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Organic farming: Benefits, climate challenges and food security

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Abstract
Organic farming seems to be more appropriate, as it considers the most important aspects like sustainability of natural resources and environment safety. It is a production system which favours maximum use of organic materials (crop residue, animal residue, legumes, on and off - farm wastages, growth regulators, bio-pesticides) and discourages the use of synthetically produced agro-inputs for maintaining soil productivity, fertility and pest management under conditions of sustainable natural resources and healthy environment. It is widely considered that organic food has a better quality from a nutritional point of view when compared with food produced by using traditional production techniques. Also, by doing organic farming we can obtain higher yield with safe environment.

Keywords: organic farming, benefits, climate challenges and food security

Introduction
Organic agriculture refers to a farming system that restricts the use of agrochemicals such as synthetic fertilizers and pesticides, use of Genetically Modified Organisms (GMOs), as well as many other synthetic compounds used as food additives (e.g., preservatives, coloring) (IFOAM, 2008 and 2010) [20, 21]. The first use of the term “organic farming" was done in 1940 by Lord Northbourne in his book “Look to the Land” (Scofield, 1986) [46]. The roots of modern organic farming can be traced in Europe, in the 1st quarter of the early 20th century (Stockdale *et al*., 2001) [49]. Its origins can be traced back in the period of 1920–1930 in North Europe (mostly Germany and UK) (Conford, 2001; Lotter, 2003; Lockeretz, 2007) [6, 31, 29], and it is now widely spread all over the world. In 1924, Dr. Rudolf Steiner, an Austrian philosopher conceptualized and advocated organic agriculture, and in 1927, a trademark ‘Demeter’ was introduced for organic products. Organic movement in India owes its origin primarily to the work of Sir Albert Howard, who believed that a shift from nature’s methods of crop production to adoption of newer methods leads to the loss of soil fertility (Howard, 1940). Organic farming system solely depends on the use of crop residues, animal manures, green manures, off-farm organic wastes, crop rotation incorporating legumes and biological pest control to maintain soil productivity. The philosophy is to feed the soil rather than the crops to maintain soil health, and it is a means of giving back to the nature what has been taken from it (Funtilana, 1990) [12].

Organic farming has received considerable attention in India, and Ministry of Agriculture and Cooperation, Govt. of India constituted a Task Force on Organic Farming under the chairmanship of Dr. Kunwarji Bhai Yadav, Former Director of Department of Agriculture, Gujarat, in year 2000. The Committee in its report emphasized on the need for consolidating the information on organic farming and its benefits. One of the steering committees constituted by this Task Force under the Chairmanship of Dr. M.S. Swamina than, and a Farmers’ Commission has suggested to take up organic farming as a challenging national task and to take up this as a thrust area of the 10th Five-Year Plan. The steering committee advocated giving a boost to organic farming in the rainfed areas and in the north-eastern states where there is limited use of agricultural chemicals. Madhya Pradesh took early lead in this regard and Uttarakhand, and Sikkim followed the suit and these states have declared themselves as organic states (Marwaha and Jat, 2004) [32]. The Ministry of Commerce launched the National Organic Programme in April 2000, and Agricultural and Processed Food Products Exports (APEDA) is implementing the National Programme of Organic Production (NPOP) (Gouri, 2004). Under the NPOP, documents like National Standards, accreditation criteria for accrediting inspection and certification agencies, have been prepared and approved by the

