KEYNOTE ADDRESS https://doi.org/10.58297/BWCP7350

The Major Challenges and Scope for Sustainable Agriculture Development in India

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Abstract

Globally the demand for organic farming is increasing and farmers need to adopt novel technologies to resolve the challenges during the practicing of organic farming. Organic agriculture includes sustainability of agricultural production, supporting the rural economy, maintaining ecological and environmental strength within agricultural systems, and also establishing sustainable human health. Improving crop productivity and income of the farmers is to be based on soil health management, pest and disease control, and adapting novel marketing strategies. The utilization of farmyard manure, vermicompost, and biofertilizers in organic farming develops soil health and plant growth that can be benefited by farmers by increasing crop yield and ecosystem health. The application of biopesticide and biocultural agents for controlling pest and diseases on the crop in organic farming will enhance crop yield and also reduces environmental pollution. Organic farmers need to adapt novel marketing strategies to sell their farm produce and to get higher economic benefits. The food produced from sustainable farming increases the health of the human, soil, and environment.

Keywords: Organic Farming, Soil Health, Pest Management, Constraints, Marketing

Introduction

Agriculture can be sustainable and self-reliant only if farmers use locally available resources as inputs eg. Farm wastes, cowdung and other biomass for preserving the soil as a living material. Organic farming can be 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. In other terms, it is a system approach of crop production, observing the rules of the nature, targeted to produce nutritive, healthy and pollution free food, protecting the entire system of the nature, maximizing the use of on-farm resources, minimizing the use of off-farm inputs and avoiding the use of chemical fertilizers and pesticides (National Project on Organic Farming-NPOF).

There are several potential applications are associated with organic farming to climate change mitigation. In particular greenhouse gases (GHG) emissions are reduced by avoidance of mineral fertilizers, lower N2O emissions due to low N input and careful management, Less CO2 emissions due to better soil structure and more plant cover, Highest mitigation potential of organic acids lies in carbon sequestration, The emission reduction potential by avoiding mineral fertilisers is about 20%, compensation potential by C sequestration is about 40-70% of world's current annual GHG emissions (Tuomisto *et al.,* , 2012; Muller et al ., 2017). The worldwide organic farming covers the total Area of 37.2 m. ha. By 1.8 million organic producers and practiced in 162 countries. the major organic cultivating land from Australia (12.02 m. ha.), Argentina (4.4 m ha) and India (1.10 m. ha) 0.6% of the total agricultural area with 5,47,591 organic farmers. The global Market for organic food: 62.9 billion US $, organic food exports increased from 100 m US $ (2008-09) to 157.22 m US $ (2010-11) (World Scenario-2012 survey; Muller *et al.,* , 2017). It is commonly assumed that by 2050, agricultural output will have to further increase by 50% to feed the projected global population of over 9 billion (Alexandratos, N. & Bruinsma, 2012). This challenge is further exacerbated by changing dietary patterns. It is, therefore, crucial to curb the negative environmental impacts of agriculture, while ensuring that the same quantity of food can be delivered. There are many proposals for achieving this goal, such as further increasing efficiency in production and resource use, or adopting holistic approaches such as agroecology and organic production, or reducing consumption of animal products and food wastage (Muller *et al.,* , 2017). Organic agriculture is one concrete, but controversial, suggestion for improving the sustainability of food systems. It refrains from using synthetic fertilizers and pesticides,

promotes crop rotations and focuses on soil fertility and closed nutrient cycles (IAASTD-2009; Foley, 2011). The growing health consciousness among the consumer and increasing awareness about organic food has led numerous opportunities for organic producers. Along with opportunities, there also arise various challenges like marketing of organic produce, soil health testing facilitates, availability of biopesticides and biofertilizers are faced by the organic farmers in India.

