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REVIEW ARTICLE

# Organic Farming in Vegetable Crops: Challenges and Opportunities

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## Abstract
In recent times, organic farming has assumed greater significance and become a buzzword, gaining momentum and instant acceptance by producers and consumers simultaneously. Rising health complications due to the overuse of different agricultural chemicals and their consequent presence as residues above maximum permitted residue levels in food (MRLs) has bolstered the demand for a renewed emphasis on organic farming, particularly in vegetables due to the very short possible withholding period before their consumption after harvest. Vegetables are highly perishable in nature and indispensable in regular consumption. Even as the practice of organic farming is indeed very attractive in terms of nutritional and edible quality of vegetables, prevention of diseases in humans, maintenance of soil biology in diversity, population, activity levels, and preservation of soil health, it still raises queries as to whether the crops can be managed in the field without using any inorganic fertilizers or pesticides in a sustainable way over a longer period of time without affecting yields. As the challenge remains to feed the burgeoning population, it is important to ponder upon the current status, challenges, modalities, certification and prospects presented by organic cultivation of vegetable crops.
**Keywords**: Organic farming, vegetables, pesticide residues, soil health, quality.

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## Introduction
Farming practices have undergone various changes from time to time. The practices of modern production systems are based on use of heavy doses of fertilizers and other agrochemicals for higher productivity. The long-term overuse of inorganic inputs in intensive cropping systems without organic inputs degrades soil quality and health and causes environmental pollution (Albiach *et al*., 2000). Concerns like declining factor productivity (Biswas & Sharma, 2008), depletion of soil organic carbon and mineral nutrients content, adverse effects on soil physico-chemical properties, microflora, water logging and salinization, increasing nitrate concentration in well water, etc., are the consequences of modern production system with unbalanced and injudicious use of chemical fertilizers and pesticides (Prasad, 2005). The quality of produce also deteriorated due to the presence of chemical residues above the maximum permitted levels in the food, percolating and accumulating at different levels of the food chain.

Vegetables are an important constituent of the Indian diet as they are an excellent source of essential nutrients, antioxidants, fiber and vitamins, carbohydrates and protein. Many vegetables are eaten fresh as salad. However, under conventional farming, vegetable growers are known to spray pesticides at higher quantities and frequent intervals than recommended to control insect pests and diseases in vegetable crops like brinjal, tomato, cauliflower, chilies, sweet pepper, cucurbits, *etc.* (Nandini *et al.*, 2021). There are innumerable health hazards posed by these agro-chemical contaminated vegetables due to the presence of higher pesticide residues and heavy metals (Singh *et al.*, 2017). Presently, both internationally and domestically, consumers are becoming more and more conscious about pesticide residues.

The emerging scenario necessitates the need of an alternate form of agriculture to produce food devoid of contaminants and the development of production technologies that are sustainable in the long run. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment and restrict the use of synthetic inputs for sustainability (Stockdale *et al.*, 2001). The adoption of organic farming maintains soil health, keeps the production system sustainable and provides high-quality food for meeting nutritional requirements (Lampkin, 1990). There is a resurgence of interest in organic farming globally, which holds sustainability of natural resources and environment supreme along with the natural taste and nutritional quality of the produce. During the last three decades, 'Organic Agriculture' has emerged as a dynamic 'Alternate Farming System'. There has been a paradigm shift and interest to adopt organic vegetable production systems, which are ecologically and economically viable socially just, and environment friendly.

### *Importance of Organic Farming*

Globally, the agricultural production system is undergoing a rapid transformation since there is a rise in demand for healthier and environmentally safer food. With increasing awareness about the safety and quality of foods, long-term sustainability and accumulating evidence of being equally productive, 'organic farming has emerged as an alternative system of farming that not only addresses the quality and sustainability concerns but also ensures a profitable livelihood option (Lampkin, 1994). There is a high demand for organic food in domestic and international markets which is estimated to be growing at a rate of 30%, a year worldwide. The area under organic farming has been increasing consistently. A larger proportion of growers are now shifting to organic production practices to meet the increasing demands. The demand for certified organic produce, particularly vegetables is presently exceeding the supply, thus fetching premium market price (Nandini *et al.*, 2021).

### *Productivity under Organic Farming*

"Can the level of productivity realized under conventional farming be achieved under organic farming in vegetable crops?" is the obvious question in the mind of vegetable growers. It has been observed that productivity in organic production systems is management-specific. Yield relative to comparable conventional systems are directly related to the intensity of farming of the prevailing conventional system (FAO, 1999). In intensive farming systems, organic agriculture decreases yield range depending on the intensity of external input used before conversion (Offermann & Neilberg, 2000) whereas in traditional rain-fed agriculture (with low external inputs), organic agriculture has shown potential to increase the yield. A number of studies have shown that under drought conditions, crops in organic agriculture systems produce significantly higher yields than comparable conventional agriculture crops (Stockdale *et al.*, 2001) often outyielding conventional crops by 7 to 90%. Others have shown that organic system has less long-term yield variability. A survey of 208 projects in developing tropical countries in which contemporary organic practices were introduced, showed an average yield increase of 5 to 10% in irrigated crops and 50 to 100% in rainfed crops (Pretty and Hine, 2001). A comparison of 133 studies from developing countries concluded that organic crop yields were 74% higher than their conventional counterparts (Badgley *et al.*, 2007). On the other hand, in a study conducted at AVRDC, Taiwan during 2006-08, no significant difference in yields of cabbage, tomato and cucumber were observed between organic and inorganic systems.

