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A Review of Organic Farming for Sustainable Agriculture in India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Producing enough food to feed the nation's expanding population has been India's biggest post-independence concern. Therefore, high-yielding cultivars are utilised in conjunction with irrigation water, fertilisers, or pesticides. All agricultural methods that uphold production in a way that is environmentally, socially, and economically sound are united by organic farming. Organic farming combines the following practises to ensure sustainable agriculture: crop rotation; soil-protecting technologies for planned chemical land reclamation; agro-technical methods to protect crops from

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weeds; preservation of agricultural and biological diversity at farms and its efficient utilisation; stabilisation of agro-landscapes through uniform system of field-protecting forest belts; facilitation of proper use and preservation of water resources; utilisation of renewable resources; harmonious balance between crop and animal production through integrated farming and utilisation of indigenous technical knowledge. Therefore, high-yielding cultivars are utilised in conjunction with irrigation water, fertilisers, or pesticides. This mix of high-yielding production technologies has contributed to soil health, environmental pollution, pesticide toxicity, and sustainable agricultural output, while also helping the nation create a food surplus. All types of certified organic food goods, such as cereals, fruits, oilseeds, honey, tea, spices, coffee, pulses, basmati rice, and their value-added products, are made in India. Cotton, clothing, makeup, functional foods, body care items, and other items of a similar nature are examples of non-edible organic products. India's sustainable agriculture is examined in relation to the production of various organic products and crops. In addition to improving the physical, chemical, and biological qualities of the soil, organic farming gives plants access to macro- and micronutrients.

Keywords: Environment; yield; organic farming; insect-pest management; sustainability.

1. INTRODUCTION

The work of Howard [1], who developed and conceptualised the majority of the ideas that were eventually embraced by individuals who joined the movement, is credited with giving rise to the organic movement in India. A production approach known as organic farming eschews, or at least mostly does not utilise, synthetic pesticides, fertilisers, growth regulators, or additives for animal feed. The fundamental goals of organic farming are social, environmental, and economic sustainability (Fig 1) [2]. Maintaining organic matter levels, encouraging soil biological activity, careful mechanical intervention, nitrogen self-sufficiency through legume use and biological nitrogen fixation, efficient recycling of organic materials, including crop residues, livestock wastes, and weeds, and controlling diseases and pests primarily with crop rotations, natural predators, diversity, organic manuring, and resistant varieties are some of the key characteristics. In order to minimise the time between the addition of NPK and its removal from the soil, substantial emphasis is focused on maintaining the fertility of the soil by returning all wastes to it, primarily through compost [3]. In order to fulfil their ever-increasing food requirements, many countries are now compelled by the pressure of an expanding population to utilise pesticides and fertilisers to boost farm output. However, excessive and extended use of chemicals has led to pollution of the environment and health risks for people and soil. Therefore, farmers in wealthy nations are being urged to convert their current farms to organic farming.

The public's willingness to pay for the more expensive product and health consciousness are the main elements influencing the demand for organic food among consumers. Organic product buyers are typically well-educated, health-conscious, and wealthy. Their inclination towards organic products is fueled by high consumer demand, a substantial price premium, and environmental concerns. Organic farming is becoming more popular among conventional growers because of these unspoken advantages. Government policies in Europe seek to promote the organic industry through consumer education, subsidies, and support in the form of marketing, teaching, and research. India has been practising agriculture for almost 4,000 years, and organic farming is very much ingrained in this nation. Farmers in the Vedic era had a reasonable understanding of soil fertility, seed selection, plant protection, sowing seasons, and the sustainability of crops in various locations, as stated in Arthashastra [4]. Because the farmers in ancient India followed the principles of nature, the soil remained fertile for comparatively longer periods of time [5].

India's growing population has relied on agriculture over the past few decades to meet their fundamental needs; 67% of the country's population and 55% of its labour force are dependent on it [6]. To satisfy the demands of a growing global population, the Green Revolution has led to notable breakthroughs in agricultural technology and policy, increasing food supply. Despite the fact that the use of chemical pesticides, herbicides, fertilisers, and other agricultural chemicals has increased food production and availability, consumers have recently developed a greater awareness of quality and are calling for more ecologically friendly, chemical-free, and nutritious food [7].

In the competitive world of agriculture today, producing organic food presents challenges for producers as well as opportunities for product exports. Growing crops with an emphasis on utilising biological elements and organic wastes to maintain healthy soil is known as organic farming. As to the International Federation of Organic Agriculture Movement (IFOAM), organic agriculture is a production method that promotes the well-being of people, ecosystems, and soils. It depends on biodiversity, cycles, and biological processes that are adapted to the local environment rather than damaging inputs. The fundamental objective of organic farming is to establish a self- sufficient, environmentally and financially sustainable farming system that enhances the local biodiversity and all of its components while producing pure food. Managing the environment is a challenging task on an organic farm.

Plants have been able to evolve resistance against insect-pest and disease attack because maintaining the health of the ecosystem has been given priority. Broad ecosystem management through small cultural adjustments like crop rotation and soil quality management with the addition of organic amendments provides the first line of defence against the attack of insectpests and diseases. This is followed by the use of curative techniques like predators, parasitoids, plant products, and environmentally safer chemicals. Organic farming undoubtedly has more benefits than drawbacks, but in real terms, there are a number of issues with it. For example, it poses a challenge to national food security because it cannot keep up with the rising demand for food. Other issues include ignorance, a lack of access to organic manures and fertilisers, low farmer profitability, and high consumer prices for organic produce. Given the growing demand for organic goods on a national and worldwide scale, the organic food sector has a great deal of potential to significantly boost the Indian economy through the appropriate implementation of policies that support organic farming, implementation, and marketing [8].