Organic farming in India

The concept of organic agriculture is not alien to India. In fact, the first scientific approach to organic farming dates back to the Vedas of the later Vedic period, the essence of which is to live in harmony with, rather than exploit, Mother Nature. There is brief mention of several organic inputs in our ancient literatures like Rigveda, Ramayana, Mahabharata, Kautilya Arthasashthra etc. In fact, organic agriculture has its roots in traditional agricultural practices that evolved in countless village's and farming communities over the millennium (Singh *et al.,* , 2019). Therefore, traditionally Indian farmers are practicing organic farming and gradually changed to chemical-based cultivation since 1950's. Chemicals increasingly applied with green revolution and liberal use of chemicals led to health hazards and also Air, water and soil pollution noticed everywhere simultaneously Soil fertility declined in many places. It is definitely true that India had witnessed a tremendous growth in agricultural production in the era of green revolution. Food grain production, which stood at a mere 50 million tons at the time of independence, had increased almost five and half times to 273.38 million tons by the end of 2016–17 (Press Information Bureau, GOI, 2017) from 159.59 million hectares of cultivated area in country (Agriculture Census, 2010–11). The technologies involved during the inception of green revolution supported by policies and further propelled by agrochemicals,

machinery and irrigation were the main driving forces for the enhanced agricultural production and productivity (Roychowdhury *et al.,* , 2013). Despite the fact that the food security of India was definitely addressed by these technologies (Charyulu and Biswas, 2010), an important setback was that the farmers using these technologies were still had to depend upon the purchased inputs. With manufacturing of fertilizers and pesticides as the two major inputs of Green Revolution (GR) technologies, an important point of consideration was the need for fossil fuels and/or expensive energy which are associated with serious environmental and health problems.

In last 50 years we are using heavy amount of fertilizers and pesticides and we already reach on plateau and diminishing low of return start to work (Venkateswarlu *et al.,* , 2008), so we need to apply more input (fertilizer and pesticides) to get small raise in production which cause second generation problem and few of such epitome examples are some regions of Punjab (cancer belt of country) and endosulfan story of cashew plantations area in Kerala. Insecticides and herbicides in ideal condition lethal for target group only, for non-target group and human it is safe but this principle is not followed strictly and indiscriminate use of these chemicals put human life and ecosystem health on verge (Aktar *et al.,* , 2009). All these thing and unsustainability issue associated with modern agriculture force us to look back (Balachandran, 2004) in history to know either we are not doing any mistake by depending on off farm inputs because crop production is a recycle system of nature by putting too much off farm input, we are making it fragile day by day. One of such natural, recyclable and sustainable approach of farming is Organic farming. It is the effective and cost-efficient way to achieve sustainable development in the agriculture sector (IFOAM, 2010). Organic source of nutrient also helps to combat with the problem of multi nutrient deficiency and low organic content in our soil which is affecting productivity of major food crops at farmer field (Singh *et al.,* , 2018).

Organic crops cannot be grown with synthetic fertilizers, synthetic pesticides or sewage sludge. They cannot be genetically engineered or irradiated. Organic animals must eat only organically grown feed and cannot be treated with synthetic hormones or antibiotics. The increasing awareness of the fitness and health benefits of organic foods are fueling the demand for these products across the world. Most developed countries, including the European Union, United States, Canada, Japan, China, Russia, and Australia, require country of origin labeling in order to market food as organic within their borders. Organic food is the fastest growing sector of the American food industry (Alexander *et al.,* , 2015). The government of India is offering strong support and promoting organic farming as it will increase the economic contribution, positive impact on biodiversity, and effective soil management. Organic foods are getting popular in India due to the availability of organic manures in rural areas, the depleted soil and

product quality, as well as increased commercialization and competitiveness of the Indian agro-market. Farmers are ready to adapt organic farming based on profitability and concern developed for safe food production and environment protection. National Programme for Organic Production (NPOP) - Launched by Ministry of Commerce, Govt. of India in 2000 for the continuous support and services to the Indian organic farmer. There are several agencies are accredited under NPOP like APEDA (Agrl. and processed food products export development authority), spices board, coffee board tea board, coconut development board and directorate of cashew and cocoa development.

Constraints on organic farming in India

The organic foods have labor intensive demand and farmers do not use pesticides, chemical fertilizers, or drugs. Thus, organic foods normally cost 20%–100% more than conventional foods. Moreover, after all the rigours involved in obtaining labels for organic foods, there is no means for distinguishing between organic and conventional foods unless they are taken into the lab for testing. Organic foods tend to spoil faster than non-organics because they are produced without artificial preservatives or irradiation. Therefore, consumers will not be able to ascertain if the food was produced according to the promised characteristics such as safety and trustworthiness or not. A lot of skepticism is shown by consumers regarding the certification process of organic and non-GMO labels. Besides all these, the major issues faced by organic farmers are soil health management, pest and disease control, and organic product marketing.