In many studies, the productivity of vegetable crops in organic farming was less in the initial years but the yields increased progressively under organic farming equating the yields under conventional inorganic farming in 4 to 5 years (Bhattacharya & Chakraborty, 2005; Singh *et al.*, 2016). The studies on potatoes have revealed that in succeeding years, the organic tuber yield increased consistently (70–80%) in all cultivars, when raised on the same plot each year, indicating a trend towards yield stabilization (Singh & Upadhyay, 2011). Organic treatments resulted in higher carrot root production compared to conventional treatments (Bruno *et al.*, 2007). The yield of cabbage and tomato grown under organic practices was better than that grown under conventional systems (Ma *et al.*, 2009). Similar results were obtained in cucumber (Mohmoud *et al.*, 2009). Better results in terms of fruit yield in vegetables could be attributed to the fact that organic amendments of the soil changed the soil dynamics as well as composition and nutritional quality. However, the transition effect in which a yield declines in first 1 to 4 years of transition to organic agriculture, followed by a yield increase when soils develop adequate biological activity (StanHill, 1990).

### *Organic Sources for Nutrition in Vegetable Crops*

In organic farming, nutrient management depends on biologically derived nutrients through the recycling of on-farm natural inputs. Organic sources of nutrition are derived mainly from the decaying remains or by-products of biological organisms, organic matter, excess crops, domestic sewage sludge, animal manure, and microorganisms such as fungi and bacteria (Chouichom & Yamao, 2011). Organic materials such as farmyard manure, compost, vermicompost, biogas slurry, green manures, crop residues, biofertilizers and cover crops are valuable sources of nutrients to improve the growth and yield attributes, yield, nutrient uptake, quality and soil fertility. Organic manures are storehouses of all essential nutrients besides providing substrate for other bio-inoculants (Choudhary & Suri, 2018). Organic matter input into the soil gives a long-term positive effect due to humus production that can increase the soil cation exchange capacity and water retention.

Farmyard manure is the most commonly used organic source of nutrition, which is a bulky organic manure obtained from a decomposed mixture of dung and urine of farm animals along with litter. Well-rotten FYM contains 0.5–1.0% N, 0.15–2.0% $P_2O_5$ and 0.5–0.6% $K_2O$. The desired C: N ratio in FYM should not exceed 15 to 20 (Bhattacharyya & Tandon, 2002). It is estimated that around 700 million tonnes of agricultural waste are available in the country every year, but most of it is not properly used. This implies a theoretical availability of 5 tonnes of organic manure/hectare of arable land/year, which is equivalent to about 100 kg NPK/ha/year (Tandon, 1997). The application of FYM is of greater significance for sustainability as it has great potential to improve the physical properties of soil besides supplying nutrients. The application of farm yard manure can increase the microbial activity in the soil both by activating the microbial action and by aiding the multiplication of the microbial population. Literature shows an increase in organic carbon in the soil, enhanced microbial activity, and an increased population of bacteria, actinomycetes and fungi by application of FYM.

Green manures are important fertilizers. The application of green manure has been found quite promising in enhancing crop yield and saving the potential cost of fertilizers. Green manuring is the plowing under or soil incorporation of any green manure crops while they are green, just before flowering or soon after they flower. Green manures are forage or leguminous crops that are grown for their leafy materials needed for soil conservation.

Castings produced by earthworms are vermicompost which are biochemically decomposed by microorganisms. Vermicomposts are finely-divided mature peat-like materials with a high porosity, aeration, drainage, and water-holding capacity and microbial activity, which are stabilized by interactions between earthworms and microorganisms in a non-thermophilic process. Vermicomposts contain most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium. Vermicompost has been reported with a higher base exchange capacity and a larger increase in oxidation potential. Vermicompost is widely used in the cultivation of vegetables. The yield of some horticultural crops on treatment using vermicompost and inorganic fertilizers was not significantly different, but the quality of yield was higher than that of the inorganic fertilizers (Nurhidayati *et al*., 2016). Vermicompost has a positive effect on the physicochemical properties of soil hence improving the growth and yield of tomato (Hashemimajd *et al*., 2004; Gutierrez-Miceli *et al*., 2007), pepper (Arancon *et al*., 2005), aubergine (Gajalakshmi & Abbasi, 2004) and sweet corn (Lazcano *et al*., 2011).

Applications of bio-fertilizers containing beneficial micro-organisms are known to improve plant growth through the supply of plant nutrients and may help to sustain environmental health and soil productivity (O'Connell, 1992). They improve nutrients in the rhizosphere, produce growth stimulants, improve soil stability, aid biological activity, biodegrade substances, recycle nutrients, and promote mycorrhiza symbiosis and bioremediation in soils contaminated with toxic, xenobiotic and recalcitrant substances. Inoculations of vegetable crops with different bio-fertilizers have depicted an encouraging response in terms of increasing yield, quality and soil fertility. The field response of *Rhizobium* is encouraging as reported by a number of research workers (Mishra & Solanki, 1996; Kanaujia *et al*., 1999).

### *Response of Organic Sources in Vegetable Crops*

Yield relative to comparable conventional systems are variable between crops (Stockdale *et al*., 2001). It has been observed that different organic sources performed differentially on different crops during different seasons.

Vegetables are highly responsive to organic sources of nutrients and profitable to farmers. Atiyeh *et al*. (2000) observed that on replacing 20% of commercial horticultural medium with vermicompost, an increase in plant height and root and shoot biomass was seen in tomatoes. Ribeiro *et al*. (2000) observed that dry matter content increased with increasing the vermicompost dose up to 400 g/kg soil in sweet pepper. Shreeniwas *et al*. (2000) observed that increasing levels of vermicompost (0, 5, 10, and 15 t $ha^{-1}$) increased fruit weight and fruit volume in ridge gourd. Rao & Sankar (2001) observed that the effect of organic manure on leaf number, leaf area index, dry matter production, and other growth characteristics was significantly better than those of inorganic fertilizer in brinjal. Choudhary *et al*. (2003) obtained the highest yield and available N of tomato cv. S-22 and cabbage cv. Golden Acre with vermicompost at 200 g/plant + FYM at 250 g/plant, while maximum K and soil organic carbon was obtained with vermicompost at the rate of 100 g/plant + FYM at 500 g/plant. Vermicompost was found a better source of organic manure than FYM for potatoes (Singh & Upadhyay, 2011) as there is the presence of enzymes, hormones, and growth regulators along with plant nutrients in vermicompost. Haase *et al*. (2007) suggested that tubers from organic potato cropping may be expected to have sufficiently high dry matter concentrations (19%)

for processing into fries. Maheswari *et al*. (2004) studied the effect of foliar organic fertilizers on the quality and economics of chili and observed the highest ascorbic acid content (175.23 mg/100 g) with vermiwash: water at 1: 5 ratios.