Fig. 1. Principles of organic farming

2. ORGANIC SOURCES OF NUTRIENTS FOR PLANTS

The most optimistic estimates available currently indicate that various organic sources can supply between 25 and 30 percent of the nutrients required by Indian agriculture. Organic fertilizers are considered as slow-release fertilizers (Shaji et al. 2021). Mineralization is the biological transformation of organic elements into simple inorganic elements (Grzyb et al. 2020). Fresh plant matter (mulch, crop wastes), as well as the cells of soil microorganisms, are the first to become mineralized and changed, whereas humus, which is stable, is the most difficult to mineralize (Martens 2000, Sapek, 2010). About 75–80% of crop residues are mineralized into nutrients available to plants (Rusnak 2017).

More crop productivity is sustained by whole N supplementation using FYM than by using traditional N fertilisers. Organic sources' efficiency in meeting crop nutrient requirements is not as guaranteed as that of mineral fertilisers because estimates of their NPK availability are based on total nutrient content. However, using chemical fertilisers in conjunction with different organic sources can sustain higher crop productivity over the long term while also enhancing soil quality and productivity [3]. Together with providing N, P, and K, these organic sources also render sources of elemental nitrogen, bound phosphates, micronutrients, and decomposing plant residues accessible to the plants, so facilitating their uptake of the nutrients. Applying organic sources can support high crop productivity and soil health. It also helps to mitigate the growing incidence or deficiency of secondary and micronutrients and promoted the growth and activity of mycorrhizae and other beneficial organisms in the soil [9]. Due to the high demand for aromatic rice (*Oryza sativa* L.), table peas (*Pisum sativum* L.), and onions (Allium cepa L.) in the local, national, and international markets, farmers can receive good compensation for their organically produced crops if they are included in high value crop rotations [10].

FYM typically has low nutrient concentrations, which can vary significantly depending on the source, storage circumstances, and length of time. The varying nature of manure production and storage results in a wide range of N, P, and K levels in fresh FYM, ranging from 0.01 to 1.9 percent on a dry weight basis [11,12]. Generally speaking, well-rotted FYM includes 0.5% N, 0.2% P_2O_5, and 0.5% K_2O, according to Tandon [13]. According to Gaur [14], 112 kg of N, 56 kg of P_2O_5, and 112 kg of K_2O can be added with a 25 t ha^{-1} application of well-rotted FYM. Numerous global researchers have demonstrated the numerous advantages of using FYM to soil characteristics and crop productivity [15]. Straw from the harvested crop is typically used by farmers as animal bedding or feed. Typically, bedding made of straw is used to retain urine and improve nitrogen cycling. Daily collections of wet straw and manures from the animal shelters are made, and the farmer stores or composts the materials on his property. Depending on the socioeconomic circumstances of the farmer, the composted manure is either applied right away or stored until the following crop season. Specifically, methods for managing soil, water, and nutrients—like using raised beds and reducing tillage—that prevent puddling from negatively impacting soil fertility and structure, enhance water and nutrient usage efficiency, and boost crop output may be suitable [16].

3. GLOBAL SCENARIO

The value of organic farming is steadily expanding, and it is presently practised in almost every nation on the earth, with an increasing amount of land going up in smoke every day. Roughly 43.1 million hectares of certified organic farmed land are located in 170 countries, up from 160 in 2010, according to FiBLIFOAM. Europe (11.5 million hectares) and Oceania (17.3 million hectares) have the largest areas dedicated to organic farming. 6.6 million hectares are found in Latin America, 3.4 million in Asia, 3 million in North America, and 1.2 million in Africa. Argentina, the United States, and Australia have the biggest organic land areas. Nearly 80% of the markets and output of organic agriculture are located in developing nations, as is a fifth of all agricultural land. The area of land used for organic farming has increased significantly in North America, Europe, Asia, and Oceania in recent years. The USDA and the Euro Zone have acknowledged that the NPOP's production and certification guidelines for raw plant products are comparable to their own [17].

4. INDIA'S PRESENT ORGANIC FARMING SITUATION

Organic farming has been a practise in India since ancient times. According to [18], organic farming allowed the great Indian civilization to flourish and become one of the richest countries in the world. Crop production in organic farming depends on natural biological processes and the use of organic waste, including farm, livestock, and crop waste. According to organic standards, before the first certified organic crop is harvested using organic methods, organic lands must be managed for three years. This is called the adjustment period because both the management and the soil are adjusting to the new system.

During this time, even weeds, insects, and rodents adapt. Organic farming thus seems to be a feasible choice for long-term sustainability.

India is a prominent country in organic production, with around 1,49 million hectares of organic land and over 1,70 million MT (2015–16) of certified organic products (World of Organic Agriculture - Figures & Emerging Trends, 2018). Based on the information at hand, India came in first place in terms of producers and ninth in the world for the amount of land used for organic agriculture in 2018. India is a major exporter of organic goods, ranking 11th in the world in terms of export pricing. The Indian government has also created a programme called National Organic Production (NPOP).

The national organic agricultural standards programme seeks to approve, promote, and implement organic agriculture practises based on survey.

Approximately 1.78 million hectares are used for organic farming in India. The amount of certified organic products produced in India is around 1.70 million metric tonnes. These products include oil seeds, sugar cane, cereals and millets, cotton, pulses, medicinal plants, tea, tea bags, dried fruits, vegetables, coffee, and other food items. Manufacturing functional food products, organic cotton yarn, and other products is not limited to the edible industry. The top producing states are Rajasthan, Uttar Pradesh, Maharashtra, Karnataka, and Madhya Pradesh. In addition to conventional fungicides and microbial bio-control agents, plant chemicals or extracts have been found to be effective against a wide range of illnesses [19].

5. CONVICTION OVER ORGANIC FARMING

1. The health principle states that organic farming should protect and enhance the wellbeing of the earth, people, animals, and plants.
2. The sustainable concept: It must be based upon living ecological systems and a cycle, and it must cooperate with, respect, and support these systems in their upkeep.
3. Principle of Equity: Fair relationships with the common environment and chances for life should be the foundation of organic agriculture.
4. The safety principle: In order to safeguard the health and welfare of present and future generations, as well as the environment, it must be managed safely and responsibly.