National Steering Committee. An Indian Organic Logo was released in July, 2002. Agriculture and Processed Food Products Export Development Authority (APEDA) Ministry of Commerce, GOI is the key Accreditation agency, the others being Coffee Board, Spice Board, Tea Board, Coconut Development Board and Directorate of Cocoa and cashew Board. Recent survey (The World of Organic Agriculture 2011 and 2012 www.organic-world.net) showed that there was around 1 Mha of land for certified organic food production at the farm level and 3.6 Mha of certified forest area for collection of wild herbs in India during 2010, but the actual area under organic farming is much more. In Maharashtra alone about 0.5 million ha area is under organic farming since 2003; out of this, only 10,000 ha is the certified area. In Nagaland, 3,000 ha area is under organic farming with crops like maize, soybean, ginger, large cardamom, passion fruit and chilli. The state of Rajasthan has 5,631 ha under organic farming with crops like pearl millet, wheat, mung bean, guar, mustard and cotton (Bhattacharya and Chakraborty, 2005) [5]. There is a tremendous potential to increase India's share in international trade on organic food by including commodities such as durum wheat, aromatic rice (e.g. Basmati rice, Keteki Joha), fruits, aromatic/medicinal herbs, vegetables, coffee, pulses, sugar, etc. India has competitive advantages in the world markets due to low production costs and availability of diverse climates to grow a large number of crops round the year (Hazarika *et al*., 2013) [16].

Major benefits of organic farming system

(a) Crop yield and plant diversity

Many reports have shown higher yield in organic agriculture system over the comparable traditional agriculture. Although, many studies reported that in organic farming, transition affect period (first 1-4 year in a land) the crop yield declines, which is followed by yield increment with high biological activity in soil (Liebhardt *et al*, 1989; Peters, 1994; Neera *et al*., 1999) [28, 37, 34]. A report on trial of organic cotton at Nagpur (Maharastra, India) showed that after 3-years of transition period of organic farming, organic farm produced a large amount of cotton as that cultivated earlier (Rajendran *et al*., 2000) [41]. In Punjab, similar report was given which clearly indicates that after initial 3 years of organic farming, organic farming system gave higher or equal yields under different cropping systems in comparison to chemical farming (Kler *et al*., 2002) [44]. Nowadays, this system seems to be beneficial for biodiversity. Organic methods of farming such as rotating crops to build soil fertility and naturally raising animals helps in promoting biodiversity, which returns health to each species. Many reports support this positive effect of organic farming in enhancement of soil fertility and enrichment of biodiversity (Stockdale *et al*., 2000; Rundolf and Smith, 2010; Rundlof *et al*., 2010) [22, 26, 23]. Also, the organic farming practice at local and landscape level, independently, can influence plant species richness (Rundolf and Smith, 2010) [43]. Other report also supports this fact and reported that extension of organic farming could contribute to restoration of biodiversity in agricultural landscapes (Rundlof *et al*., 2010) [44].

(b) Organic farming and environmental earnings

Many reports have indicated that significant environmental amelioration through conversion from conventional farming to organic farming is awesome (Kler *et al*., 2001) [25]. A review report showed that under 12 environmental factors out of 18, organic farming performed better than conventional farming (Kler *et al*., 2002) [26]. Organic farming is a system in which chemicals and pesticides are avoided for crop production. So, organic farming discourages environmental exposure to these harmful inputs and fight for environment protection (Kler *et al*., 2002) [26]. This system can be helpful in fighting against greenhouse effect. It has shown by Rodale Institute Farming Systems (U.S.A) that an organic agriculture system can actually reduce CO_2 and plays an important role in slowing down the climate change. In fact, the Rodale research shows that "If only 10,000 medium sized farms in the U.S. converted to organic production, they would store so much carbon in the soil that would be equivalent to taking 1,174,400 cars off the road, or reducing car miles driven by 14.62 billion miles" (Stolze *et al*., 2000) [50].

(c) Insect and ailment control in organic farming

In organic farming system, prevention from pest and disease is done by means of naturally resistant crops or by selecting suitable sowing times that may avoid disease and subsequent pest epidemics. Other methods are encouragement of natural biological agents for control of diseases, insects, rotating crops, or by using chemicals partly for trapping pests (Ramesh *et al*., 2005) [42]. Some reports have also indicated that organic crops are more tolerant and able to oppose insect attack. Organic rice is reported to have bulky cell wall and lesser level of free amino acid than customary rice (Lotter *et al*., 1999; Kajimura *et al*., 1995) [30, 24]. Studies have reported that root diseases are less severe in organic crops than conventional crops because of regular and prolong use of diverse crop rotation, crop mixtures in organic farming (Van Bruggen, 1995; Azcon Aguilar and Barea, 1996) [51, 1].