Combined application of different organic nutrition shows encouraging results. Application of 20 to 30 t/ha FYM/NADEP compost or 7.5 to 10 t/ha vermicompost or poultry manure @7.5 to 10 t/ha along with the bioinoculation of *Azotobacter* and phosphate solubilizing bacteria (PSB) produced 20 to 35% higher yield over conventional system (Anonymous, 2016). Mixture of different organic sources like FYM @10 t/ha + vermicompost @3.5 t/ha or FYM @10 t/ha + poultry manure @2.5 t/ha or NADEP Compost @10 t/ha + vermicompost @3.5 t/ha along with bioinoculation of *Azotobacter* and PSB were equally effective and produced yield comparable to the conventional inorganic system in cabbage, brinjal, broccoli, cauliflower, pea, bottle gourd, tomato, cowpea and okra crop etc., (Singh *et al*., 2016). Integrated application of FYM @25 t/ha + Biofertilizer (PSB+*Azotobacter*/*Rhizobium*) increased yield of okra, cowpea and bottle gourd during summer by 27.5, 40.1 and 8.33% while in rabi season integrated application of NADEP compost @25 t/ha+Biofertilizer (PSB+ *Azotobacter*/*Rhizobium*) increased yield of cabbage and pea by 12.8 and 23.5%, respectively over inorganic system (Singh *et al*., 2017).

### *Organic-based practices in improving the Soil Physical and Chemical Properties*

Regular addition of organic manure improves soil fertility and quality. Organic carbon is a good indicator of soil quality because it improves soil physical and biological properties and also acts as a reservoir for nutrients. Organic carbon buildup was noticed in organically fertilized fields in vegetable crops. In the organic field, a 39% increase in organic carbon and 22.3% increase in soil carbon stock over conventional systems over a period of only three years was seen (Anonymous, 2016). The application of organic manures can directly modify the physicochemical properties of soil, which is advantageous to plants (Nagavallemma *et al*., 2006). Organic manure can improve the physical structure of soil such as porosity, aeration, drainage, and resistance to corrosion and infiltration thus providing a better medium for root growth. The organic potato production increased soil organic carbon content significantly, available phosphorus and potassium status also showed improvement (Upadhyay *et al*., 2004). Singh & Upadhyay (2011) reported that organic amendments showed higher carbon and carbon sequestration rates in potato-based cropping systems. Maintenance of soil structure is very useful for root development and nutrient availability to plants (Manivannan *et al*., 2009). Studies have shown that organic manures are enriched with polysaccharides. In soil, polysaccharides act as a cementing substance, creating aggregate stability and maintaining soil structure for better aeration, water retention and drainage. An increase in the water retention capacity of soil is due to absorbent organic matter, which holds the necessary amount of water required by plant roots which is important under dry farming conditions.

The bulk density is less in organic field soil, which is a sign of better soil aggregation and physical condition. A reduction in bulk density of soil treated with vermicompost was also noted by Manivannan *et al*. (2009). Similarly, Singh & Upadhaya (2011) have reported that physical properties viz. soil aggregation, bulk density, water holding capacity and biological properties of soil were improved when the organic potato was grown continuously for 2 to 3 years. Enhanced microbial biomass improves soil physiological functions such as faster phosphorous supply for plant growth (Ramesh *et al*., 2010). Nutrient loss in organic manure is less due to its slow release. Higher phosphorus use efficiency was noted in organic soils due to slow release rate and phosphate ion fixation in organic soils (Ramesh *et al*., 2010).

Continuous addition of organic manure assures a regular supply of micronutrients. A steady increase in the positive balance of Zn, Cu, Fe and Mn was recorded in organic plots as compared to the conventional system (Ramesh *et al*., 2010). It is well-documented that there is a significant positive correlation between organic matter and micronutrient availability. Nevertheless, the availability of micronutrients from organic manures is not as fast as from chemical fertilizers, because it depends upon the rate of their decomposition which in turn is controlled by their C: N ratio, soil temperature and moisture (Prasad & Power, 1997).

### *Organic Farming and Soil Biological Properties*

In a long-term field trial in which organic and conventional agricultural systems were compared, microbial biomass was higher in soils from organic plots (Gelsomino *et al*., 2004; Tu *et al*., 2005). The addition of animal or green manures on organic farms provided significantly greater input of organic carbon, which increased the bacterial population. Moreover, other researchers have shown that the incorporation of organic amendments increased soil microbial activity, microbial diversity, density, fluorescent *Pseudomonas* spp, fungi and nematodes. The majority of research has shown increased microbial diversity in soils from organic farming systems compared to conventional farming systems (Shannon *et al*., 2002). An increase in microbial biomass activity also results in changes in soil enzymes that play an important role in soil biochemical reactions (Ros *et al*., 2006). Microbial activity measured in terms of dehydrogenase activity, alkaline phosphatase and microbial biomass carbon was higher in organic soils by 32, 26.8 and 22.4%, respectively compared to the conventional system in cabbage and tomato crops (Singh *et al*., 2017). Increased microbial population with organic sources of nutrition resulted in enhancement in the dehydrogenase activity. The higher microbial activity in organically fertilized plots helps in nutrient transformation and increased availability of these nutrients to the plants (Garcia-Gil *et al.*, 2000).

