Organic farming: Its relevance to the Indian context

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Increasing consciousness about conservation of environment as well as health hazards associated with agrochemicals and consumers’ preference to safe and hazard-free food are the major factors that lead to the growing interest in alternate forms of agriculture in the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. The demand for organic food is steadily increasing both in the developed and developing countries with an annual average growth rate of 20–25%. Organic agriculture, without doubt, is one of the fastest-growing sectors of agricultural production. However, there are certain issues that should be clarified before we go for a large-scale conversion to organic agriculture. The most important issues are – Can organic farming produce enough food for everybody? Is it possible to meet the nutrient requirements of crops entirely from organic sources? Are there any significant environmental benefits that accrue from organic farming? Is the food produced by organic farming superior in quality? Is it economically feasible? In this article, we review these aspects of organic farming. In India, vast stretches of arable land, which are mainly rain-fed and found in the Northeastern region where negligible amount of fertilizers and pesticides are being used and have low productivity, could be exploited as potential areas for organic agriculture. Considering the potential environmental benefits of organic production and its compatibility with integrated agricultural approaches to rural development, organic agriculture may be considered as a development vehicle for developing countries like India, in particular.

GREEN revolution technologies involving greater use of synthetic agrochemicals such as fertilizers and pesticides with adoption of nutrient-responsive, high-yielding varieties of crops have boosted the production output per hectare in most cases. However, this increase in production has slowed down and in some cases there are indications of decline in productivity and production. Moreover, the success of industrial agriculture and the green revolution in recent decades has often masked significant externalities, affecting natural resources and human health as well as agriculture itself. Environmental and health problems associated with agriculture have been increasingly well documented, but it is only recently that the scale of the costs has attracted the attention of planners and scientists. The external costs of agriculture in the UK have been estimated as 1.1–3.9 billion pounds per annum. As the external costs of farming are not internalized in the price of food, tax payers (or more likely the future generations) will have to pay the bill that is getting bigger every day.

Increasing consciousness about conservation of environment as well as of health hazards caused by agrochemicals has brought a major shift in consumer preference towards food quality, particularly in the developed countries. Global consumers are increasingly looking forward to organic food that is considered safe and hazard-free. The global market for organic food is expected to touch US$ 29 to 31 billion by 2005. The demand for organic food is steadily increasing both in developed and developing countries, with annual average growth rate of 20–25%. Worldwide, over 130 countries produce certified organic products in commercial quantities.

The concept of organic agriculture

Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. Organic production systems are based on specific standards precisely formulated for food production and aim at achieving agro ecosystems, which are socially and ecologically sustainable. It is based on minimizing the use of external inputs through use of on-farm resources efficiently compared to industrial agriculture. Thus the use of synthetic fertilizers and pesticides is avoided.
Organic ‘in organic agriculture is a labelling term that denotes products that have been produced in accordance with certain standards during food production, handling, processing and marketing stages, and certified by a duly constituted certification body or authority. The organic label is therefore a process claim rather than a product claim. It should not necessarily be interpreted to mean that the foods produced are healthier, safer or all natural. It simply means that the products follow the defined standard of production and handling, although surveys indicate that consumers consider the organic label as an indication of purity and careful handling. Organic standard will not exempt producers and processors from compliance with general regularity requirements such as food safety regulations, pesticide registrations, general food and nutrition labelling rules, etc.

Many definitions have been proposed for organic agriculture. Ethical issues such as fair labour practices and animal ethics have also been included in organic agriculture definitions. All these however primarily focus on ecological principles as the basis for crop production and animal husbandry. To promote organic agriculture and to ensure fair practices in international trade of organic food, the Codex Alimentarius Commission, a joint body of FAO/WHO framed certain guidelines for the production, processing, labelling and marketing of organically produced foods, with a view to facilitate trade and prevent misleading claims.

The Codex Alimentarius Commission defines organic agriculture as a holistic food production management system, which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system.

Organic versus conventional agriculture

In recent years, there is a lot of debate between the proponents of organic farming and a section of the community who questioned the scientific validity and feasibility of organic farming. The most often debated issues on organic agriculture fall under the following six categories:

(i) Can organic farming produce enough food for everybody?
(ii) Is it possible to meet the nutrient requirements of crops entirely from organic sources?
(iii) Are there any significant environmental benefits of organic farming?
(iv) Is the food produced by organic farming superior in quality?
(v) Is organic agriculture economically feasible?
(vi) Is it possible to manage pests and diseases in organic farming?