Soil health management

Soil health is a term which is widely used within discussions on sustainable agriculture to describe the general condition or quality of the soil resource. Soil management is fundamental to all agricultural systems, yet there is evidence for widespread degradation of agricultural soils in the form of erosion, loss of organic matter, contamination, compaction, increased salinity and other harms (European Commission 2002). This degradation sometimes occurs rapidly and obviously, for example when poor soil management leads to gully erosion. Often degradation is slower and subtler, and may only impact on agricultural production and the wider environment over years. For this reason, research has been directed to devising measures of the health of soil, which could be used to monitor its condition and inform its management so that degradation is avoided (Kibblewhite *et al.,* , 2008).

Agroecological systems such as organic farming and other forms of soil-conserving sustainable agriculture can compete with conventional agriculture and have the potential to maintain food productivity while improving health as well as sustaining soils, waters and ecosystems (Halberg *et al.,* 2015). Agroecological systems are two to four times more energy efficient than conventional agriculture (IPES-Food 2016). They are thus important for the future because of their reduced reliance on fossil fuels for cheap energy and fertilizers and on the novel idea that technology can continue to solve our problems (Weis, 2010). Agroecology, with such emphases on efficient input use and environmental benefits, is also compatible with ideas of sustainable intensification (Lampkin *et al.,* 2015). Organic farming provides sustainable soil quality, crop yield, and ecosystem services, perhaps as a result of soil-aware management (Taylor *et al.,* 2006).

Assessment of soil health across agricultural systems, soil types, and climatic zones presents major scientific and policy challenges. Clearly, no single indicator will encompass all aspects of soil health, nor would it be feasible (or necessary) to measure all possible indicators (Kibblewhite *et al.,* 2008). Soils provide multiple ecosystem services, and as such, soil health management in support of sustainability must consider three points: that enhancing many soil ecosystem services requires multi-functional management; that managing soil to improve one service can have positive (synergistic) or negative effects (trade-offs) on another service; and that soil health management should sustain soil services over the long term (Lehmann *et al.,* 2020).

Management of agricultural practices using new technologies such as testing of soil nutrients is found to be economical and environment friendly in organic farming. In agriculture, encouraging alternative means of soil fertilization rely on organic inputs to improve nutrient supply and conserve field management. Several organic sources are associated to improve soil fertility under organic farming like farm yard manure, compost, vermicompost, coir pith compost, poultry manure, crop residues, green manures, and agro wastes. Biofertilizers, known as microbial inoculants, contain actively living cells of micro-organisms. Efficient nitrogen fixers perform other

functions which beneficially affect plant growth and yield. N and P are the main nutrients that can be supplemented by biofertilizers. Rhizobium, Azotobacter, Azospirillum, blue-green algae and Azolla for N, Mycorrhiza, and phosphate solubilizing microorganisms for P are important to many crops. All these natural sources enhance the soil nutrient concentrations, moisture content, and their contribution to plant uptake, and also crop nutrient requirements are to be considered to estimate the quantity of organic sources.

Farmers and stakeholders need to be made aware of the importance of management for the long-term sustainability of soil and food production, and we believe this could be facilitated by improving their connection with the soil. Also, human society as a whole need to become more aware of its connection to the soil and realize the dependence on soil for food, biomass and the functions it provides to maintain the biosphere (FAO and ITPS 2015). It is also very important to increase awareness and understanding of soil security and soil health management in the general public and in agriculture.

