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Organic Agriculture: An option for fostering sustainable and inclusive agriculture development in India

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Introduction

Land scarcity, degraded ecosystems and climate change are pressures that the agriculture sector confronts in the 21st century whilst needing to meet demands for food, feed and fibre, preserve natural resources as well as ensure profitability, economic and social equity (FAO, 2015). Industrialized agriculture,[1] which is capital intensive, substituting animal and human labour with machines and purchased inputs (IAASTD, 2009) has been the favoured model for agriculture development due to its tremendous success in increasing food production. With a principal focus on enhancing yields, industrial agriculture is typically illustrated in large sized mechanized farms that are chemically intensive, mono-cropping production systems. While these systems are dominant in the developed world, the Green Revolution technologies introduced in Asia including India in the 1960s also promoted input intensive approaches to farming as a way to achieve food self-sufficiency. Yet, although industrial modes of agriculture have led to a significant growth in food production and therefore a decrease in the proportion of the world's hungry (Godfray *et al.*, 2010; World Bank, 2008), hunger and malnutrition continue to persist in today's world. The current level food production is 1.5 times greater than what's needed to feed the world. It is thus sufficient to feed 10 billion people which is the projected population peak of 2050 (Holt-Gimenez, 2012). Yet one in nine people remain hungry in the world today (FAO, IFAD, and WFP, 2015).

Given the various pressures the planet and its people face today, focusing solely on high external input-fossil energy-based approach for agriculture development has many constraints. For one, it relies heavily on non-renewable and finite resources such as fossil energy and phosphorous, the scarce nature of which is already apparent globally. In addition, modern agriculture has increased global fertilizer use by 500% (for nitrogen use, over 800%) (Matson *et al.*, 1997; Tilman *et al.*, 2001; Foley *et al.*, 2011) and induced perturbations in global nitrogen and phosphorous cycles, the former having crossed planetary boundaries while the latter is close to planetary limits (Rockstrom *et al*., 2009). Since a significant proportion of the nitrogen fertilizer utilized is lost to ground or surface water systems instead of being taken up by plants, it results in the disruption of aquatic ecosystems and drinking water contamination by nitrates (IFOAM, 2006).

Agricultural intensification has been accompanied by severe soil erosion and degradation, loss of soil fertility and biodiversity, eutrophication, water pollution, and water scarcity (various studies compiled in Foley *et al*., 2015 and Ponisio *et al*., 2014). Since current agricultural systems have often traded the maintenance of ecosystem services for short-term gains in production (Foley *et al*., 2005), the very resources that sustain agricultural productivity are now under threat. Furthermore in case of major cereal crops, there is a steady decline in the relative rate of yield gain (Cassaman, 2007; Cassman *et al*., 2002).

Along with expansion, the intensification of agriculture contributes to greenhouse gas (GHG) emissions and climate change as well as global hydrological shifts that increase the risk of catastrophic ecological regime shifts (Gordon *et al*., 2008). Increased use of pesticides has generated residues in ecosystems with effects on human beings and wildlife (Ponisio *et al*., 2014). Furthermore, industrial production systems have been implicated in contaminating food chains and water bodies with persistent pesticide residues, and encouraging low-cost yet intensive food production and/or processing that have reduced nutrient and flavour contents (Lairon, 2010). Consequently, there is a growing demand for safe food the world over.

The externalities generated by industrial agriculture have often been masked by the productivity success of the Green Revolution (IFOAM, 2006). Additionally, the hidden costs of addressing human health and environment externalities generated by the food system while not included in the price of food, are borne by government and society. The costs to health from the food system in Germany and the UK in 1996 were estimated at $81–117 per ha and $343 per ha, respectively (Pretty *et al*., 2000).

There is an urgent need to re-orient agricultural production systems in ways that balance food production with environmental and resource sustainability to achieve food security (Foley *et al.,* 2011) and safety. The threat of climate change also demands approaches that enhance the resilience of agriculture production systems and contribute to mitigation through promoting biodiversity over mono-cropping, increasing soil organic matter and de-linking food production from fossil fuel reliance (De Schutter, 2010). For this, a variety of approaches that facilitate agricultural sustainability needs to be examined in order to comprehend the viability and fit of these options with various agricultural and food systems. Small-scale producers and subsistence farming systems operating in rain-fed areas are predominant in developing regions such as Africa, Latin America and the Caribbean, and South and East Asia. Thus, these options must also address the livelihoods and well-being of subsistence farmers, numbering over 1.5 billion across the world and generating half of the world's food (Holt-Gimenez *et al*., 2012).