In this article, a brief review on the above aspects of organic farming is presented. The review is made mostly from research work conducted elsewhere, since most of the published data on organic farming comes from developed nations; but wherever possible, Indian literature is taken into account. This review is not exhaustive, but indicative on certain pertinent aspects of organic farming, which are often talked about and debated, particularly with reference to its adoption among Indian farming communities, especially under rainfed zones, tribal areas and northeast mountain areas, where use of agrochemical is low or negligible.

Can organic farming produce enough food for everybody?

Organic agriculture and yield

Yields relative to comparable conventional systems are directly related to the intensity of farming of the prevailing conventional systems. This is not only the case for comparison between regions, but also between crops within a region, and for individual crops over time. An over-simpli-
fication of the impact of conversion to organic agriculture on yield indicates that:

(i) In intensive farming systems, organic agriculture decreases yield; the range depends on the intensity of external input use before conversion 9-12.

(ii) In the so-called green revolution areas (irrigated lands), conversion to organic agriculture usually leads to almost identical yields 13,14.

(iii) In traditional rain-fed agriculture (with low external inputs), organic agriculture has shown the potential to increase yields 15,16.

A number of studies have shown that under drought conditions, crops in organic agriculture systems produce significantly higher yields than comparable conventional agricultural crops 9,17, often out-yielding conventional crops 10,18,19 by 7-90%. Others have shown that organic systems have less long-term yield variability 20,21. A survey of 208 projects in developing tropical countries in which contemporary organic practices were introduced, showed average yield increases of 5-10% in irrigated crops and 50-100% in rainfed crops 22.

The so-called organic transition effect, in which a yield decline in the first 1–4 years of transition to organic agriculture, followed by a yield increase when soils have developed adequate biological activity 20,23,24, has not been borne out in some reviews of yield comparison studies 25,26. Trials conducted on organic cotton at Nagpur indicated that after the third year, the organic plot, which did not receive fertilizers and insecticides, produced as much cotton as that cultivated with them 27. Similarly, studies conducted in Punjab clearly indicated that organic farming gave higher or equal yields of different cropping systems compared to chemical farming after an initial period of three years 14.

Organic agriculture and food security

The common claim that large-scale conversion to organic agriculture would result in drastic reduction in world food supplies or large increases in conversion of undisturbed lands to agriculture 26,27, has not been borne out in modeling studies. Conversion studies showed that domestic food consumption would not suffer, exports would vary depending on crop, but the structure of farming would definitely change with more diversification of agriculture 28. Widespread conversion to organic agriculture would result in crop yield increase over the current averages as a result of increased investment in research and extension 29.

In northern Europe domestic food demand could be met with organic methods, but food would be more expensive 30. Similar conclusions were also reached in studies in the US 31. A German study concluded that if the per capita dietary calories from meat were reduced to 21% from the current 39%, all German crop lands could be converted to organic agriculture without an increase in imports or expansion of agricultural land. According to the report such a conversion would be possible by 2017, as the survey indicated that 40% of German youth have planned to maintain low or no-meat diets 32. The threshold for this conversion may come sooner, as abandonment of meat-consumption is accelerating in Europe as a result of BSE 33. Several studies have proved the benefits of vegetarian diet over non-vegetarian in terms of energy consumed for food production as well as other nutritional advantages.

Organic farmers grow a variety of crops and maintain livestock in order to optimize use of nutrients and the space between species. This ensures economic advantages through low crop production or yield failure due to biotic and abiotic factors in all of these simultaneously. This can have an important impact on local food security and resilience. In rain-fed systems, organic agriculture has demonstrated to out-perform conventional agricultural systems under environmental stress conditions 9,10,20. Under the right circumstances, the market returns from organic agriculture can potentially contribute to local food security by increasing family income. At the global level, especially in developing countries with high population pressure, and with the present state of knowledge and technology, organic farmers cannot produce enough food for everybody.

Nutrient management in organic farming

Organic farming is often understood as a form of agriculture with use of only organic inputs for the supply of nutrients and management of pests and diseases. In fact, it is a specialized form of diversified agriculture, wherein problems of farming are managed using local resources alone. The term organic does not explicitly mean the type of inputs used; rather it refers to the concept of farm as an organism. Often, organic agriculture has been criticized on the grounds that with organic inputs alone, farm productivity and profitability might not be improved because the availability of organic sources is highly restricted 7. True, organic resources availability is limited; but under conditions of soil constraints and climate beggaries, organic inputs use has proved more profitable compared to agrochemicals 15.