Pest and disease control

One way to increase food availability is to improve the management of pests. There are estimated to be around 67 000 different crop pest species—including plant pathogens, weeds, invertebrates, and some vertebrate species—and together they cause about a 40 per cent reduction in the world's crop yield (Oerke *et al.,* 1994). Crop losses caused by pests undermine food security alongside other constraints, such as inclement weather, poor soils, and farmers' limited access to technical knowledge. In contrary to synthetics, biopesticides have emerged as a green tool in the era of sustainable agriculture. These are the most likely alternatives to some of the most problematic chemical pesticides currently in use. Biopesticides offer solutions to concerns such as pest resistance, public health issues and detrimental effects on the surrounding environment. Despite the benefits associated, the overriding challenge for the biopesticide industry is to live up to the promises and expectations of the end-users or the market and public as a whole. It is a well-known fact that as far as environmental perspective is concerned, biopesticides are far better than synthetics, but at the same time, we can't deny that this greener approach is struggling for its place in the established conventional chemical pesticide market (Mishra *et al.,* 2020).

In India, the concept of biocontrol of plant diseases has been in practice for a very long time. The neem tree (*Azadirachta indica* A. Juss) and its derivatives, i.e. leaf extract, oil, and seed cake have been used as fertilizers and also for minimizing the risk of post-harvest loss in stored cereals (Brahmachari 2004). There are evidences where some insects and birds were used in pest eradication and during the 1960s, the concept of integrated pest management (IPM) also emerged with a target of judicious use of pesticides in agriculture. Later, the US National Academy of Sciences also exemplified the term IPM in a broader way, and along with multiple complementary methods to suppress pests, biocontrol was also added (Peshin *et al.,* 2009).

However, in India, a major technological breakthrough in the field of biocontrol happened when chemical insecticides failed to control *Helicoverpa armigera, Spodoptera litura,* and other pests of cotton (Kranthi *et al.,* 2002). It was realized that biocontrol is the only means that can be utilized as a safe, cost-effective, and eco-friendly method to control the widespread resistance of chemical insecticides towards pest insects. Later, biopesticides became a part of IPM which was previously completely based on the use of chemical pesticides. To control pests and diseases in organic farming the farmers need to practice sustainable preventive and controlling methods like selection and cultivation of tolerant crops and crop varieties, cultural control, mechanical control, biological control, use of pheromone traps and biopesticides.

Biological control comprises of the use of plants or botanicals, microbial pesticides, biocontrol by insects, and biorationals (**Table 1**). Botanicals means use of various plant products that been in use for many centuries in India to minimise losses in crops and grain storage. A large database of plant species that possess pest-controlling insecticidal, antifeedant, repellant, attractant and growth-inhibiting properties exists in every village. Plants widely used for botanical pesticides are *Annona* sp, *Azadirachta indica*, *Chrysanthemum* sp., *Cymbopogan* sp., *Nicotiana* sp, *Pongamia* sp, *Vitex* sp., etc. Seeds, leaves, extracts, fruits, kernels, oil and decoctions from botanicals are used to control the pests. Biopesticides are living organisms – or their derived parts – which are used as biocontrol agents to protect crops against insect pests. Seed treatment, seedling root dip, soil application or foliar spray will effectively control fungal diseases and bacterial diseases.

Table 1. Commercially important microbial bio-pesticides and biorationals used in India

Category	Products	Target pest	Major crops
Bacteria	Bacillus thuringiensis Bacillus sphaericus Bacillus subtilis Pseudomonas fluorescens	Lepidoptera Mosquitoes, flies Fungal pathogens Fungal pathogens	Cotton, maize, vegetables, soybean, groundnut, wheat, peas, oilseeds, rice
Viruses	Nuclear Polyhedrosis Virus (NPV) of Helicoverpa armigera, Spodoptera sp. and Chilo infescatellus	American Boll worm,tobacco caterpillar and shoot borer	Cotton, sunflower, tobacco and sugarcane
Fungi	Trichoderma viride Trichoderma harzianum Trichoderma hamatum	Fungal pathogens	Wheat, rice, pulses, vegetables, plantations, spices and sugarcane
	Beauveria bassiana Verticillium lecanii Metarhizium anisopliae Paecilomyces lilacinus Nomuraea rileyi	Insect pests such as bollworms, white flies, root grubs, tea mosquito bugs	Cotton, pulses, oilseeds, plantation crops, spices and vegetables
Biorationals	Pheromone traps Pheromone lures, sticky traps and mating disruptants	Bactocera sp. Chilo sp. Dacus sp. Earias vittella Helicoverpa armigera Leucinodes orbonalis Pectinophora gossypiella Plutella xylostella	Cotton, sugarcane, vegetables, fruit crops