6. THE CONSUMERS OF ORGANIC FOOD IN INDIA

In India, the use of organic food is growing. Concern for the health of their children was the main motivator for over 66% of parents to purchase organic food, with organic food being preferred. Given the perceived health benefits of organic food, many Indian parents are willing to pay the higher cost of organic food, even if it is more than 25% more expensive than conventional food. Countries that import organic goods from India acknowledge those that have been duly certified by reputable Indian certifying authorities.

4.58 lakh metric tonnes (MT) were exported total in 2017–18. The revenue generated by exports of organic food was around INR 3453.48 crore. Among the countries to which organic products are shipped are the US, the EU, Canada, Switzerland, Australia, Israel, South Korea, Vietnam, New Zealand, and Japan. Cereals and millets (10%), dry fruits (8.88%), tea and coffee (8.96%), spices and condiments (7.76%), and other goods are exported along with oil seeds (47%) and other goods.

7. MANAGEMENT OF DISEASES AND INSECT PESTS WITH ORGANIC AGRICULTURAL TECHNIQUES

Insect pests and diseases were categorised into the following groups under the title of organic farming pest and disease control methods.

- Examples of modifications to cultural practises include crop rotation, controlling soil health, and using insect-resistant plants.

- Using protective belts and hedge rows to reintroduce natural enemies are examples of management practises.
- The introduction, engulfment, or discharge of biological control agents, such as parasitoids, insect illnesses, or insect pests.
- The application of herbal mixtures and components, such as mineral oils, Panchagavya, and Dasagavya, as therapeutic agents.
- The use of seductive chemicals such as pheromones.
- Using conventional insecticides along with certified organic pesticides.

8. CROP PRODUCTIVITY AFFECTED BY ORGANIC NUTRITION

It is well knowledge that adding organic matter to the soil can boost crop production. According to Sharma and Mitra [6], using organic materials enhanced rice grain and straw yield. Although similar to FYM, Ranganathan and Selvaseelan [7] discovered that applying composted rice straw and wasted mushrooms boosted rice grain yields by 20% when compared to NPK fertiliser. According to Singh et al. [8], compared to unfertilized fields, the application of 7.5 t FYM ha−1 resulted in significantly higher yields of grain and straw. With rising rates of FYM, every rice yield-related characteristic increased. The yield of rice and chickpea grains increased significantly when dhaincha (*Sesbania aculeata* L.) was used in organic farming [20,21]. The advantages of organic farming for developed countries (protection of the environment, enhancement of biodiversity, decreased energy consumption and CO2 emissions), as well as for developing countries (sustainable resource use, increased crop yield without excessive reliance on expensive inputs, and protection of the environment and biodiversity) were described by Stockdale et al. [2].

Numerous studies have found that earthworm activity is higher in organically managed fields than in inorganic agriculture [22]. Vermicompost worm faeces combined with worm casts—is created during the biodegradation process when earthworms and bacteria cooperate. Macroelements like N, P, K, Ca, and Mg as well as microelements like Fe, Mo, Zn, and Cu were supplied by vermicompost [23]. The vermicompost had nitrogen, phosphorus, and potassium contents of 0.74, 0.97, and 0.45 percent, respectively [24].

Organic farming yields crops that are as productive as conventional farming in low-input agriculture. Rice grew more effectively under continuous organic farming than it did under conventional farming, according to Tamaki et al. [25]. Agroeconomic research on growing maize in low-potential areas using compost and liquid manure top dressing performed noticeably better than existing standard farmer practises, which apply manure and mineral fertilisers together. The yields of maize grains produced by conventional methods were 11–17% lower [26].

When organic materials are applied to an organic management system, soil fertility levels gradually rise, resulting in higher crop productivity in the first year of the organically managed field [27]. In a similar vein, Surekha [28] reported that the application of organic fertilisers was associated with a progressive rise in grain yield over time. According to Chan et al. [29], the input required for producing organic rice was 46, 25, and 22% higher than that of conventional rice production in three distinct locales; nevertheless, the resulting rice yields were only 55, 94, and 82% of conventional rice production, respectively. But the higher premium pricing of organic products in the marketplace offset the expense of reduced yield with more inputs [29].

Farmers find that growing vegetables is profitable and that they respond well to organic sources of nutrients. According to Kalembasa [30], the highest tomato crop yield was obtained when 15 kg of vermicompost were applied per square metre. In their investigation into how vermicompost affected chillies (*Capsicum annuum* L.), Singh et al. [31] found that adding vermicompost boosted the microbial activity. Crop performance benefits from vermicompost because it produces more branches and fruits [31]. With vermicompost, Tomar et al. [32] obtained the maximum yield (97 g per plant) for brinjal (*Solanum melongena* L.). With vermicompost, Kalembasa and Deska [33] were able to obtain a much better yield of sweet pepper (*Capsicum annum* L. var. grossum). With the treatment of vermicompost (10 t ha^{-1}), Reddy et al. [34] observed the maximum plant height at harvest, days to first blooming, and branches plant−1. Similar findings were made by Tomar et al. [32], who found that applying vermicompost greatly improved the leaf area of carrot *(Daucus carota* L.) plants.

In a greenhouse setting, Manjarrez et al. [35] experimented on chilli plants receiving 1.25, 2.0, 3.0, 4.0, 6.0, or 10.0 g of vermicompost kg^{-1} of soil. They found that as the amount of vermicompost applied increased, so did the foliar area and photosynthetic rate. The highest photosynthetic rate (12 mol CO2 $m^{-2} s^{-1}$) was seen with vermicompost at 10 g^{-1} soil. Plant height and root and shoot biomass in tomato crops increased significantly when vermicompost substituted 20% of commercial horticulture medium, according to Atiyeh et al. [36]. In sweet pepper cv. Nacional Ag. 506, Ribeiro et al. [37] found that the dry matter content rose as the vermicompost dose was increased to 400 g kg^{-1}. Tomatoes were grown in a standard commercial greenhouse container medium (Metro-Mix 360, Manufacturer: Sun Gro Horticulture Canada Ltd., 770 Silver Street Agawam, MA, USA, 01001) in an experiment by Atiyeh et al. [36]. This medium was used as the control and was replaced with 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100% (by volume) pig (*Sus scrofa* L.) manure vermicompost in the experiment. The maximum commercial output (5.1 kg/plant) was achieved by substituting 20% vermicompost for Metro-Mix 360. Metro-Mix 360 was substituted with 10, 20, and 40% vermicompost, which decreased the amount of unmarketable fruit and increased the production of large (6.4 cm in diameter) as opposed to tiny (5.6 cm in diameter) fruits. In a field trial involving ridge gourds (*Luffa acutangula* L. Roxb.), Shreeniwas et al. [38] found that fruit weight and volume increased as the amount of vermicompost (0, 5, 10, and 15 t/ha) increased. In brinjal, Rao and Sankar [39] found that the effects of organic manure were much better than those of inorganic fertiliser on leaf number, leaf area index, dry matter production, and other growth features.