### *Organic Farming in Improving the Quality of Vegetable Produce*

Many studies have examined the relative quality of organically and conventionally grown crops including fruits and vegetables. The results of these studies are quite diverse. In some cases, no difference has been reported in organically and conventionally grown fruits and vegetables, whereas many have reported better quality and taste in organic produce. Many studies on comparison between organic and conventional production systems have pointed out that differences in soil fertility management affect plant composition and nutritional quality (Worthington, 2001; Bourn & Prescot, 2002). In organic farming, since nutrition management is through organic sources, the nutritional quality of organically grown vegetables has been found to be appreciable. Higher levels of iron and magnesium were recorded in vegetable crops like carrot, beetroot, lettuce, kale, leek, turnip, onion, celery and tomato when grown organically (Laison, 2010). Organic produce contains more vitamins, minerals, enzymes, trace elements and even cancer-fighting antioxidants than conventionally grown food (Bhattacharya & Chakraborty, 2005). The quality, taste and flavor improve in organically produced vegetables mainly through increased dry matter, vitamin C, protein quality and content (Anonymous, 2015). Organic farming also improved the physical attributes of vegetables. The organically produced cowpea, okra, cabbage, and tomato had better color, luster and texture (Singh *et al.*, 2017). Singh & Upadhyay (2011) reported that organic potatoes have more shining surface than conventionally raised tubers from fertilizers. Besides, organic production of potatoes also improved the tuber dry matter, specific gravity and chip color in both processing and non-processing potato varieties.

Smith (1993) observed that organically grown apples, potatoes, pears, wheat and sweet corn averaged 63% higher in calcium, 73% higher in iron, 118% higher in magnesium, 178% higher in molybdenum, 91% higher in phosphorus, 125% higher in potassium and 60% higher in zinc. The organic food averaged 29% lower in mercury than the conventionally raised food. Research work also showed that organically grown vegetables have higher vitamin C, total carotenoids, higher mineral levels and higher phytonutrients, which can be effective against cancer (Worthington, 2001; Bahadur *et al.*, 2009).

Haglund (1998) and Johansson *et al.* (1999) reported that organic tomatoes were sweeter and carrots had more 'carrot taste' than conventional grown vegetables. Duncan *et al.* (2011) compared the micronutrient content in organically and conventionally grown foods including vegetables and reported that organic vegetables and legumes contain higher levels of micronutrient compared to their conventional counterparts. Some research workers reported that organically produced vegetables are considered wholesome and valuable.

A detailed scientific analysis of organic fruits and vegetables (Baker *et al.*, 2002) showed that organic foods have significantly fewer pesticide residues than conventionally grown foods. The nitrate content of organically grown crops is significantly lower than in conventionally grown products (Worthington, 2001). Leafy vegetables, in particular, accumulate more nitrates followed by root vegetables and potatoes. Studies have confirmed that organically produced vegetables like potato, carrot, cabbage, beetroot, celery, leek, parsley and lettuce contain lesser levels of nitrates and higher levels of vitamin C content when compared to conventionally grown vegetable crops. Similarly, it has been found in studies that organically grown vegetables accumulate higher content of total sugars, minerals like phosphorous and magnesium and phenolic compounds in vegetables like carrot, potato, spinach, brinjal, lettuce and cabbage. Organically grown vegetables like sweet pepper and brinjal exhibited higher levels of phenolic compounds and peroxidase.

### *Profitability and Economics in Organic Farming*

Organic agriculture is known to improve soil quality and fertility, provide healthier food and contribute to the economy, specifically the rural economy. According to Behera *et al.* (2012), organic agriculture produces the same crop variants as those produced from conventional farming methods, but it involves 50% less expenditure on fertilizer and energy while retaining 40% more topsoil. Chouichom & Yamao (2011) reported that organic agriculture costs were approximately 33.5% less than conventional methods. In short, organic agriculture costs less and does not seem to affect the productivity of vegetables. A study on the effect on farm returns due to the shift from chemical-based agriculture to organic while keeping productivity constant was done by (Ghosh, 2004). The research showed that the substitution of chemical fertilizers with organic fertilizers may not, hurt income in most households. Also, the use of organic fertilizer seems feasible as it manages to sustain crop yield levels. In another study, Lobley *et al.* (2009) revealed that organic agriculture promoted employment which contributed to rural development. The economic profitability in organic farming is also characterized by reduced water use, pesticide contamination, soil erosion, lower carbon emissions and increased biodiversity (Behera *et al.*, 2012). Studies have shown that a common combination of lower input costs and favorable price premiums can offset reduced yield and make organic farming equally and often more profitable than conventional farms. In India, where 85% of farmers are either small or marginal, any reduction/saving in cost of cultivation will go a long way in ensuring sustainability.

### *Improved Management Practices for Organic Cultivation*

Organic farms have greater diversity due to mandatory crop rotations and preference for crop varieties with high tolerance to complex abiotic and biotic factors such as climate extremes, pests and diseases. Soil quality is the foundation of organic farming. Soil fertility is build and maintained through farming practices. Multi and sequential cropping, crop rotations, growing legume crops as cover crops, use of organic manures and pesticides, and minimum tillage are employed for this purpose. Natural plant nutrients from green manures, farmyard manures, composts and plant residues are added to supplement the nutritional requirement of crops. Through intercropping and other practices, organic farms establish systems of functional biodiversity that stabilize the agro-ecosystem. Other practices such as crop residue retention, mulching and agro-forestry conserve soil moisture and protect crops against microclimate extremes. These techniques have a profound impact in maximizing the carbon sequestration in lands where organic practices are followed. The annual sequestration rate has been found to increase substantially by up to 3.2 tons of $CO_2$/ha/year by organic farming practices which have direct implications in reducing greenhouse gases (Smith *et al*., 2007).

Different strategies are adopted to prevent weeds from competing with the crops for nutrients and water. The main weed control strategies used in organic farming is often by combining cultural or husbandry techniques (Lampkin, 1994; Stockdale *et al*., 2001). Mechanical and thermal intervention includes ridging up spaced row crops, inter-row cultivation, post-emergence harrowing and heat treatment of weeds prior to crop emergence and in between rows and agro technique includes adopting diverse crop rotations that are effective in reducing weed seed bank and volunteer crops from becoming dominant (Karnel *et al*., 1994; Lampkin, 1994).