Marketing of organic produces

Marketing and distribution are not efficient because organic food is produced in smaller amounts from the need of world's population that needs to survive. This could lead to starvation in countries that produce enough food today. Along with great opportunities with organic farming, there also arise marketing challenges faced by the organic and conventional farmers in India. The major marketing challenges faced by the farmers, namely, lack of warehousing facility, lack of price information, inadequate demand for crop, costly transportation, market price variations, and lack of government support. There are significant differences in the marketing challenges faced by the conventional and organic farmers across the nation.

Marketing of organic produce is mainly the buying and selling. Rapid transformation in terms of increasing concentration in processing, trading, marketing and retailing is being observed in the agrifood system all over the world. Traditionally the farmers were unaware in advance when, to whom and at what price they are going to sell their produce. This scenario has changed with the greater coordination between farmers, processers, retailers and other players in the supply chain. Now the farmers are producing to the requirements of the market rather than relying on the markets to absorb whatever they produce. The real challenge lies in organising the small and marginal farmers for marketing and linking them to high value agriculture. Thus, group approach is needed for getting benefits from marketing. Small farmers can also benefit from the emerging super markets and value chains if linked effectively. According to the ways in which the farmers link to the buyers, market linkages can be classified into the following categories: 1. Farmer to domestic trader, 2. Farmer to retailer, 3. Linkages through cooperatives, 4. Farmer to agro-processor, 5. Farmer to exporter, 6. Contract farming (**Table 2**).

Table 2. Marketing Linkages for organic agriculture

Type of linkage	Collective activity	Advantages for farmers	Disadvantages for farmers
Direct between farmers and traders	Farmers usually act on individual basis with traders. May work together informally to bulk-up produce to reduce costs and attract larger traders	Trust ensure long term sustainability Formal farmer organisations not usually needed	May need to accept short-term deferred payments Limited access to better markets
Direct between farmers and retailers Linkages through cooperatives	May require formal group structure Farmers may link directly with the cooperatives or through groups	Reliable market at agreed price Inputs, technical assistance etc. may be supplied on credit Crop marketing, packaging, grading and storage and sometimes processing organised by cooperatives Potential for farmers to sell large volumes	Must meet variety, quality and safety specifications Must be able to supply agreed quantities at all times Cooperatives often depend on subsidies and external managerial assistance. Commercial activities can collapse when subsidies and assistance run out
Direct between farmers and agroprocessors	Farmer groups can bulk-up produce for collection by processor Groups can facilitate supply of inputs and provision of technical assistance	May provide secure market at agreed price Inputs, technical assistance, etc. may be supplied on credit Processor often provides transport Potential for farmers to sell larger volumes	There may be an inadequate market for the processed products, thus jeopardizing sustainability Must meet variety, quality and safety specifications Open market price may be higher than that agreed with processor
Farmer to exporter	Often involves grouping of farmers External technical assistance may be required	Potential high returns if quality can be achieved Inputs, technical assistance, etc may be supplied on credit Exporter often provides transport and packaging	Export markets are inherently risky Compliance with standards can be problematic even with technical assistance
Formal large-scale contract farming	Company may prefer to group farmers, formally or informally, for inputs and output marketing and extension	Inputs, technical assistance, etc. may be supplied on credit Crop marketing organized by company	Companies often require external agency (bank) to finance credit provision Frequent mistrust between farmers and companies and their employees Contracted price lower than market price may lead to sales outside of the contract

In the marketing of the final produce, the price that they receive at the farm gate is considerably lower than the retail price. The new institutional innovations in the marketing have been initiated in India in the last decade and some of the cases show that they are far friendlier to the farmers when compared to the traditional marketing forms (**Table 3**). The evolving innovative marketing concepts like direct marketing, co-operative marketing, contract farming etc are however not free of hitches. Proper planning and action of the farmers and the private players capable of engaging in such innovative channels.