According to Samawat et al. [40], vermicompost significantly affected the weight of the tomato's roots and fruit. Fruit, shoot, and root weights were three, five, and nine times higher in the 100% vermicomposted treatment than in the control, respectively. In comparison to inorganic fertilisers, vermicompost applied at 5 t/ha or 10 t/ha improved the shoot weight and leaf area of pepper plants (*Capsicum annuum* L.) [38]. With vermicompost at 200 g/plant + FYM at 250 g/plant, Choudhary et al. [41] obtained the highest yield and available N of tomato cv. S-22 and cabbage (*Brassica oleracea* L.var. capitata) cv. Golden Acre; maximum K and soil organic carbon were obtained with vermicompost at the rate of 100 g $plant^{-1}$ + FYM at 500 g $plant^{-1}$. According to Hashemimajd et al. [42], tomatoes' shoot and root dry matter (DM) was more readily digested by the treatment vermicompost made from raw dairy manure (RDM) and another compost made from sewage sludge and rice husk than by the control (soil + sand). Ghazi et al., 2022 studied the effect of different compost sources *i.e.,* plant residues compost, FYM compost, and town refuse compost. The maximum values of growth and yield parameters of red cabbage plants expressed in plant height, leaf area, head length, number of outer leaves $plant^{-1}$, head diameter, head weight, and head yield were recorded in the plants treated with the FYM compost followed by those treated with plant residues compost and lately that treated with town refuse compost.

According to Patil et al. [43], applying vermicompost at 4 t/ha and FYM at 25 t/ha resulted in a considerably increased yield of total potato (*Solanum tuberosum* L.) tubers. The cultivation system was found to have the greatest impact on the proportion of commercial potato tubers and tubers with a diameter of 4-6 cm in the overall yield, according to Sawicka et al. [44]. According to Haase et al. [45], tubers from organic potato cropping should have high enough tuber dry matter concentrations (19%) to be processed into French fries without affecting the fries' texture when the concentration goes above 23%. After a combined N and K fertiliser was sprayed, the crisps (cv. Marlen) tubers' dry matter concentration did not reach the necessary minimum of 22%. Potato cultivar Virgo yielded 66% of the conventional harvest when grown organically, while Raja yielded 46.6%, according to research by Mourao et al. [46]. In comparison, the nitrogen uptake of organic crops (leaf and tubers) was 37.0 kg/ha for Raja and 50.5 kg/ha for Virgo, while the nitrogen uptake of mineral fertiliser was 21.1% and 27.8%, respectively.

During the winter months, illnesses in pea (*Pisum sativum* L.), mustard (*Brassica juncea* L. Coss.), and chickpea (*Cicer arietinum* L.) were effectively controlled by adding organic amendments to the soil and releasing earthworms into it. Together with fertilisers, higher doses of vermicompost also led to a rise in the accumulation of nitrogen, phosphorus, potassium, calcium, and magnesium [47]. According to Singh [48], vermicompost applied at 13–20 q/haenhanced the yield of groundnut (*Arachis hypogaea* L.) (12.16 q/ha) and pea (23.62 q/ha). According to Jat and Ahlawat's main findings [49], applying 3 t/ha vermicompost to chickpea enhanced the cropping system's total nitrogen and phosphorus uptake, dry matter accumulation, grain yield, and grain protein content in chickpea as well as the bacterial count, soil nitrogen and phosphorus, and dry fodder yield of subsequent maize (Zea mays L.). According to Baswana and Rana [50], the application of farm yard manure (1 t/ha) + poultry manure (1 t/ha) with mulch treatment resulted in the maximum pod production (93.96 q/ha) of peas, which was followed by farm yard manure (2 t ha−1) + biofertilizers with mulch treatment. The harvest index and biological yield showed a similar pattern. According to El-Dkeshy et al. [51] conducted that all vegetative growth parameters of cabbage were significantly enhanced by all organic treatments, except for wrapper leaves number. However, plots of plant manure treatment (28 ton/ha) had the highest significant values of head length without wrapper leaves, stem length, and inner stem diameter. Total head yield (ton/feddan) was also consistently significantly higher in plant compost, followed by T2 mixture plant and animal manure 28 ton/ha (14 ton/ha of vegetable & 14 ton/ha of animal manure in the plot).

Dayal and Agarwal [52] found that a greater rate of vermicompost (10 t/ha) boosted sunflower (*Helianthus annus* L.) seed output; the optimal combination was 5 t/ha vermicompost. According to Somasundaram et al. [53], the study found that using biogas slurry, maize, sunflower, and green gramme (*Vigna radiata* L.) had higher soluble protein content and nitrogenase activity [54]. Under biogas slurry with panchagavya, maize, sunflower, and green gramme showed increased nitrogen accumulation at all growth phases. Under biogas slurry with panchagavya (a preparation of five cow products—dung, urine, milk, ghee, and curds—a higher yield of maize and sunflower was seen). For small-scale farmers in the Eastern Cape of South Africa, Silwana et al. [55] documented the value of organic manure and its enduring usefulness in raising the productivity of the maize-bean (*Phaseolus vulgaris* L.) intercrop.