Despite their intrinsic role in meeting global food security (Nwanze, 2011),[2] resource poor, small-scale farmers in developing countries comprise the "largest portion of world's chronically hungry people"(FAO, 2009; Ponisio *et al*., 2015; Holt-Gimenez *et al*., 2012; De Schutter, 2010). This underscores the fact that rather than problems with food production *per se*, hunger stems from poverty and inequality which arise due to socio-economic-political factors that prevent access or affordability to sufficient food and/or adequate diet (Ponisio *et al.*, 2015; Holt-Gimenez *et al*., 2012; De Schutter, 2010).[3] While improved productivity is one of the essential elements for addressing hunger and economic vulnerability, for these resource-poor farmers who own small and marginal landholdings, input intensive-monoculture based agriculture is neither sustainable, nor viable (Holt-Gimenez *et al.*, 2012). For these reasons, there is growing interest and support for agroecological and organic forms of agriculture especially for small holders (De Schutter, 2010; Altieri *et al*., 2012; IFAD, 2005; IFAD, 2003). Hence, these approaches must be explored for their feasibility in the context of developing countries.

Agriculture development in India: Need for a paradigm shift

India's total cropped area is 195.25 million ha out of which 54.44 million ha is sown more than once. The nation's average cropping intensity rests at 138.67% and the gross irrigated area is 46 % of the total cropped area (GoI, 2014a). To meet food security needs, irrigated areas with better soils and water availability were targeted for developing input and energy intensive, mono-cropping based cultivation systems directed mainly at rice and wheat (Mishra, 2013) (Box1). Forming the base of the green revolution, these practices and technologies have been instrumental in increasing food grain production and availability in India.

BOX 1 INPUT-INTENSIVE AND RAIN-FED FARMING SYSTEMS IN INDIA

Green revolution technologies were fostered in irrigated areas from the 1960s onwards. These specialized mono-cropping systems utilized high yielding varieties that require water, fertilizer to translate their inherent potential into productivity gains. Double cropping or even multiple cropping cycles are undertaken in these areas, although the focus has been mainly on 4–5 crop varieties (Mishra *et al.,* 2013). Input intensive systems primarily comprise of the green revolution belt—mainly Punjab, Haryana, western Uttar Pradesh, and also some parts of Andhra Pradesh, Tamil Nadu, and others. Although input-intensive irrigated agriculture is responsible for the significant increases in the production and availability of food grain (mainly rice and wheat production) in India, there is much concern about the degradation of natural resource base, plateauing of productivity and the heavily subsidized nature of farming in these areas.

Rain-fed agriculture is practiced under various agro-climatic zones (rainfall conditions between 400—1,600mm, including arid, semi-arid, and sub-humid regions) displaying variability in natural resource base with resource rich as well as resource-constrained areas (Sharma *et al*., undated; Mishra *et al*., 2013). Rain-fed farming supports the cultivation of 34 varieties of crops and harbours a major proportion of the nation's livestock—cattle (78%), sheep (64%) and goats (75%). In rain-fed systems, 48% of the area is under food crops whereas 68% is under non-food crops. A significant share of the total cropped area for coarse cereals (85%), pulses (77%), oilseeds (66%), and rice (42%) is under rain-fed systems. It contributes to 44% of the total food grain production of India. Experts believe that despite achieving full irrigation potential, approximately 50% of the cultivated area will remain dependent on rainfall (Mishra *et al*., 2013; Planning Commission, 2011). Rain-fed areas can experience harsh environments with variable and undependable rainfall, dry spells and drought, soil erosion, and degraded soils. Small holders and subsistence farming are a key characteristic in rain-fed areas although attempts to extend the input intensive modes of agriculture are being made to improve productivity. This has resulted in a shift towards high yielding varieties, monoculture cropping pattern, and chemical input use in some rain-fed areas (Venkateswarlu, 2008). This strategy has however not yielded significant gains and has put more pressure on the natural resource base in these areas. Not having received appropriate attention with regards to farming strategies and natural resource management, rain-fed areas experience chronic poverty, backwardness, and hunger (Planning Commission, 2011).