Table 3: Marketing strategies for organic agriculture

Marketing Institutions	Features
Rythu Bazaar in Andhra Pradesh	First started in Andhra Pradesh in the direction of empowering the farmers to participate effectively in the open market to get a remunerative price for their produce. To avoid the exploitation of both the farmers and the consumers by the middlemen by creating a positive atmosphere of direct interface between them
Apni Mandi	First started in Punjab in the direction of ensuring direct contact of the producer farmers and consumers and thereby enhancing the distributional efficiency of the marketing system. This system does away with the middlemen. The price spread is considerably low. Working satisfactorily in the case of fruits and vegetables
Farmers markets	Farmers markets initiated in various states to eliminate middlemen and traders from the marketing of vegetables in the farmers markets, and to establish direct contacts between farmers and consumers.
Hardaspar Vegetable Market	Hadaspar vegetable market is a model market for direct marketing of vegetables in Pune city, this is one of the ideal markets in the country for marketing of vegetables. The market has modern weighing machines. Linking farmers to vegetable markets
Shetkari	Shetkari bazaars were established in the Maharashtra state for marketing of fruits and vegetables
Bazar	It will eliminate middlemen, links producers and consumers directly, reduce price spread, and enhance producer share's in consumer rupee. Thus these markets increase the farm income, wellbeing of the farmers
Krushak	Established in the state of Orissa in 2000-01
Bazars	· The purpose is to empower farmer-producer to compete effectively in the open market to get a remunerative price and ensure products at affordable prices to the consumer
Cooperative Marketing Society	The need for cooperative marketing arose due to defects in the private and open marketing system. A cooperative marketing society can eliminate some or all of the intermediaries. Few successful cooperative marketing societies for fruits and vegetables. eg. Maha-grape-cooperative federation marketing, Maharashtra, Cooperative marketing. pomegranate, Co- operatives marketing banana in Jalgaon district, Vegetables co-operatives in Thane District, Milk co-operatives in Maharashtra, HOPCOMS, Bangalore and Gujarat and Co-operative cotton marketing society.
Contract Farming/ Contract Marketing	Essentially is an agreement between farmer-producers and the agribusiness firms to produce certain pre-agreed quantity and quality of the produce a particular price and time. This is an important initiative for reducing transaction costs by establishing farmer-processer linkages. Successful contract farming includes Organic dyes- Marigold farmers and extraction units in Coimbatore, Pepsi Company and farmers of Punjab and Rajasthan for tomato growing
Safal Market	NDDB started a fruits and vegetable unit of SAFAL at Delhi was one of the first fruit and vegetable retail chain. NDDB has set up an alternate system of whole sale markets in Bangalore as a pilot project. This market is a move to introduce a transparent and efficient platform for sale and purchase fruits and vegetables by connecting growers through Grower's associations.

Marketing Institutions	Features
Forward and Future Markets	Forward and Futures markets have been identified as important tools of price stabilization and risk management. Extension of forward and futures markets to all major agro commodities has, therefore, assumed great importance. Commodity futures markets in the country are regulated through Forward Contracts (Regulation) Act, 1952
Commodity Exchanges	Commodity exchanges for futures trading narrows the marketing, storage and processing margins, there by benefiting both growers and consumers. NAFED started National Multi-Commodity Exchange of India Ltd. on 26th November, 2002, for cash crops, food grains, plantations, spices, oilseeds, metals and bullion among others. National Commodity and Derivate Exchange of India Ltd. was established in Dec, 2003 at Mumbai with a similar purpose.
Food retail super markets	Food retail markets in India during 1990s and early 2000 opened up the availability of food products dramatically. They key functions are • Higher standards • Lower prices
Organic Mandi	Being initiated in Haldwani in Uttarakhand by Mandi Samiti

There are many constraints that are responsible for their lower adaptability among organic farmers. To extend the understanding of certain impact factors like differences in microbial applications, selections of specific cultivars suitable for organic and conventional systems, climate change, negotiation on input material and marketing strategies, and also more investigations are needed to drive a complete picture, especially in the context of sustainable agriculture. However, technological challenges and long-term sustainability are the major issues that require immediate consideration. Popularizing and educating farmers on organic agriculture through information services could enhance productivity. More technology services and financial support need to be provided to households to promote the conversion from the traditional production model to sustainable agriculture.

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