According to Sangakkara et al. [56], the addition of organic matter improved the soil's ability to retain water, which in turn promoted root growth and raised maize yields. Compared to cowpea, maize was more affected, particularly when gliricidia leaves were used. Hairy vetch significantly boosted the amount of organic nitrogen in the soil, according to Seo and Lee [57]. With N rates exceeding 160 kg/ha, maize dry matter yields rose more in hairy vetch than in ammonium nitrate [58,59]. The fertilised maize-grass and maize-pigeon pea (*Cajanus cajan* L. Millspaugh) rotations were found to sustain reasonably high maize yields, restore significant amounts of residue to the soil, and reduce soil carbon loss, according to Adiku et al. [60].

The treatment of earthworm compost at 27 and 29 t/ha, respectively, resulted in the highest average head weight (700 g) and yield (38 t/ha) in cabbage cv. Matsukaze, according to Oliveira et al. [61]. According to Datta et al. [62], yield was enhanced by inoculating seeds with Rhizobium leguminosarum bv. phaseoli and adding FYM one week before to rajmash (*Phaseolus vulgaris* L.) seeding. In a similar vein, compared to the control (no seed inoculation and no FYM incorporation in soil), the inoculation of seed improved N fixation and the inclusion of FYM left a net positive balance of 42 and 84 kg N, respectively. When FYM was incorporated into the soil and seeds were inoculated, the rate of accessible nitrogen accumulation in the rajmash increased compared to the control group, which did not receive either of these treatments.

Marketable yields of vegetable crops, specifically tomato, bean, cabbage and zucchini (*Cucurbita pepo* L.), did not exhibit statistically significant differences between the organic and conventional farming systems in any of the four years under investigation. Compared to conventional farming, the yields from organic farming were 10% and 3% higher, respectively [63].

According to Sarangthem and Salam [64], the application of decomposed urban trash containing 0.58–1.9 percent total nitrogen, 0.45–0.67 percent available phosphorus, and 1.4–1.8 percent available potash enhanced the bean yield from 53 gm/pot to 228 gm/pot. The response in terms of bean growth and yield (228 g/pot) was higher in the vermiculture-enriched decomposed manure. When compared to inorganic fertiliser (18.44 tonnes), Renuka and Sankar [65] found that the application of organic manures boosted tomato output by two and a half times. Likewise, vermicompost was found to have a noteworthy impact on tomato fruit count by Samawat et al. [40]. Fruit numbers were four times higher in the 100% vermicompost treatment than in the control group. According to Arancon et al. [19], marketable tomato yields in all vermicompost-treated plots were significantly higher than those from the inorganic fertiliser plots when vermicompost was applied at 5 or 10 t/ha. When compared to inorganic fertilisers, the total and marketable fruit production of pepper rose when using vermicompost. According to Thanunathan et al. [66], the combination of soil, mine debris, and coir pith vermicompost (1:1:1) greatly enhanced the height of the onion plants, the number of leaves, and the length of the roots (*Allium cepa* L.). According to Lopes et al. [67], the application of vermicompost at 10 t/ha greatly enhanced cowpea (*Vigna sinensis* L.) nodulation and dry matter yield compared to its lower levels, which are 0 and 5 t/ha.

9. CULTURAL PRACTISES CHANGING

Traditional farming is where many of the preventive measures used in contemporary organic farming originated [68]. Among the first methods of pest management are cultural ones. A tiny alteration in cultural practises will have an effect on the environment overall. Early-planted sweet corn is less susceptible to corn earworm infestations. It is best to avoid planting fish and cauliflower off-season, especially in endemic areas [67]. Brindal treated with different organic manures resulted in a significantly reduced population of whiteflies [69,70] found that spraying DAP in addition to vermic compost made from various organic sources decreased the infestation of stem flies in vegetable pea plants. Godase and Patel [71] discovered that neem cake sprayed at 1.7 t / ha had the lowest infestation of fruit borer and jalapeño shoots (14.3%), although nitrogen fertiliser levels were greater.

10. CONSERVATION TECHNIQUES FOR NATURAL ENEMY RESTORATION

Varghese [18] revealed that a variety of organics and botanicals were equivalent to untreated care and had been shown to be particularly useful for coccinellids and predatory mites. Godase and Patel [72] looked into how natural enemies in a chilli ecosystem were affected by native plant products and cow poop. All of the native sprays described in the research have been observed to benefit from Coccinellids and Chrysoperla spp. Apart from 3% of garlic chilli kerosene. Soumya [17] reports that enhancements to organic soil, such vermicompost, neem cake, and botanical sprays like NSKE and neemazal, have been discovered to be especially advantageous to the natural enemy fauna in the chilli habitat.In comparison to treatments that were fertilised directly, the pest population was lowest in the organically manured treatments, such as vermicompost, neem cake, and farmyard manure. While the leaves of groundnut plants fertilised directly showed higher levels of phenols and tannins and lower levels of nitrogen, the plants that received organic manures showed the opposite. The presence of nitrogen was positively connected with the pest incidence, while phenols and tannins were adversely correlated. The production of phenols and tannins in groundnut plants was stimulated by organic manures; as a result, the induced resistance plays a significant role in the management of groundnut insect pests [73].

11. BOTH ORGANIC AND NON-ORGANIC PESTICIDES

Natural weathering of aluminium minerals, like feldspar, produces kaolin, a clay mostly composed of kaolinite. For usage as a plant protectant, kaolin is ground to a uniform particle size and applied as a water suspension to particular plant areas. It has been demonstrated that this substance works well against both diseases and insects.

By coating the leaves with a white covering that deters insects, kaolin prevents insects from being drawn to the covered plant. It could be challenging to find the insect's host because of the white covering. By establishing an unsuitable food source or egg-laying surface, this also serves as a physical barrier to keep insects out of delicate areas and as a repellent [74].

12. LIMITATIONS OF USING AN ORGANIC METHOD TO PROTECT PLANTS

- The high expense of organic pesticide inputs, the dearth of organic pesticide inputs, the lack of a market for organic pesticides, and poorer yield all hinder plant protection in organic farming.
- Compared to synthetic pesticides, natural pesticides usually have shorter residual periods and are less effective since they decompose in the environment more quickly.
- The other main barriers include ignorance, limited job opportunities, and lack of experience with organic pesticides.