On the other hand, rain-fed agriculture is also practiced in approximately 60% of the total cropped area of the country. Rain-fed farming systems are extensive, location specific, diverse, and highly integrated production systems that are characterized by low external input and energy use (Mishra, 2013) (Box 1). However, considered as drought prone with low productivity, there is a thrust by state agencies for replicating the input intensive approach of agriculture originally conceived for irrigation intensive areas in rain-fed regions (Mishra, 2013).

Challenges faced by the agricultural sector

The socio-economic and environmental challenges facing Indian agriculture are immense. While unseasonal or extreme climate events unfavourably impact cropping systems, natural resource degradation—land degradation, depleted soils, as well as ground water—are prevalent in input intensive as well as in rain-fed farming systems. The green revolution belt characterized by industrialized agriculture is especially illustrative of the negative repercussions of the food-water-energy nexus—over exploitation of groundwater, loss of soil fertility and biodiversity, and water and soil pollution. The Indian agriculture sector has contributed to 17.6 % of the nation's GHG emissions in 2007.[4] Widespread pesticide contamination of foodstuffs[5,6] and occupational exposure to pesticides amongst farmers are also serious concerns.

At the economic front, productivity is stagnating in industrialized/irrigated-input intensive systems whereas low productivity in rain-fed and degraded land also continues to pose a problem. This has resulted in significant shrinking of the Gross Domestic Product (GDP) contribution of this sector[7] that still employs nearly 55 % of the workforce (GoI, 2014b; DoAC, 2015), the majority (close to 87%)[8,9] of which constitutes farmers owning small and marginal land holdings (less than 2 ha land). Overall, there is a decrease in the number of cultivators from 54.4% of the total agricultural workers in 2001 to 45.1 in 2011 which is indicative of shift to non-farm employment (DoAC, 2015; GoI, 2014b).

The farming community, especially the small and marginal farmer, experiences significant socio-economic hardships. Farmers grapple with the non-availability of or poor quality infrastructure, lack of access to information and institutional support (such as irrigation, electricity, scheme benefits, extension services, crop insurance, markets).[10, 11] Juxtaposed against growing input costs and use, decreasing crop response to inputs, low returns and adverse yield impacts due to unpredictable weather, the resultant agrarian crisis is typified by widespread debt[12,13] (GoI, 2014a; NSSO, 2014), poverty and farmer suicides. Significantly, lack of access to ample and nutritionally adequate food is a major issue amongst small and marginal farmers in India. Given the state of the sector, a significant number of farmers would leave farming if alternate jobs were available in the city (CSDS, 2014).[14,15] However, migration into cities does not necessarily provide them access to better lives and also places greater pressure on overburdened infrastructure and public services in cities.

Need for re-imagining agriculture development: Exploring options for small holder and rain-fed farming

There is strong research backing for the fact that investing in agriculture is the most effective way out of poverty in developing nations[16] (World Bank, 2007). Agriculture will also continue to employ a substantial workforce in India (it presently holds the largest proportion of the country's workforce).[17] This clearly points to the need to revive, strengthen,[18] and prioritize agriculture within public policy. However, the question of whether green revolution based input-intensive approach to farming is suitable for rain-fed areas and for small holders still remains.

While small holders form the majority of the Indian agriculture workforce, industrialized systems of agriculture have demonstrated a poor track record over the years for these farmers. Furthermore, an expansion of the green revolution technologies in rain-fed systems will not meet with much success for it is not aligned with the specifics and functions of such farming systems. Besides, in cases where the expansion of the green revolution in rain-fed areas has met with relative successes, it has been achieved with social and environmental costs (Mishra *et al*., 2013). Thus for these reasons and the challenges confronting Indian agriculture, there is a need for a paradigm shift in the way agriculture development is envisioned for the future in the country. Rather than applying the industrialized agriculture approach (commonly referred to as conventional agriculture) to all production systems, approaches that utilize and harness the strengths of rain-fed or small holder agriculture systems (e.g., lower external input use, natural resource variability and diversity in production systems, integrated systems, synergy enhancing and knowledge centric systems, adaptation to climate variability) (Mishra *et al*., 2013) need to be fostered for sustainable agriculture development in these areas.