The control of insects, pests and pathogens is one of the most challenging jobs in organic farming. Nonchemical, biological pest and disease management is encouraged in organic farming. Lampkin (1994) stated that pests are generally not a significant problem in organic systems, since healthy plants living in good soil with balanced nutrition are able to resist pest and disease attacks. Many botanicals have the potential to control pests and diseases of plants. Extracts of neem, custard apple and C*allophyllum* (undui) seed can control a wide range of insects, bacteria and fungi. Harmful insect pests can also be controlled by releasing appropriate bio-control agents in the field. Pest management under organic farming relies on cultural, physical, mechanical, biological and botanicals; therefore, there is huge build-up of the population of beneficial insects (predators, parasites, antagonists, etc.) in the field, which keep the harmful pests under control.

### *Relevance of Organic Practices in Vegetable Cultivation*

Vegetables being highly nutritious and easily digestible, hold a major position in eradicating hunger and malnutrition and offer vast potential for ensuring food and nutritional security for millions of people of our country. As a result, in recent years' major emphasis has been given for the commercial exploitation of vegetable crops. More than 70 types of vegetables are commercially grown in our country, which generates high income and employment, for small farmers, particularly in peri-urban areas. However, contaminated vegetables carrying pesticide residues are causing several health problems in humans like cancer, infertility, Parkinson's, baldness, *etc*. The primary goal of organic vegetable production is to optimize the health and productivity of interdependent communities of soil, plants, animals, and people. Vegetable crops grown organically are valued more than conventionally grown vegetables due to its nutritive quality and storage attributes. Organoleptic studies have shown that vegetables like tomatoes and potatoes taste better when grown organically. Likewise, the fruits had a better taste, flavor, texture and juiciness when compared to conventionally grown ones. Similarly, organically grown okra and carrots were found to possess better quality attributes like taste, flavor and sugar content than those grown conventionally (Nandini *et al*., 2021).

India is the second largest vegetable producer country with 204 million tonnes of vegetable production. The high production base provides an opportunity to convert this plenty into quality production for big domestic and export markets. Organics added in its cultivation will lead to more value addition providing better income and a sustainable production. Export preference of organic vegetables offers a great scope to a country like India, which has inculcated the skill of growing crops organically since times immemorial. The availability of quality organic vegetables will not only boost the consumption of vegetables internally but also reduce the chances of rejection by the importing countries. Vegetable crops having great market potential find a prominent place in the government strategy to promote organic farming in the country.

Besides, vegetable crops require soil conditions that are crumb due to shallow rooting. Organic manure provides a better medium for root growth and hence the growth and crop yields increase (Manivannan *et al*., 2009). Thus, vegetable crops are naturally organic manure-loving crops that respond to organic manure application tremendously and therefore are apt for organic farming. Vegetable crops are more vulnerable to climate change and extremes of weather. With the unpredictable climatic conditions in the present day, organic farming which increases soil water retention capacity can go a long way in fighting the drought situation. Resiliency to climate disasters is closely linked to farm biodiversity; practices that enhance biodiversity allow farms to mimic natural ecological processes, enabling them to better respond to change and reduce risk. By increasing resilience within the agroecosystem, organic agriculture increases its ability to continue functioning when faced with unexpected events such as climate change (Borron, 2006). Thus, organic agriculture suffers less damage compared to conventional farmers planting monocultures (Ensor, 2009). Organic agriculture can potentially lower greenhouse gas emissions. Greenhouse warming potential in organic systems is 29 to 37% lower because of the omission of synthetic fertilizers and pesticides (Niggli *et al*., 2009).

### *Challenges and Opportunities*

The transition from conventional to organic farming is accompanied by high input costs and low yields in the initial years. The current use of organic manure by farmers is still low due to its higher retail price per kg of nutrient supply as compared to synthetic fertilizer. Unless the farmers use their own farm-grown/produced manure in large quantities, they are unable to meet the expenses. Lack of proper organic inputs often results in low yield making organic farming unsustainable for the farmers. Farmers also face an acute shortage of quality standardized organic agriculture inputs, which are often much more expensive than conventional agricultural inputs. The impediment to adopting organic cultivation practices in vegetable crops is the higher input cost. However, considering the environmental concerns and long-term sustainability of organic farming, the producers need awareness justifying the worthiness of the added costs. This will provide ample opportunity for employment and bring prosperity (Nandini *et al*., 2021).

The collection, transportation, and storage of fresh organic produce is also an issue. Due to relatively low volumes, the marketing and distribution chain of organic food products is relatively inefficient and the costs involved are very high. For example, organic produce cannot be stored in government warehouses that practice chemical treatment of storage areas. Issues like high certification costs, lengthy procedures, inadequate certifying agencies and inadequate supporting infrastructure facilities for verification are causing hindrances in the certification process for pursuing organic farming. There is a lack of quality organic seeds that are fit for organic cultivation. Strong government support for producing high-yielding varieties and niche crops for organic farming under different agroecological zones across India requires investment in organic research and extension.

There are many hurdles faced by small-scale farmers, for instance, the lack of knowledge and experience in organic fertilizer use; poor ability to react to unpredicted external factors such as drought, the sudden arrival of new diseases and pests; high certification cost; difficulty in assessing organic markers and bias of most legal structures in favor of conventional agriculture (Azadi & Ho, 2010; Chouichom & Yamao, 2011). More research therefore needs to be conducted to address farmers' concerns. For example, innovative and effective agricultural service systems could be implemented and developed to educate and assist farmers on the mechanics of organic farming in order to address the insufficient knowledge and inexperience in sustaining an organic agricultural system. The current research and extension on organic farming are much less than those on conventional farming. There is no timely advisory available for organic pest and disease control measures.