13. MOTIVES FOR FURTHER INVESTIGATION

- Provide weather-based agricultural insect, pest, and disease forecasting modules.

- Diseases and pest insects are surveyed and managed.
- Determining the origins of resistance to important agricultural diseases and insect pests
- Assessment of bioagents, microbes, and plants for their insecticidal potential against agricultural pests.
- Creation of modules to manage disease in important crops.
- Establishing economic threshold values that are depending on the environment for the main pests in agroclimatic settings.
- Plant insects, diseases, and insecticide, fungicide, and pesticide resistance are tracked and controlled.

14. CONCLUSION

The Green Revolution is currently facing serious environmental problems, such as the degradation of the environment and the depletion of all natural resources, such as soil, water, air, forests, biodiversity, and so forth. The only workable and effective answer to these serious issues is organic farming. Theoretically, a wide range of optimal crop security options are available for any given crop, location, labour availability, and money availability. A few examples include timing, integrated pest management, agricultural production that is organic, natural, biodynamic, and biological, and security systems.

While alternative methods may use radically different conceptual frameworks, they can also function as workable groupings of the most effective crop production management practises.
To promote and develop alternative crop protection measures that are economically, socially, and environmentally feasible, it may be necessary to conduct alternative research and to implement alternative pricing, land-use, and agricultural policies. Researchers will concentrate on locating and acquiring access to a collection of crop production tools and techniques that combine to form a preferred growth syndrome in order to boost crop safety in organic farming. High-quality food can be produced through organic farming without negatively impacting the environment or the health of the land. In order to meet the demands of the global market for organic production, it is necessary to select appropriate crops and products on a regional basis. Due to its obligations to ensure food and nutritional security, the region as a whole cannot afford to switch to organic food at this time. This will lead to wealth and peace in India as well as plenty of job opportunities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Howard A. An Agricultural Testaments, Oxford University Press; 1940.
2. Stockdale EA, Lampkin NH, Hovi M, et al. Gronomic and environmental implications of organic farming systems. Advances in Agronomy. 2001;70:261–327,.
3. Chhonkar PK. “Organic farming myth and reality,” in Proceedings of the FAI Seminar on Fertilizer and Agriculture Meeting the Challenges, New Delhi, India, December; 2002.
4. Sofia PK, Prasad R, Vijay VK. Organic farming-tradition reinvented. Indian Journal of Traditional Knowledge. 2006;5(1)139–142.
5. Chandra S, Chauhan SK. Prospects of organic farming in India. Indian Farming. 2004;52(2):11–14.
6. Sharma AR, Mitra BN. Complementary effect of organic material in rice-wheat crop sequence. The Indian Journal of Agricultural Sciences. 1990;60(3):163–168.
7. Ranganathan DS, Selvaseelan DA. Mushroom spent rice straw compost and composted coir pith as organic manures for rice. Journal of the Indian Society of Soil Science. 1997;45(3):510–514,.
8. Singh G, Singh OP, Yadava RA, Singh PP, Nayak R. Response of rice (*Oryza sativa*) varieties to nitrogen levels in flash flood conditions. Indian Journal of Agronomy. 1998;3(3):506–510.
9. Nambiar KKM, Soni PN, Vats MR, Sehgal DK, Mehta DK. AICRP on long term fertilizer experiments. Annual Reports 1987-88 and 1988-89, IARI, New Delhi, India; 1992.
10. Kalyan S. Development of sustainable farming system model for the Irrigated agro-ecosystem of Eastern UP, ICAR, Ad-hoc project. Final Annual Report, Department of Agronomy, Institute of Agricultural Science, Banaras Hindu University, Varanasi, India; 2005.
11. Inoko A. Compost as source of plant nutrients. In Organic Matter and Rice, S.

Banta and C. V. Mendoza, Eds. 1984;137–146. IRRI, Los Banos, Philippines.
12. Zhu ZI, Liu CQ. Jiang BF. Mineralization of organic nitrogen, phosphorus and sulphur in some paddy soils in China," in Organic Matter and Rice. IRRI, Los Banos, Philippines. 1984;259–272.
13. Tandon HLS. Fertilizers and their integration and organics and bio-fertilizers. in Fertilizers, Organic Manures, Recyclable Wastes and Bio-Fertilizers, H. L. S. Tandon, Ed. FDCO, New Delhi, India 1992;32–36.
14. Gaur AC. Bulky organic manures and crop residues. In Fertilizer Organic Manures Recyclable Wastes and Bio-Fertilizers, H. L. S. Tandon, Ed., Fertiliser Development and Consultation Organisation, New Delhi, India; 1992.
15. Prabhakar RT, Umadevi M, Chandrasekhar RP. Effect of fly ash and farm yard manure on soil properties and yield of rice grown on an inceptisol. Agricultural Science Digest. 2010;30(4): 281–285.
16. Timsina J, Connor DJ. Productivity and management of rice-wheat cropping systems: Issues and challenges. Field Crops Research. 2001;69(2):93–132.
17. Soumya G. Role of vermicompost, vermiwash and other organics in the management of thrips and mites of chilli. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, India; 2007.
18. Varghese T.S. Management of thrips, Scirtothrips dorsalis Hood and mite, Polyphagotarsonemus latus Banks on chilli using biorationals. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, India; 2003.
19. Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lee S, Welch C. Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries, the 7th international symposium on earthworm ecology, Cardiff, Wales, 2002, Pedobiologia. 2003;47(5-6):731–735.
20. Singh KN, Prasad B, Sinha SK. Effect of integrated nutrient management on a Typic Haplaquant on yield and nutrient availability in a rice-wheat cropping system. Australian Journal of Agricultural Research. 2001;52(8):855–858.
21. Singh KN, Sharma IP. Srivastava VC. Effect on FYM fertilizer and plant density on productivity of rice-what sequence. Journal of Research, Birsa Agricultural University. 2001;13(2):159–162.
22. Edwards CA, Lofty JR. The invertebrate fauna of the Park Grassplots. I: soil fauna. Rothamsted Report, part. 1974;2:133–154,.
23. Amir K, Fouzia I. Chemical nutrient analysis of different composts (Vermicompost and Pitcompost) and their effect on the growth of a vegetative crop Pisum sativum. Asian Journal of Plant Science and Research. 2011;1(1):116–130.
24. Pal M. Basics of agriculture, jain brothers, New Delhi, India; 2002.
25. Tamaki M, Itani T, Nakano H. Effects of organic ad inorganic fertilizers on the growth of rice plants of rice plants under different light intensities," Japanese Journal of Crop Science. 2002;71(4):439–445.
26. Onduru DD, Diop JM, Van der Werf E, De Jager A. Participatory on-farm comparative assessment of organic and conventional farmers' practices in Kenya," Biological Agriculture and Horticulture. 2002;19(4): 295–314.
27. Yadav SK, Yogeshwar S, Yadav MK, Subhash B, Kalyan S. Effect of organic nitrogen sources on yield, nutrient uptake and soil health under rice (*Oryza sativa*) based cropping sequence. Indian Journal of Agricultural Sciences. 2013;83(2):170–175.
28. Surekha K. Nitrogen-release pattern from organic sources of different C : N ratios and lignin content, and their contribution to irrigated rice (*Oryza sativa*). Indian Journal of Agronomy. 2007;52(3):220–224.
29. Chan KY, Dorahy C, Wells T, et al. Use of garden organic compost in vegetable productionunder contrasting soil P status," Australian Journal of Agricultural Research. 2008;59(4):374–382.
30. Kalembasa D. The effects of vermicompost on the yield and chemical composition of tomato. Zeszyty Problemowe Postępów Nauk Rolniczych. 1996;437:249–252,.
31. Singh J, Bhat SS, Sudharshan MR, Jasvir-Singh, Sreekrishna-Bhat S. Performance of Scotch Bonnet chilli in Karnataka and its response to vermicompost," Indian Cocoa, Arecanut & Spices Journal. 1997; 21:9–10.
32. Tomar VK, Bhatnagar RK, Palta RK. Effect of vermicompost on production of brinjal

