposting
- Green Manuring Technique

Subsidy schemes of NABARD for Organic Farming:

The capital investment subsidy scheme for commercial production units of organic/ biological inputs is being implemented by the Department of Agriculture & Cooperation through the National Centre of Organic Farming (NCOF) in collaboration with NABARD. The main objectives of the scheme are to promote organic farming in the country by making available the organic inputs, to increase agricultural productivity while maintaining the soil health and environmental safety. It is also to reduce the total dependence on chemical fertilizers and pesticides by converting the organic waste into plant nutrient resources and to prevent pollution and environment degradation.

Entities Eligible for Subsidy: New and existing units (expansion/renovation) engaged in the production of organic fertilizers or bio fertilizer and fruit & vegetable waste compost unit are eligible for subsidy under the scheme.

Project Location & Project Cost: There are no specific requirements for location under the scheme. Therefore, the entrepreneur can set up the unit at any place where it will be technically feasible and commercially viable. The estimated total cost for establishing a new biofertilizer or bio-pesticide production unit of 200 ton/annum capacity is about Rs.160 lakhs and the estimated total project cost for establishing a new fruit and vegetable waste compost unit of 100TPD capacity is Rs.200 lakhs. The above mentioned estimated total project costs are just indicative and the actual project cost for a project will depend on multiple factors such as capacity, location, technology, pricing of equipment, etc.

Subsidy Component & Release of Subsidy: The scheme provides credit linked and back-ended capital investment subsidy. Biofertilizer and bio-pesticides unit are provided with a capital subsidy of 25% of the total project cost subject to a maximum of Rs.40 lakhs per unit. Fruit & vegetable compost units are provided with a capital subsidy of 33 per cent of the total project cost subject to a maximum of Rs.60 lakhs per unit. NABARD will release the subsidy to the units financed by Commercial Banks, Regional Rural Banks and other institutions which are eligible for refinancing from NABARD.

Conclusion

The role of Organic Farming can be leveraged to mitigate the ever-increasing problem of food security in India. With rapid industrialization of rural states of India, there has been a crunch for farmland. Further, with the exponential population growth of India, the need for food sufficiency has become the need of the hour. Furthermore, the overuse of plant growth inhibitor, pesticides and fertilizers for faster growth of agricultural produce is detrimental to human health and the environment as a whole. The proposition of Organic Farming in India's Rural Economy holds good, as an alternative to arrest this problem.

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PUBLICATIONS DIVISION COMMEMORATES 100 YEARS OF THE JALLIANWALA BAGH MASSACRE

A special programme titled "Yaad Karo Qurbani" was organised by Publications Division, in collaboration with Indira Gandhi National Centre for the Arts (IGNCA), New Delhi on April 15, 2019 to commemorate 100 years of the Jallianwala Bagh massacre. Professor Chaman Lal, an eminent writer and a specialist in Modern Indian History, Dr. Sachchidanand Joshi, Member Secretary, IGNCA, Director General, Publications Division and Additional Director General, Publications Division were among the dignitaries present.

Speaking on the occasion, Professor Chaman Lal spoke about the brutalities of the massacre and the events that unfolded after it, which led to a united struggle by the people. Dr. Sachchidanand Joshi urged the youth to take inspiration from the freedom fighters and work hard for the progress of the nation.

Students from three schools in Delhi presented various interesting performances on the occasion. Students of Kendriya Vidyalaya, Pragati Vihar performed a skit and read letters of freedom fighters, viz. Bhagat Singh, Chandrashekhar Azad, Subhash Chandra Bose, and others, from the book "Yaad Kar Lena Kabhi: Shaheedon ke Khat" brought out by Publications Division. This book has been translated into other Indian languages, i.e. Malayalam, Tamil, Odiya and Urdu. These translated books were also released on this occasion. Students from Kendriya Vidyalaya, President's Estate and Jawahar Bal Bhawan, Mandi, recited poems from "Zaptshuda Taraane", published by DPD, which is a collection of poems written by martyrs and freedom fighters which were confiscated by the colonial government.

Continuing the remembrance, Publications Division and IGNCA also organised a book reading and discussion session by eminent authors, Professor Chaman Lal and Ms. Kishwar Desai, on April 16, 2019 at the IGNCA auditorium where they read excerpts from their books, out of which "Shaheed Bhagat Singh: Dastavezon Ke Aaine Me" by Prof. Chaman Lal, is also a DPD publication.

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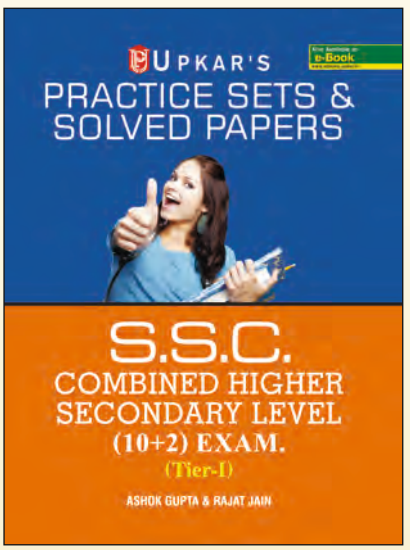

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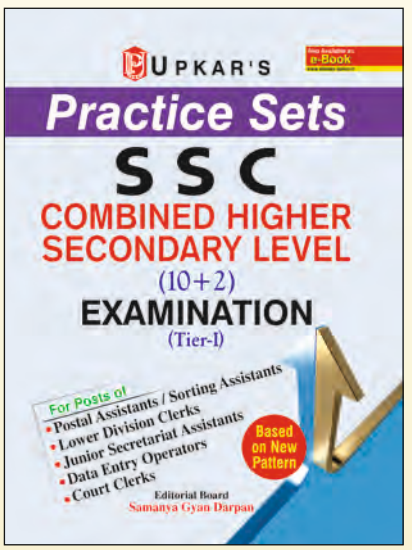

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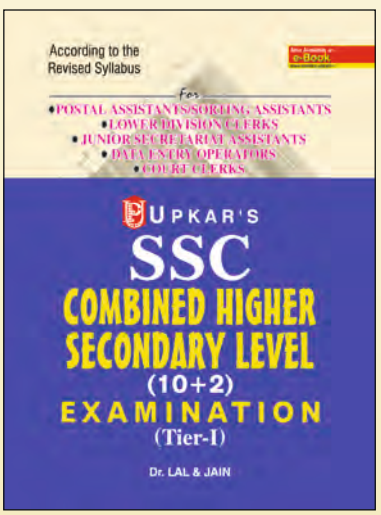

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