While there is potential for growth in rain-fed areas, the productivity of these systems and livelihoods of rain-fed farmers are intrinsically linked to the health of natural resources (Planning Commission, 2011). On the other hand, there is growing international support for small holder farming and its ability to sustainably feed the world and ensure food security given the right kind of policy and institutional support (Nwanze, 2011; Maass Wolfenson, 2013). Therefore, strategies that base themselves on agroecological approaches and integrate natural resource conservation and sustainable use with productivity enhancement (Planning Commission, 2011) are key to facilitating sustainable and inclusive agriculture growth in these milieus. Amongst them, organic agriculture that can sustain the health of soils, ecosystems, and people (IFOAM, 2006) would be suitable in context of developing countries such as India.

Organic agriculture could be more appropriate where low-input agriculture prevails and organic nutrient sources and labour can perhaps be made available (Seufert, undated). It could also have potential in rain-fed areas and the northeast regions due to prevalence of low input use (Venkateswarlu, 2008; Ramesh *et al*., 2005). Traditional agriculture in India was based on use of local resources and ecological practices, and having evolved over time was tuned to suit specific agro-ecosystems. Organic agriculture that is sensitive to local contexts and builds on indigenous knowledge and practices can be a natural alternative for small holder farmers operating in organic by default or low input systems.

There is growing momentum in the organic agriculture landscape in India. The movement has strong civil society support. More recently, post the turn of the century, a foundation was established by the state to support organic agriculture (Boxes 2, 3, and 4).Therefore, organic agriculture must be seriously explored and assessed as one among the portfolio of options for fostering sustainable agriculture development in India.

Scope and diversity of organic agriculture

According to IFOAM, "Organic agriculture is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity, and cycles adapted to local conditions, rather than

BOX 2 SNAPSHOT OF ORGANIC FARMING IN INDIA

- There is interest and engagement from farmers in organic agriculture for various reasons—enhancing soil health, tapping export or growing domestic markets, for availing premium prices or even ideological reasons.
- Whereas there is information on certified organic production including the number of certified organic farmers, there are greater numbers of farmers (especially small holders) who are organic by default or cultivate near organic systems as they cannot afford costs of external inputs.
- Participation of civil society and non-governmental organizations in India is strong in organic agriculture —they have provided invaluable assistance and encouragement to organic farmers especially in relation to providing extension and capacity building as well as support for certification and developing market linkages.
- There is an export market for Indian organic produce. The domestic market is nascent but emerging.
- Organic agriculture has also received policy and institutional support at the national level, mainly focusing on bolstering the export market and for improving soil health through organic practices. Key programs are as follows:
    - The National Program for Organic Production overseen and implemented by Agricultural and Processed Food Products Export Development Authority(APEDA) under the Ministry of Commerce and Industry, Government of India (GoI), focusing on standards development and processes for third party certification.
    - The National Project on Organic Farming (NPOF), now subsumed under the National Mission of Sustainable Agriculture (NMSA), developed and executed by National Centre for Organic Farming (NCOF), Ministry of Agriculture, GoI.
    - Participatory Guarantee Systems (PGS), a less expensive, alternative quality assurance system for guaranteeing organic integrity (especially suited to small farmers), is being promoted by the government and civil society engaged with organic agriculture.
    - Rashtriya Krishi Vikas Yojna (RKVY) and National Horticulture Mission (NHM) also have support for organic agriculture.
- At least nine states have formulated organic agriculture policies, with few intending to go completely organic in the near future*.
- Prime Minister Shri Narendra Modi announced a new scheme "Paramparagat Krishi Vikas Yojna" for organic agriculture in India with an allocation of 300 crore.#

Sources

* Shantanu Shantaram, 2015, Is the organic mantra for real?, Live Mint. Available at http://www.livemint.com/Opinion/LeNI9i16mbNcd5L8J8sU1L/Is-the-organic-mantra-for-real.html, last accessed on 25 June 2015.

\# Gargi Parsai, 2015, Irrigation, organic farming take centre stage, The Hindu. Available at http://www.thehindu.com/business/budget/irrigation-organic-farming-take-centre-stage/article6946570.ece, last accessed on 25 June 2015.

inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved".[19] IFOAM's globally accepted principles of health, ecology, fairness, and care are the basis for the development of organic agriculture and seek to inspire the movement in its "full diversity". To be implemented within local "socio-economic contexts, climatic and cultural settings", they serve to promote a system that gives due consideration to ecosystem health and safety, ecological balance, social equity and justice, and responsible production (IFOAM, 2006).