Organic farming systems rely on the management of soil organic matter to enhance the chemical, biological and physical properties of the soil. One of the basic principles of soil fertility management in organic systems is that plant nutrition depends on ‘biologically-derived nutrients’ instead of using readily soluble forms of nutrients; less available forms of nutrients such as those in bulky organic materials are used. This requires release of nutrients to the plant via the activity of soil microbes and soil animals. Improved soil biological activity is also known to play a key role in suppressing weeds, pests and diseases 34.

Animal dung, crop residues, green manure, biofertilizers and bio-solids from agro-industries and food processing wastes are some of the potential sources of nutrients of orga-
nic farming. While animal dung has competitive uses as fuel, it is extensively used in the form of farmyard manure. Development of several compost production technologies like vermicomposting, phosphocomposting, N-enriched phosphocomposting, etc. improves the quality of composts through enrichment with nutrient-bearing minerals and other additives. These manures have the capacity to fulfil nutrient demand of crops adequately and promote the activity of beneficial macro- and micro-flora in the soil.

There are several doubts in the minds of not only farmers, but also scientists about whether it is possible to supply the minimum required nutrients to crops through organic sources alone. Even if it is possible, how are we going to mobilize the organic matter? At this juncture, it is neither advisable nor feasible to recommend the switchover from fertilizer use to organic manure under all agro-ecosystems. Presently, only 30% of our total cultivable areas has irrigation facilities where agrochemicals use is higher compared to rain-fed zones. It is here that ingenuity and efforts are required to increase crop productivity and farm production despite recurrence of environmental constraints of drought and water scarcity.

The basic requirement in organic farming is to increase input use efficiency at each step of the farm operations. This is achieved partly through reducing losses and adoption of new technologies for enrichment of nutrient content in manure. Technologies to enrich the nutrient supply potential from manure, including farmyard manure three to four times are being widely used in organic farms. According to a conservative estimate, around 600 to 700 million tonnes (mt) of agricultural waste is available in the country every year, but most of it is not used properly. We must convert our filth into wealth by mobilizing all the biomass in the rural and urban areas into bioenergy to supply required nutrients to our starved soil and fuel to farmers. India produces about 1800 mt of animal dung per annum. Even if two-thirds of the dung is used for biogas generation, it is expected to yield biogas not less than 120 m³ per day. In addition, the manure produced would be about 440 mt per year, which is equivalent to 2.90 mt N, 2.75 mt P₂O₅ and 1.89 mt K₂O.

Organic farms and food production systems are quite distinct from conventional farms in terms of nutrient management strategies. Organic systems adopt management options with the primary aim to develop whole farms, like a living organism with balanced growth, in both crops and livestock holding. Thus nutrient cycle is closed as far as possible. Only nutrients in the form of food are exported out of the farm. Crop residues burning is prohibited; so also the unscientific storage of animal wastes and its application in the fields. It is, therefore, considered more environment friendly and sustainable than the conventional system. Farm conversion from high-input, chemical-based system to organic system is designed after undertaking a constraint analysis for the farm with the primary aim to take advantage of local conditions and their interactions with farm activities, climate, soil and environment, so as to achieve (as far as possible) closed nutrient cycles with less dependence on off-farm inputs. This implies that the only nutrients leaving the farm unit are those for human consumption.

Crop rotations and varieties are selected to suit local conditions having the potential to sufficiently balance the nitrogen demand of crops. Requirements for phosphorus, sulphur and micronutrients are met with local, preferably renewable resources. Organic agriculture is, therefore, often termed as knowledge-based rather than input-based agriculture. Furthermore, organic farms aim to optimize the crop productivity under a given set of farm conditions. This is in contrast to concept of yield maximization through the intensive use of agrochemicals, irrigation water and other off-farm inputs. There are ample evidences to show that agrochemical-based, high-input agriculture is not sustainable for long periods due to gradual decline in factor productivity, with adverse impact on soil health and quality.

Environmental benefits of organic agriculture

The impact of organic agriculture on natural resources favours interactions within the agro-ecosystem that are vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrient cycling, predation, pollination and habitats. The environmental costs of conventional agriculture are substantial, and the evidence for significant environmental amelioration via conversion to organic agriculture is overwhelming. A review of over 300 published reports showed that out of 18 environmental impact indicators (floral diversity, faunal diversity, habitat diversity, landscape, soil organic matter, soil biological activity, soil structure, soil erosion, nitrate leaching, pesticide residues, CO₂, N₂O, CH₄, NH₃, nutrient use, water use and energy use), organic farming systems performed significantly better in 12 and performed worse in none. There are also high pre-consumer human health costs to conventional agriculture, particularly in the use of pesticides. It is estimated that 25 million agricultural workers in developing countries are poisoned each year by pesticides.