There is need to identify suitable crops/products on a regional basis for organic production that has international market demands. The market for organic food is currently exhibiting strong growth in India. A major factor driving the demand for organic food is urbanization, increasing income levels and rising levels of health awareness in the country. The demand for organic food in India is also being catalyzed by the strong support of the government. The Indian government is promoting organic farming by providing financial support to farmers who are adopting organic farming under various government schemes such as the Mission for Integrated Development of Horticulture (MIDH), National Food Security Mission (NFSM), National Mission for Sustainable Agriculture (NMSA), Rashtriya Krishi Vikas Yojana (RKVY), Prampragat Krishi Vikash Yojana, etc.

The farmers of rural areas are shifting towards organic vegetable cultivation due to more profit as compared to conventional cultivation. The farmers will continue if they get more net profit. The future of organic farming consists of improving and developing current technologies to improve fertilizer efficiency in terms of nutrient supply and utilization of locally available organic resources.

## Conclusion

Organic farming can provide quality food without adversely affecting the soil, plant, human and environmental health. It can mitigate land degradation and irreversible ecosystem damage due to indiscriminate use of agro-chemicals. The organic agriculture system has a strong potential for building resilient food systems in the face of uncertainties through farm diversification and building soil fertility with organic residues. Certified organic vegetable products offer high-income options for farmers and therefore can serve as promoters for climate-friendly farming practices worldwide.

## References

Albiach, R., Canet, R., Pomares, F., & Ingelmo, F. (2000). Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. Bioresource Technology, 75(1), 43-48.

Anonymous, (2015). Base paper on Organic farming, National Academy of Agriculture Sciences, New Delhi, India.

Anonymous, (2016). Annual Report, ICAR-Indian Institute of vegetable Research, Varanasi, Uttar Pradesh.

Arancon, N. Q., Edwards, C. A., Bierman, P., Metzger, J. D., & Lucht, C. (2005). Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. Pedobiology, 49(4), 297-306.

Atiyeh, R. M., Arancon, N., Edwards, C. A., & Metzge, J. D. R. (2000). Influence of earthworm-processed pig manure on the growth and yield of greenhouse tomatoes. Bioresource Technology, 75(3), 175-180.

Azadi, H., & Ho, P. (2010). Genetically modified and organic crops in developing countries: a review of options for food security. Biotechnology Advances, 28, 160-168.

Badgley, C., Moghtader, J. K., Quintero, E., Zakem, E., Chappell, M. J., Aviles, K. R., Vazquez., Samulon, A., & Perfecto. (2007). Organic agriculture and the global food supply. Renewable Agriculture & Food Systems, 22(2), 86-108.

Bahadur, A., Singh, J., Singh, K. P., Upadhyay, A. K., & Rai, M. (2009). Morpho-physiological, yield and quality traits in lettuce (*Lactuca sativa*) as influenced by use of organic manures and biofertilizers. Indian Journal of Agricultural Sciences, 79(4), 282-285.

Baker, B., Benbrook, C. M., Groth, III E., & Lutz, B. K. (2002). Pesticide residues in conventional, IPM-grown and organic foods: Insights from three U.S. data sets. Food Additives & Contaminants, 19(5), 427-446.

Behera, K. K., Alam, A., Vats, S., Sharma, H. P., & Sharma, V. (2012). Organic farming history and techniques. Sustainable Agriculture Reviews, Eds. Lichtfouse, E., Springer, Berlin, 287-328.

Bhattacharaya, P., & Chakraborty, G. (2005). Current status of organic farming in India and other countries. Indian Journal of Fertilizers, 1(9), 111-123.

Bhattacharyya, P., & Tandon, H. L. C. (2002). Dictionary of biofertilisers and organic fertilizers. Fertilizer development & consultation organization, New Delhi. 165.

Biswas, P. P., & Sharma, P. D. (2008). A new approach for estimating fertilizer response ratio-the Indian Scenario. Indian Journal of Fertilizers, 4(7), 59-62.

Borron, S. (2006). Building resilience for an unpredictable future: How organic agriculture can help farmers adapt to climate change. FAO, Rome.

Bourn, D., & Prescott, J. (2002). A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. Critical Reviews in Food Science & Nutrition, 42(1), 1-34.

Bruno, R. L. A., Viana, J. S., Silva, V. F. G. B., & Moura, M. F. (2007). Production and quality of seeds and roots of carrot cultivated under organic and mineral fertilization. Horticultura Brasiliera, 25, 170-174.

Choudhary, A. K., & Suri, V. K. (2018). Low-cost vermi-composting technology and its application in bio-conversion of obnoxious weed flora of north-western Himalayas into vermi-compost. Communications in Soil Science & Plant Analysis, 49(12), 1429-1241.

Choudhary, R. S., Das, A., & Patnaik, U. S. (2003). Organic farming for vegetable production using vermicompost and FYM in Kokriguda watershed of Orissa. Indian Journal of Soil Conservation, 31(2), 203-206.

Chouichom, S., & Yamao, M. (2011). Organic fertilizer use in northeastern Thailand: an analysis of some factors affecting farmers' attitudes. Sustainable Agriculture Development, Ed. by Behnassi, M., Shahid, S. A., & and D'Silva, J. Springer, Berlin, 185-196.

Duncan, H., Meika, F., Jennifer, O. M., Rachel, O., & Samman, P. P. S. (2011). Evaluation of the micronutrient composition of plant foods produced by organic and conventional agricultural methods. Critical Reviews of Food Science & Nutrition, 51(6), 571-582.

Ensor, J. (2009). Biodiverse agriculture for a changing climate. Practical Action, UK.

FAO, (1999). FAO guidelines for the production, processing, labelling and marketing of organically produced food. Joint FAO/WHO Food Standards. Project Codex Alimentarious Commission, Rome, CAC/CL 32, 49.

Gajalakshmi, S., & Abbasi, S. A. (2004). Neem leaves as a source of fertilizer cum-pesticide vermicompost. Bioresource Technology, 92(3), 291-296.