and carrot. Bhartiya Krishi Anusandhan Patrika. 1998;13(3-4):153–156,.

33. Kalembasa S, Deska J. The possibility of utilizing vermicompost in the cultivation of radish and paprika," Annals of Agricultural University of Poznan. 1998;27: 131–136.
34. Reddy R Reddy MAN, Reddy YTN, Reddy NS, Anjanappa M. Effect of organic and inorganic sources of NPK on growth and yield of pea," Legume Research. 1998; 21(1):57–60,.
35. Manjarrez MJ, Martinez R, Ferrera Cerrato M, Gonzalez Chavez C. Effect of vermicompost and mycorrhizal fungi on growth and photosynthetic rate of chilli," Terra. 1999;17(1):9–15,.
36. Atiyeh RM, Arancon N, Edwards CA, Metzger JD. Influence of earthworm-processed pig manure on the growth and yield of greenhouse tomatoes," Bioresource Technology.2000l;75(3):175–180.
37. Ribeiro LG, Lopes JC, Martins FS, Ramalho SS. Effect of organic fertilizer application on sweet pepper yield. Horticultura Brasileira. 2000;18:134–137,.
38. Shreeniwas CH, Muralidhar S, Rao MS. Yield and quality of ridge gourd fruits as influenced by different levels of inorganic fertilizers and vermicompost. Annals of Agricultural Research. 2000;1:262–266.
39. Rao TSS, Sankar CR. Effect of organic manures on growth and yield of brinjal. South Indian Horticulture. 2001;49:288–291.
40. Samawat S, Lakzian A, Zamirpour A. The effect of vermicompost on growth characteristics of tomato. Agricultural Science and Technology. 2001;15,(2):83–89.
41. Choudhary RS, Das A, Patnaik US. Organic farming for vegetable production using vermicompost and FYM in Kokriguda watershed of Orissa," Indian Journal of Soil Conservation. 2003;31(2):203–206.
42. Hashemimajd K, Kalbasi M, Golchin A, Shariatmadari H. Comparison of vermicompost and composts as potting media for growth of tomatoes. Journal of Plant Nutrition. 2004;2796):1107–1123.
43. Patil MP, Hulamani NC, Athani SI, Patil MG. Response of tomato (*Salanum tuberosum*) cv. Kufri Chandramukhi to integrated nutrient management. Advances in Agricultural Research in India. 1997;8: 135–139.
44. Sawicka B, Barbas P, Kus J. Variability of potato yield and its structure in organic and integrated crop production systems. Electronic Journal of Polish Agricultural Universities. 2007;10(1):425–427.
45. Haase T, Schüler C, Haase NU, Heß J. Suitability of organic potatoes for industrial processing: effect of agronomical measures on selected quality parameters at harvest and after storage," Potato Research. 2007;50(2);115–141,
46. Mourao I, Brito LM, Coutinho J. Cultivating the-future based-on science, volume-1: Organic crop-production," in Proceedings of the 2nd Scientific Conference of the International Society of Organic Agriculture Research ISOFAR, held at the 16th IFOAM Organic World Conference in Cooperation with the International Federation of Organic Agriculture-Movements IFOAM and the Consorzio ModenaBio. International Society of Organic Agricultural Research (ISOFAR), Bonn, Germany. June 2008;596–599.
47. Tripathi SC, Chauhan DS, Sharma RK, Dhillon OP. Productivity and economics of different wheat (*Triticum aestivum*) based cropping sequences," Indian Journal of Agronomy. 1999;44(2):237–241,.
48. Singh RA. Feasibility of vermi-farming in peanut (*Arachis* hypogaea)-vegetable pea (*Pisum sativum*) cropping system," Indian Journal of Agronomy. 2000;45(2):257–262.
49. Jat RS, Ahlawat IPS. Direct and residual effect of vermicompost, biofertilizers and phosphorus on soil nutrient dynamics and productivity of chickpea-fodder maize sequence. Journal of Sustainable Agriculture. 2006;28(1):41–54.
50. Baswana KS, Rana MK. Effect of organic sources and biofertilizers on growth and yield of garden pea (*Pisum sativum* L). Haryana Journal of Horticultural Sciences. 2007;36(3-4):326–330
51. EL-Dkeshy MHZ, Abbas H, Abdalla R, Kandeel NN. Evaluation of the Efficiency of Various Organic Fertilizers on the Growth and Head Yield of Cabbage. Assiut Journal of Agricultural Sciences. 2022;53(2):118-128.
    DOI: 10.21608/ajas.2022.125135.1104
52. Dayal D, Agarwal SK. Response of sunflower genotypes (*Helianthus annuus*) to nutrient management. Indian Journal of Agricultural Sciences. 1999;69(1):10–13,.
53. Somasundaram E, Mohamed MA, Thirukkumaran K, Chandrasekaran K,