Safety and quality of organically produced food

There is a growing demand for organic foods driven primarily by the consumer’s perceptions of the quality and safety of these foods and to the positive environmental impact of organic agriculture practices. The ‘organic’ label is not a health claim, it is a process claim. It has been demonstrated that organically produced foods have lower levels of pesticides and veterinary drug residues and in many cases lower nitrate contents. No clear trends have, however, been established in terms of organoleptic quality differences between organically and conventionally grown foods.
There have been many claims that eating organic foods increases exposure to microbiological contaminants. But studies investigating these claims have no evidence to support them. Organic foods must meet the same quality and safety standards applied to conventional foods. These include the CODEX General Principles of Food Hygiene and Food Safety Programmes based on the Hazard Analysis and Critical Control Point. Analysis of pesticide residues in produce in the US and Europe has shown organic products have significantly lower pesticide residues than conventional products. Nitrates are significant contaminants of foods, generally associated with intensive use of nitrogen fertilizers. Studies that compared nitrate contents of organic and conventional products found significantly higher nitrates in conventional products.

There are also claims that food produced by organic methods tastes better and contains a better balance of vitamins and minerals than conventionally grown food. However, there is no clear scientific evidence, with some studies showing increase in vitamin C, minerals and proteins, more sweeter and less tart apples and others not. A crude analysis of the literature, however, favours organic products in this area. A tasting panel convened by the Consumer Association in the United Kingdom did not consistently favour the taste of organic fruits and vegetables. Quality after storage has been reported to be better in organic products relative to conventional products after comparative tests. Reviews of organic vs conventional product sensory analysis studies have reported results that do not clearly substantiate claims of superior organic product tastiness.

It is a known fact that the quality of crops is controlled by a complex interaction of factors, including soil type and the ratio of minerals in added compost, manure and fertilizer. So it is difficult to separate the influence of the environment and farming system. There is scope to generate information on the quality of produce generated on organic farms in future studies.

Economics of organic farming

The replacement of external inputs by farm-derived resources normally leads to a reduction in variable input costs under organic management. Expenditure on fertilizers and sprays is substantially lower than in conventional systems in almost all the cases. In a few cases, higher input costs due to the purchase of compost and other organic manure have been reported. Studies have shown that the common organic agricultural combination of lower input costs and favourable price premiums can offset reduced yields and make organic farms equally and often more profitable than conventional farms. Studies that did not include organic price premiums have given mixed results on profitability.

Studies from Europe and Canada show labour costs in organic agriculture average 40–50% higher where the wage rates are generally higher. Gross margins, the difference between farm output and variable costs are generally similar or, where there are favourable price premiums, higher in organic agriculture. The economics of organic cotton cultivation over a period of six years indicated that there is a reduction in cost of cultivation and increased gross and net returns compared to conventional cotton cultivation in India.

Pest and disease management in organic farming

Pest control in organic farming begins by making sensible choices, such as growing crops that are naturally resistant to diseases and pests, or choosing sowing times that prevent pest and disease outbreaks. Careful management in both time and space of planting not only prevents pests, but also increases population of natural predators that can contribute to the control of insects, diseases and weeds. Other methods generally employed for the management of pests and diseases are: improving soil health to resist soil pathogens and promote plant growth; rotating crops; encouraging natural biological agents for control of diseases, insects and weeds; using physical barriers for protection from insects, birds and animals; modifying habitat to encourage pollinators and natural enemies of pests; and using semi-chemicals such as pheromone attractants and trap pests.

Organic farmers have long maintained that synthetic fertilizers and pesticides increase crop susceptibility to pests. Research substantiates some of these claims. Organic crops have been shown to be more tolerant as well as resistant to insect attack. Organic rice is reported to have thicker cell walls and lower levels of free amino acid than conventional rice. Plant susceptibility to insect herbivory has been shown in numerous studies to be associated with high plant N levels related to high inputs of soluble N fertilizers. Free amino acids, associated with high N applications, have been reported to increase pest attack.

Soil-borne root diseases are generally less severe on organic farms than conventional farms, while there were no consistent differences in foliar diseases between the systems. The successful control of root diseases in organic systems is likely to be related to the use of long and diverse crop rotations, crop mixtures and regular application of organic amendments. Increased levels of soil microbial activity leading to increased competition and antagonism in the rhizosphere, the presence of beneficial root-colonizing bacterial and increased levels of vesicular-arbuscular mycorrhizal colonization of roots have all been identified as contributing factors in the control of root diseases.