(d) Nutrient management and safety of organic foods

In recent time, organic farming system is getting value and popularity due to its positive results in nutrient management and healthy food produced. Crop rotation and use of crop varieties is also a suitable method in this system because of potential to balance the demand of nitrogen for crops (Ramesh *et al*., 2005) [42]. Organic foods, as conventional food, have same quality and safety standards according to CODEX, General Principles of Food Hygiene and Food Safety Programmes (Joint FAO/WHO Food Standards Program, 1999). Studies have found out that Nitrate contaminants are lesser in organic food in comparison to conventional food (Woese *et al*., 1997; Muramoto, 2008) [52, 33].

Climate change challenges for organic agriculture

Organic agriculture avoids nutrient exploitation and increases soil organic matter content. In consequence, soils under organic agriculture capture and store more water than soils under conventional cultivation (Niggli *et al*., 2009) [35]. Production in organic agriculture systems is thus less prone to extreme weather conditions, such as drought, flooding and water logging. Organic agriculture accordingly addresses key consequences of climate change, namely occurrence of extreme weather events, increased water stress and drought and problems related to soil quality (IPCC, 2007a) [22], reduces the vulnerability of the farmers to climate change and variability. It comprises highly diverse farming systems and thus increases the diversity of income sources and the flexibility to cope with adverse effects of climate change and variability, such as changed rainfall patterns. This leads to higher economic and ecological stability through optimized

ecological balance and risk spreading. Secondly, organic agriculture is a low-risk farming strategy with reduced input costs and therefore, lower the risks with partial or total crop failure due to extreme weather events or changed conditions in the wake of climate change and variability (Scialabba and Hattam, 2002; Eyhorn, 2007) [45, 7].

It is considered a viable alternative for poor farmers. Higher farm incomes are thus possible due to low input costs and high sale prices. The coping capacity of the farms is increased and the risk of indebtedness is lowered. In addition, higher prices can be realized for the products via organic certification. Risk management, risk-reduction strategies and economic diversification to build resilience are also prominent aspects of adaptation. Crops and crop varieties used in organic agriculture are usually well adapted to the local environment though local effects of climate variability cannot be foreseen in detail because, at local level, climate change models are not very accurate or even available. Adaptation thus may utilize measures that build on self-adaptive capacity, such as local crop-breeding and the systemic character (on farm breeding) of such sustainable agricultural system is especially adequate for it. Notwithstanding this potential, more research is needed to know how organic farming system performs under increased disease and pest pressures, which are the important effects of climate change on agriculture (IPCC, 2007a) [22] as well as on how local crop varieties adapt to climate change and variability. Organic agriculture also seems to perform better than conventional agriculture under water constraints (Hepperly *et al*., 2006; Badgley *et al*., 2007). Thus, organic agriculture is an adaptation strategy that can be targeted at improving the livelihoods of rural populations and those part of societies that are especially vulnerable to the adverse effects of climate change and variability, for example rural population in sub-Saharan Africa, and their improvements via reducing the financial risk, indebtedness and by increasing diversity (Eyhorn, 2007) [7]. Due to systemic character, organic agriculture is an integrative approach to adaptation. Organic agriculture addresses many of the key challenges identified for adaptation to climate change and variability and it fulfills many other criterias, which are seen as important general prerequisites for such strategies (Slater *et al*., 2007; Prowse and Braunholtz-Speight, 2007; FAO, 2008) [55, 23, 26]. Organic agriculture as a mitigation strategy, addresses both emissions avoidance and carbon sequestration. The first is achieved through:

- Low N_2O emissions (due to lower nitrogen input) - it is usually assumed that 1-2% of the nitrogen applied to farming systems is emitted as N_2O, irrespective of the form of the nitrogen input. The default value currently used by the IPCC is 1.25%, but new research finds considerably lower values, such as semi-arid areas (Barton *et al*., 2008) [4].
- Less CO_2 emissions through erosion (due to better soil structure and more plant cover) -there is usually less erosion in organic farming systems than in conventional ones. The effect of erosion on CO_2 emissions is still controversial (IPCC, 2007b) [23].
- Low CO_2 emissions from farming system inputs (pesticides and fertilizers produced using fossil fuel)

Yield response towards organic farming

All the studies shows the potential of organic farming to produce enough food to feed the world's current population, despite the limited research and development it has received over the last 60 years. Examples include studies, though, limited in scope, indicates that organic agriculture has the potential to contribute "substantially to the global food supply" (Badgley *et al*., 2006). Though conservative about organic agriculture's potential, organic farming provides a good analysis of the strengths, weaknesses, and areas of future development (Halberg's *et al*., 2006). Studies, which deal with additional concerns other than simple yield comparisons, are also useful in pointing out the failure of food distribution under the current system and noted the environment sustainability problems of non-organic farming compared to organic systems (Halberg *et al*., 2006) [15]. Current evidence suggests that it is possible to massively cut the amount of chemical inputs used worldwide without a drop in food availability, through low-input farming methods that use organic techniques.

In reviewing the current data on organic farming's total productive capacity, results generally differ between North and South. Current figures in the North show organic yields to be around 50-100% of those on non-organic farms, depending on the crop and location. These figures come from a wealth of research throughout Europe and North America. The 20 years research at the Rodale institute, USA (Pimentel *et al.*, 2005) [38] has revealed consistently that organic agriculture delivers almost equal yields, uses less energy than non-organic farming and is more environments friendly. In contrast to this, research published in Europe indicates that due to the high inputs of non-organic farming practices there, have shown less favourable yields over US studies. Despite this, another study done in Switzerland for 20 year has shown an average yield of 80% in non-organic plots, while using half of the inputs (Fliessbach *et al.*, 2000) [11].

In contrast to the intensive agriculture of the North, non-organic farming in South typically have low-input with low yield. Here, the introduction of organic agricultural techniques can produce dramatic increases in yield, without financial outlay on new crop varieties, chemical fertilizers, or pesticides. The comparative yield research done in Brazil revealed that switch to organic farming increases maize yields by 20-250% and in Peru the increase in yield is 150% for a range of upland crops (Parrott & Marsden, 2002) [36]. However, despite the limited number of studies in the South in tropical climates, an emerging body of data from a multitude of sources is indicating similar findings (Pretty & Hines, 2001) on the increase in yields, achieved by organic systems. Another example includes a current study (Gibbon *et al.*, 2007) in Uganda and (IFAD, 2005; FAO, 2007) [19, 20] in Asia, has also noted the same studies in places like Ethiopia, Indonesia, and the Philippines, with a same sample size, and in some cases above 350 farms.

The different studies done support the conclusions that global adoption of organic farming would lead to widespread starvation. However, though organic yields look promising, none of the research provides conclusive evidence that organic farming could feed the world. This is primarily due to the unique conditions inherent to local organic systems in assessing organic yields, though it is less easy to generalize than for more uniform conditions of non-organic farming, thus an enormous amount of data from around the globe would be required to answer the question conclusively. This caveat applies to the studies that comment positively on organic farming's potential to feed the world (Badgley *et al.*, 2006, and Halberg *et al.*, 2006) [15].

Conclusion

With the help of reviews mentioned above it is concluded that organic farming is helpful for maintaining soil health and environment and also to produce a higher yield with more nutritive value. But it can only be achieved, when both i.e. farmers and scientists, opines that there are merits in the organic farming and we should proceed cautiously considering the national interest and the conditions in which Indian agriculture functions. They are fully aware of the environmental problems created by the conventional farming and advocate its adoption wholeheartedly.

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