Garcia-Gil, J. C., Plaz, C., Soler-Rovira, P., & Polo, A. (2000), Long-term effects of municipal solid waste compost application on soil enzyme activities and microbial biomass. Soil Biology & Biochemistry, 32(13), 1907-1913.

Gelsomino, C. C., Ambrosoli, A., Minati, R., & Ruggiero, P. (2004). Functional and molecular responses of soil microbial communities under differing soil management practice. Soil Biology & Biochemistry, 36, 1873-1883.

Ghosh, N. (2004). Reducing dependence on chemical fertilizers and its financial implications for farmers in India. Ecological Economics, 49, 149-162.

Gutierrez-Miceli, F. A., Santiago-Borraz, J., Molina, J. A. M., Nafate, C. C., Abdud-Archila, M., Llaven, M. A. O., Rincon-Rosales, R., & Dendooven, L. (2007). Vermicompost as a soil supplement to improve growth, yield and fruit quality of tomato (*Lycopersicum esculentum*). Bioresource Technology, 98(15), 2781-2786.

Haase, Schuler. T. C., Haase, N. U., & Heb, J. (2007). Suitability of organic potatoes for industrial processing: effect of agronomical measures on selected quality parameters at harvest and after storage. Potato Research, 50(2), 115-141.

Haglund, A. (1998). Sensory quality of tomato, carrot and wheat. Influences of growing systems. Doctoral dissertation, Uppsala University, Uppsala, Sweden.

Hashemimajd, K., Kalbasi, M., Golchin, A., & Shariatmadari, H. (2004). Comparison of vermicompost and composts as potting media for growth of tomatoes. Journal of Plant Nutrition, 27(6), 1107-1123.

Johansson, L., Haglund, A., Berglund, L., Lea, P., & Risvik, E. (1999). Preference for tomatoes, affected by sensory attributes and information about growth conditions. Food Quality & Preference, 10(4-5), 289-298.

Kanaujia, S. P., Tripathy, D., Narayan, R., & Shukla, Y. R. (1999). Influence of phosphorus, potassium, and Rhizobium on green pod yield of pea. Advances in Horticulture & Forestry, 7, 107-112.

Karnel, D. L., Varvel, G. A., Bullock, D. G., & Cruse, R. M. (1994). Crop rotations for the 21st century. Advances in Agronomy, 53, 1-45.

Laison, D. (2010). Nutritional quality and safety of organic food. A review. Agronomy for Sustainable Development, 30, 33-41.

Lampkin, N. (1990). Organic farming. Farming Press Books, Ipswich, U.K. 715.

Lampkin, N. H. (1994). Estimating the impact of widespread conversion to organic farming on land use and physical output in the United Kingdom. In Economics of Organic Farming (Eds. Lampkin, N. H. & Padel, S.), CAB, Wallingford, UK 353–359.

Lazcano, C., Revilla, P., Malvar, R. A., & Dominguez, J. (2011). Yield and fruit quality of four sweet corn hybrids (*Zea mays*) under conventional and integrated fertilization with vermicompost. Journal of the Science of Food & Agriculture, 91(7), 1244-1253.

Lobley, M., Butler, A., & Reed, M. (2009). The contribution of organic farming to rural development: an exploration of the socio-economic linkages of organic and non-organic farms in England. Land Use Policy, 26, 723-735.

Ma, C. H., Chen, J. H., Yang, R. Y., Palada, M. C., Ous, C., Lin, Y. H., & Chen, L. H. (2009). Monitoring soil and vegetable quality under six fertilization strategies in organic and conventional farming systems. In: The 9th international conference of the east and Southeast Asia Federation of Soil Science Societies, 373-374.

Maheswari, T. U., Haripriya, K., Poonkodi, P., & Kannan, K. S. (2004). Effect of foliar application of organic nutrients on some quality indices and economics of chilli (*Capsicum annuum* L). Advances in Plant Sciences, l17(1), 259-262.

Mahmoud, E., El-Kader, N. A., Robin, P., Akkal-Corfini, N., & El-Rahman, L. A. (2009). Effects of different organic and inorganic fertilizers on cucumber yield and some soil properties. World Journal of Agricultural Sciences, 5(4), 408-414.

Manivannan, S., Balamurugan, M., Parthasarathi, K., Gunasekaran, G., & Ranganathan, L. S. (2009). Effect of vermicompost on soil fertility and crop productivity – beans (*Phaseolus vulgaris*). Journal of Environmental Biology, 30, 275-281.

Mishra, K. S., & Solanki, R. B. (1996). Effect of Rhizobium inoculation, nitrogen, and phosphorus on growth and seed yield of cowpea. Indian Journal of Horticulture, 53, 220-224.

Nagavallemma, K. P., Wani, S. P., Lacroix, S., Padmaja, V. V., Vineela, C., & Rao, M. B. (2006). Vermicomposting: recycling wastes into valuable organic fertilizer. Journal of SAT Agricultural Research, 2, 20-37.

Nandini U, N., Harinarayanan, & Pugalendhi, L. (2021). Organic vegetable cultivation. DOI: http://dx.doi.org/10.5772/intechopen.99744.

Niggli, U., Fliebach, A., Hepperly, P., & Scialabba, N. (2009). Low green house gas agriculture: Mitigation and adaptation potential of sustainable farming systems. Rev 2. FAO, Rome.

O'Connell, P. F. (1992). Sustainable Agriculture—A Valid Alternative. Outlook Agriculture, 21, 5-12.

Nurhidayati, N., Ali, U., & Murwani, I. (2016). Yield and quality of cabbage (*Brassica oleracea* L.var. capitata) under organic growing media using vermicompost and earthworm *Pontoscolex corethrurus* inoculation. Agricultural Science Proceedings, 11, 5-13.

Offermann, F., & Nieberg, H. (2000). Economic performance of organic Farms in Europe. Organic farming in Europe: Economics and Policy 5, University of Hohenheim, Hohenheim.