Organic agriculture: Its relevance to Indian farming

Only 30% of India’s total cultivable area is covered with fertilizers where irrigation facilities are available and in the remaining 70% of arable land, which is mainly rain-fed, negligible amount of fertilizers is being used. Farmers in...
these areas often use organic manure as a source of nutrients that are readily available either in their own farm or in their locality. The northeastern region of India provides considerable opportunity for organic farming due to low utilization of chemical inputs. It is estimated that 18 million hectares of such land is available in the NE, which can be exploited for organic production. With the sizable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world’s organic market.

The report of the Task Force on Organic Farming appointed by the Government of India also observed that in vast areas of the country, where limited amount of chemicals is used and have low productivity, could be exploited as potential areas for organic agriculture. Arresting the decline of soil organic matter is the most potent weapon in fighting against unabated soil degradation and imperilled sustainability of agriculture in tropical regions of India, particularly those under the influence of arid, semi-arid and humid climate. Application of organic manure is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity.

It is estimated that around 700 million tonnes of agricultural waste is 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 arable land/year, which is equivalent to about 100 kg NPK/ha/yr. However, in reality, only a fraction of this is available for actual field application. Various projections place the tapable potential at around 30% of the total availability. There are several alternatives for supply of soil nutrients from organic sources like vermicompost, biofertilizers, etc. Technologies have been developed to produce large quantities of nutrient-rich manure/compost. There are specific biofertilizers for cereals, millets, pulses and oilseeds that offer a great scope to further reduce the gap between nutrient demand and supply. There is no doubt that organic agriculture is in many ways a preferable pattern for developing agriculture, especially in countries like India.

Conclusions

The interest in organic agriculture in developing countries is growing because it requires less financial input and places more reliance on the natural and human resources available. Studies to date seem to indicate that organic agriculture offers comparative advantage in areas with less rainfall and relatively low natural and soil fertility levels. Labour realizes a good return and this is important where paid labour is almost non-existent. Organic agriculture does not need costly investments in irrigation, energy and external inputs, but rather organic agricultural policies have the potential to improve local food security, especially in marginal areas.

Possibly, the greatest impact of organic agriculture is on the mindset of people. It uses traditional and indigenous farming knowledge, while introducing selected modern technologies to manage and enhance diversity, to incorporate biological principles and resources into farming systems, and to ecologically intensify agricultural production. Instead of being an obstacle to progress, traditions may become an integral part of it. By adopting organic agriculture, farmers are challenged to take on new knowledge and perspectives, and to innovate. This leads to an increased engagement in farming which can trigger greater opportunities for rural employment and economic upliftment. Thus through greater emphasis on use of local resources and self-reliance, conversion to organic agriculture definitely contributes to the empowerment of farmers and local communities.

The following conclusions can be drawn on important issues regarding organic farming:

1. Large-scale conversion to organic agriculture would result in food shortage with the present state of knowledge and technology, as the yield reductions of organic systems relative to conventional agriculture average 10–15%, especially in intensive farming systems. However, in traditional rain-fed agriculture, organic farming has the potential to increase the yield, since 70% of total cultivable land falls in this category. Mere 8–10% increase in farm production would definitely help achieve the targetted growth rate of 4–5% in agricultural production in the Tenth Plan period.

2. Organic manure is an alternative renewable source of nutrient supply. A large gap exists between the available potential and utilization of organic wastes. However, it is not possible to meet the nutrient requirements of crops entirely from organic sources, if 100% cultivable land is converted to organic farming.

3. Organic farming systems can deliver agronomic and environmental benefits both through structural changes and tactical management of farming systems. The benefits of organic farming are relevant both to developed nations (environmental protection, biodiversity enhancement, reduced energy use and CO2 emission) and to developing countries like India (sustainable resource use, increased crop yields without over-reliance on costly external inputs, environment and biodiversity protection, etc.).

4. Organic foods are proved superior in terms of health and safety, but there is no scientific evidence to prove their superiority in terms of taste and nutrition, as most of the studies are often inconclusive.

5. Combination of lower input costs and favourable price premiums can offset reduced yields and make organic farms equally and often more profitable than conventional farms. However, studies that did not include organic price premiums have given mixed results on profitability. Thus it is the premium price on the organic food which decides the economic feasibility of organic farming, at least at the current rate of development in organic agriculture.
(6) In organic farming systems, pest and disease management strategies are largely preventive rather than reactive. In general, pest and disease incidence is less severe in organic farms compared to conventional farms.


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