Vaiyapuri, Sathyamoorthi K. Biochemical changes, nitrogen flux and yield of crops due to organic sources of nutrients under maize based cropping system," Journal of Applied Sciences Research. 2007;3:1724–1729.

54. Trivedi A, Nandeha N, Mishra S. Dryland agriculture and farming technology: Problems and Solutions. Climate resilient smart agriculture: approaches & techniques. 2022;35-51.
55. Silwana TT, Lucas EO, Olaniyan AB. The effects of inorganic and organic fertilizers on the growth and development of component crops in maize/bean intercrop in Eastern Cape of South Africa. Journal of Food, Agriculture and Environment. 2007; 5(1):267–272,.
56. Sangakkara R, Bandaranayake P, Dissanayake U, Gajanayake JN. Organic matter addition in organic farming—impact on root development and yields in maize and cowpea over dry seasons," in Proceedings of the 2nd Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR '08), held at the16th IFOAM Organic World Conference in Cooperation with the International Federation of Organic-Agriculture Movements IFOAM and the Consorzio ModenaBio, Modena, Italy; June 2008.
57. Seo J, Lee HJ. Mineral nitrogen effects of hairy vetch (*Vicia villosa* Roth) on maize (*Zea mays* L.) by green manure amounts. Journal of Agronomy. 2008;7(3):272–276.
58. Verma NS, Trivedi A, Rao KVR, Rajwade Y, Yadav D. Organic and Sustainable Agriculture for Livelihood Security. Climate resilient smart agriculture: Approaches & techniques. 2022;52-65.
59. Trivedi A, Verma NS, Nandeha N, Yadav D, Rao KVR, Rajwade Y. Spatial Data Modelling: Remote Sensing Sensors and Platforms. Climate resilient smart agriculture: approaches & techniques. 2022;226-240.
60. Adiku SGK, Jones JW, Kumaga FK, Tonyigah A. Effects of crop rotation and fallow residue management on maize growth, yield and soil carbon in a savannah-forest transition zone of Ghana. Journal of Agricultural Science. 2009; 147(3):313–322.
61. Oliveira AZ. Ferreira DS, Casta CC, Silva AF, Alves EV. Utilization of cattle manure and earthworm compost in hybrid cabbage production. Horticulture Brasileira. 2001; 13:70–73.
62. Datta N, Rana MC, Sharma RP. Effect of seed inoculation and farm yard manuring on nitrogen balance and yield in Rajmash (*Phaseolus vulgaris*). Indian Journal of Plant Physiology. 2006;11(1):108–112.
63. Tabaglio V, Gavzzi C, Nervo G. Cultivating the future based on science. Volume 1: organic crop production, in Proceedings of the 2nd Scientific Conference of the International Society of Organic Agriculture Research, held at the 16th IFOAM Organic World Conference in Cooperation with the International Federation of Organic Agriculture Movements (IFOAM) and-the-Consorzio ModenaBio, International Society of Organic Agriculture Research, Modena, Italy June 2008;328–331.
64. Sarangthem I, Salam JS. Recycling of the urban waste as manure on French bean (*Phaseolus vulgaris*) as test crop. Indian Journal of Agricultural Research. 2008; 42(2):124–127.
65. Renuka B, Sankar CR. Effect of organic manures on growth and yield of tomato. South Indian Hort. 2001;49:216–219,.
66. Thanunathan K, Natarajan S, Sentikumar R, Asulmurogan K. Effect of different sources of organic amendments on growth and yield of onion in mine spoil. Madras Agricultural Journal. 1997;84(7): 382–384.
67. Shivalingaswamy TM, Satpathy S. Integrated Pest Management in Vegetable Crops. In: Entomology: Novel Approaches, [(Eds) Jain, P.C. and Bhargava, M.C.], New India Publishing Agency, New Delhi. 2007;353-75.
68. Verma NS, Rao KVR, Rajwade Y, Yadav D, Trivedi A. Integrated Pest Management: A holistic approach towards crop protection. Recent Developments in Agriculture. 2022;103-115.
69. Godase SK, Patel CB. Studies on the influence of organic manures and fertilizerdoses on the intensity of sucking pests infesting brinjal. Plant Protection Bulletion. 2002;54(2):3-6.
70. Mahto TP, Yadav RP. Effect of vermicompost prepared from different organic sources alone or in combination with chemical fertilizer on stem fly incidence and yield parameters in vegetable pea Rajasthan University of Agriculture. Journal of Research. 2003; 13(1 and 2):26-29.

71. Godase SK, Patel CB. Effect of different treatments of organic manures and fertilizers on infestation of brinjal shoot and fruit borer. Pestology. 2003;27(5):9-12.
72. Kumar. Evaluation of organics and indigenous products for the management of Helicoverpa armigera in chilli. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, India; 2004.
73. Rao KR. Influence of host plant nutrition in the incidence of Spodoptera litura and *Helicoverpa armigera* on groundnut. Indian Journal of Entomology. 2003;65(3):386-392.
74. Haldhar SM, Jat GC, Deshwal HL, Gora JS, Singh D. Insect Pest and Disease Management in Organic Farming. Research Gate. 2017;359-390.

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