Refraining from the use of synthetic or chemical based inputs is just one of the dimensions of organic production systems. More importantly, it views the farm as an organism where all the components (soil minerals, organic matter, microorganisms, insects, plants, animals, and humans) interact with one another creating a self-regulating and stable system (Lampkin, 1999; IFOAM, 2006). Thus in contrast to industrial agriculture, which relies heavily on non-renewable resources and prompts disruption of natural cycles drawing farmers into a vicious cycle of input use (to address pest/disease outbreaks and nutrient management), organic agriculture relies on natural regulating processes, local resources, and ecosystem capacities to optimize ecosystem functions, improve yields as well as disease resistance. In the process, it diminishes reliance on either chemical or external organic inputs although it does allow the use

BOX 3 SNAPSHOT OF CERTIFIED ORGANIC AGRICULTURE IN INDIA

Indicator	Statistics
Area under certified organic agriculture in India Acreage certified under PGS	• 0.51 million ha (World: 43.1 million ha)* • Represents 0.3% of the total area under agriculture in India (World: 1% of the total area under agriculture)* • Second highest in Asia; 15th highest in the world* • Acreage reported for organic agriculture reduced by over half from 2011 (1.08 million ha) to 2013* • 6,442 ha*
Certified organic producers in India Producers involved in PGS Producers certified by PGS	• 650,000 (World:2 million)*; 1st in the world* • 5,977* • 5,191*
Non-agricultural organic area in India	5.18 million ha (refers mainly to areas where wild collection is practiced)*
Leading states with certified organic land	• Madhya Pradesh, Himachal Pradesh, and Rajasthan# • Even states like Maharashtra, Sikkim, and Gujarat had greater than 0.40 million ha under organic certification (including wild areas)^
Certified goods production in India	• 1.24 million MT • Includes sugarcane, oilseeds, Basmati rice, pulses, spices, dry fruits, tea, and coffee as well as fruits and vegetables besides cotton and all their value added products
Retail sales of organic produce in India	• 130 million Pounds*
Exports volume, revenue, and products	• 0.19 million MT in 2013–14 and included 135 products# • Generated a revenue of $403 million through exports in countries such as the United States, European Union, Canada, Australia, Southeast Asian and Middle eastern countries@ • Growth in exports in 2013–14 from 2012–13 was 7.73%#

Sources

* FiBL and IFOAM, 2015, World of Organic Agriculture, Statistics And Emerging Trends, Research Institute of Organic Agriculture (FiBL), Switzerland and International Federation of Organic Agriculture Movements (IFOAM-Organics International), Germany

APEDA, Organic Products, Agricultural and Processed Foods Export Development Authority, Ministry of Commerce and 2, GoI. www.apeda.gov.in/apedawebsite/organic/PresentStatus.htm

^ National Centre for Organic Farming, 2013 National Project on Organic Farming, Annual Report 2012-13, page 57 http://ncof.dacnet.nic.in/AnnualReports/AnnualReport2012-13.pdf

@ APEDA, 2014, Annual Report, 2013-14, Agricultural and Processed Foods Export Development Authority, Ministry of Commerce and Industry

of commercial organic fertilizers/pesticides (IFOAM, 2006). Bearing in mind that varied regional conditions necessitate locally relevant and adapted systems, organic farming emphasizes management practices (agronomic, biological, and mechanical methods) to fulfil functions of the production system (FAO, 1999; Codex Alimentarius Commission, 1999). Therefore, in comparison to conventional systems, organic agriculture can present to farmers a wider range of farm management options and alternatives which are more flexible and accommodating to local biophysical conditions (Altieri 1995 in IFAD, 2005).

Organic agriculture draws and builds on traditional farming practices (Twarog, 2006). Yet organic agriculture could be distinct from "traditional" farming (IFOAM, 2006) or organic by default systems in developing countries. These farms are cultivated by resource-poor farmers mainly in the absence of or with few external/synthetic inputs, relying on some local farm resources and perhaps utilizing ecological practices. However, unlike organic farming production systems, they may not necessarily (i) demonstrate an improved awareness or understanding of the dynamics and inter-relationships in agro-ecosystems (IFOAM, 2006), (ii) apply or utilize improved farm management/organic practices or (iii) harness ecological processes/capacities for sustainable natural resource management and productivity improvements.