Prasad, R. (2005). Organic farming vis-à-vis modern agriculture. Current Science, 89, 252-254.

Prasad, R., & Power, J. F. (1997). Soil Fertility Management for Sustainable Agriculture. CRC Press, Boca Raton.

Pretty, J. N., & Hine, R. (2001). Reducing Food Poverty with Sustainable Agriculture: A Summary of New Evidence. Final Report of the "SAFE-World" (The Potential of Sustainable Agriculture to Feed the World) Research Project. Centre for Environment and Society, University of Essex, Colchester.

Ramesh, P., Panwar, N. R., Singh, A. B., Ramana, S., Yadav, S. K., Srivastava, A. K., & Subba, R. A. (2010). Status of organic farming in India. Current Science, 98(9), 1190-1194.

Rao, T. S. S., & Sankar, C. R. (2001). Effect of organic manures on growth and yield of brinjal. South Indian Journal of Horticulture, 49, 288-291.

Ribeiro, L. G., Lopes, J. C., Martins, F. S., & Ramalho, S. S. (2000). Effect of organic fertilizer application on sweet pepper yield. Horticultura Brasiliera, 18, 134-137.

Ros, M., Pascual, J. A., Garcia, C., Hernandez, M. T., & Insam, H. (2006). Hydrolase activities, microbial biomass and bacterial community in a soil after long-term amendment with diferent composts. Soil Biology & Biochemistry, 38(12), 3443-3452.

Shannon, D., Sen, A. M., & Johon, D. B. (2002). A comparative study of the microbiology of soils managed under organic and conventional regimes. Soil Use & Management, 18, 274-283.

Shreeniwas, C. H., Muralidhar, S., & Rao, M. S. (2000). Yield and quality of ridge gourd fruits as influenced by different levels of inorganic fertilizers and vermicompost. Annals of Agricultural Research, 21, 262-266.

Singh, B., & Upadhaya, N. C. (2011). Organic potato production in plains. In Souvenir of the International Conference on Organic Agriculture, Patna.

Singh, S. K., Yadav, R. B., Singh, J., & Singh, B. (2017). Organic farming in vegetables. IIVR technical bulletin no.77, ICAR-IIVR, Varanasi.

Singh, S. K., Yadava, R. B., Chaurasia, S. N. S., Prasad, R. N., Singh, R., Chaukhande, P., & Singh, B. (2016). Producing organic vegetables for better health. Indian Horticulture, 61(1), 5-8.

Smith, B. (1993). Organic foods vs. supermarket foods: element levels. Journal of Applied Nutrition, 45, 35-39.

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H. H., Kumar, P., McCael, B. S., O Mara, F., Rice, C., Scholes, B., & Sirotenko, O. (2007). Agriculture. In climate change 2007: Mitigation, contribution of working group III to the fourth assessment report of the Intergovermental panel on climate change (Metz OR, Davidson PR, Bosch R, Dave LA. Mayer (eds)) Cambridge university press, United Kingdom and nNew Yoark, NY, USA.

Stanhill, G. (1990). The comparative productivity of organic agriculture. Agriculture, Ecosystems & Envioronment, 30, 1-26.

Stockdale, E. A., Lampkin, N. H., Hovi, M., Keatinge, R., Lennartssen, E. K. M., MacDonald, D. W., Padel, S., Tattersall, F. H., Woffe, M. S., & Watson, C. A. (2001). Agronomic and environmental implications of organic farming systems. Advances in Agronomy, 70, 261-327.

Tandon, H. L. S. (1997). In Plant Nutrient Needs, Efficiency and Policy Issues: 2000-2025, National Academy of Agricultural Sciences, New Delhi, 15-28.

Tu, C., Ristaino, J. B., & Hu, S. (2005). Soil microbial biomass and activity in organic tomato farming systems: effects of organic inputs and surface mulching. Soil Biology & Biochemistry, 37, 1-9.

Upadhayay, N. C., Rawal, S., & Kumar, P. (2004). Effect of organic and inorganic sources of nutrients on potato production and soil fertility. In: Organic farming in Horticulture. (Eds). Pathak, R. K., Kishun, R., Khan, R. M., & and Ram, R. A. CISH, Lucknow, 290 -293.

Worthington, V. (2001). Nutritional quality of organic versus conventional fruits, vegetables and grains. Journal of Alternative Complementary Medicine, 7(2), 161-173.

## सारांश

खेती में अच्छी उपज पाने के लिए कई अवसरों पर कीटनाशकों व रसायनिक उर्वरकों की किसान आवश्यकता से अधिक मात्रा में उपयोग करते हैं। इसके कारण फसलों खासकर सब्जियों में जिनकी तुड़ाई और खाद्य उपयोग में बहुत कम समय का अंतराल होता है, अनुमति से अधिक अवशेष रह जाते हैं। कई शोध कार्यों में इनका असर कुशल स्वास्थ्य के लिए हानिकारक पाया गया है। साथ ही मृदा की सूक्ष्म जीवों की विभिन्नता, संख्या, क्रिया और लाभकारी कीटों के ऊपर भी इन रसायनिक छिड़कावों का असर विपरीत ही पाया गया है। इस कारण आजकल के समय में जैविक खेती की महत्ता और भी अधिक बढ़ गयी है। अब किसान और उपभोक्ता दोनों ही जैविक खेती के फायदे विशेषकर कम लागत, प्राकृतिक उर्वरकों और कीटरोधियों के उपयोग तथा स्वाद और पोषण में बेहतरी के कारण इसकी तरफ आकर्षित हो रहे हैं। जैविक उत्पादों की भी बाजार में अधिक मूल्य के बाद भी मांग में विशेष वृद्धि देखी जा रही है। जैविक खेती के सिद्धांतों, आर्थिक लाभ, प्रामाणिक औपचारिकताओं, उपज, गुणवत्ता, समस्याओं और संभव समाधानों पर इस पत्र में चर्चा की गई है।