Organic agriculture is based on democratically developed international standards established over 25 years ago by IFOAM. International guidelines are

BOX 4 COMPARING CERTIFIED ORGANIC AGRICULTURE IN INDIA WITH THAT OF OTHER SPECIFIC COUNTRIES

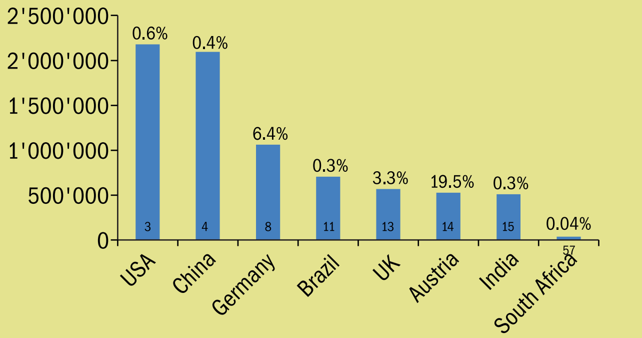

Figure 1: Land under certified organic agriculture (including in-conversion areas) in hectares by country

Note: Number in the bar describes rank of country based on total land under organic agriculture. Numbers on top describe as a percentage share of land under organic agriculture to total land under agriculture in the country.

Data Source: FiBL and IFOAM, 2015, World of Organic Agriculture, Statistics And Emerging Trends, Research Institute of Organic Agriculture (FiBL), Switzerland and International Federation of Organic Agriculture Movements (IFOAM-Organics International), Germany

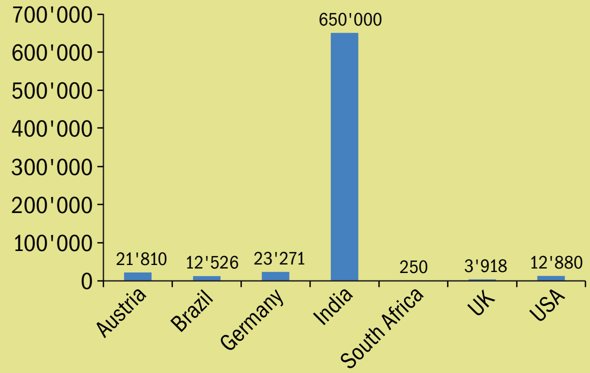

Figure 2: Number of certified organic producers in specific countries

Data Source: FiBL and IFOAM, 2015, World of Organic Agriculture, Statistics And Emerging Trends, Research Institute of Organic Agriculture (FiBL), Switzerland and International Federation of Organic Agriculture Movements (IFOAM-Organics International), Germany

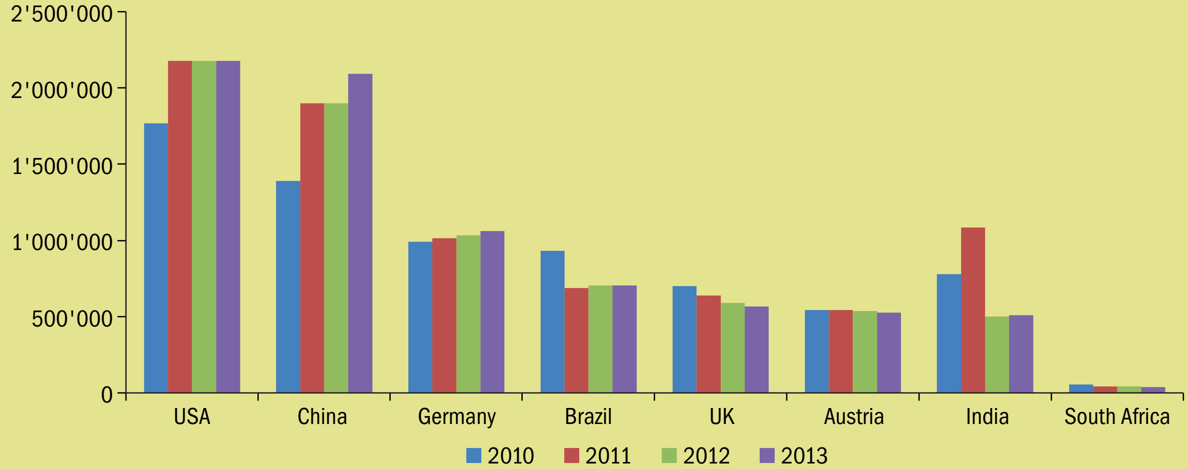

Figure 3: Trends in land under certified organic agriculture (including in-conversion areas) in hectares in India and selected countries

Data Source: FiBL and IFOAM, 2015, World of Organic Agriculture, Statistics And Emerging Trends, Research Institute of Organic Agriculture (FiBL), Switzerland and International Federation of Organic Agriculture Movements (IFOAM-Organics International), Germany

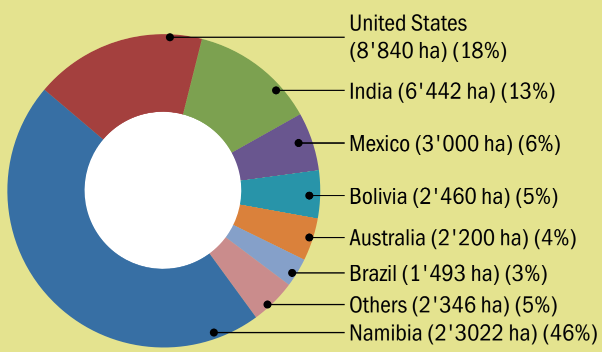

Figure 4: Organic agricultural land (including in-conversion areas) in hectares (ha) under PGS certification in specific countries

Data Source: FiBL and IFOAM, 2015, World of Organic Agriculture, Statistics And Emerging Trends, Research Institute of Organic Agriculture (FiBL), Switzerland and International Federation of Organic Agriculture Movements (IFOAM-Organics International), Germany also been developed by CODEX Alimentarius. Many countries have developed legislations for organic agriculture based on these guidelines (IFOAM, 2006). Nevertheless, organic agriculture captures a full diversity of organic production systems.[20] Organic farms can be either certified by a third-party system and leverage their produce for a premium price market (this system is useful for international markets and anonymous markets). Alternatively they can also be non-certified but follow other methods of quality assurance (self-declaration or participatory guarantee systems). Sometimes where relations between producer and consumer are strong and verification is not needed, it can act as a trust building mechanism. In other cases—subsistence farmers' producing for self and their communities or other organic farmers selling their produce where there is no demand for organic produce—farmers may not gain from certification (IFOAM, 2006).

Impacts and implications of organic agriculture

Assessment of benefits and limitations of organic agriculture is complex given that impacts depend on various factors, for instance existing field and soil condition, farmer's knowledge and skills as well as resources/advice available to him (IFOAM, 2006). Various studies and initiatives have demonstrated that organic farming based on locally relevant agroecological practices can provide benefits to agro-production ecosystems, the environment, the farming community, and society. However, ambiguity persists on some issues[21] for studies examining particular issues may display heterogeneity, resulting from differences in regions, soil types, farming practices, research methods, and time of measurement (Mondelaers *et al*., 2009). The significant influence of local contexts towards outcomes points to the need for a greater number studies on the impacts of organic agriculture versus conventional agriculture in varied developing country environments and tropical climes (Seufert, undated).

Environmental aspects

Organic agriculture provides greater environmental benefits per unit area than input-intensive industrial/conventional systems and even low input farming systems on a variety of indicators. These include increased soil organic matter as well as soil organic carbon concentration and stocks, (Gattinger *et al*., 2012) improved agronomic, natural, and soil biodiversity; reduced nitrogen and phosphorous leaching[22] and GHG emissions (Seufert, undated; Mondelaers *et al*., 2009; Pimentel *et al*., 2005). There evidence that organic systems can contribute to soil carbon sequestration (Rodale institute, 2014) and higher sequestration rates compared to conventional systems; although when zero net input systems[23] were compared to conventional systems, the difference in the rate of sequestration was insignificant.

On the other hand, a generalized opinion on the environmental performance of organic agriculture per unit product and land use efficiency cannot be made since farming systems are heavily influenced by the local specificities. A meta-analysis that included studies from varied geographical contexts in developed nations showed that positive effects of organic agriculture on nitrogen and phosphorous leaching and GHG emissions may be less pronounced or not significantly different from conventional systems when per unit product comparisons are made (due to lower land use efficiency). Land use efficiencies were around 83% of conventional systems (Mondelaers *et al*., 2009) due to lower yields. A study focused on solely a European context showed that in the case of per unit product comparisons to conventional agriculture, organic agriculture underperformed on land use, nitrous oxide emissions, nitrogen leaching, eutrophication, and acidification potential (Tuomisto *et al*., 2012). However in contrast to experiences in context of developed countries increased yields have been observed in organic production systems in developing countries (Badgely *et al*., 2007; Gibbon and Bolwig, 2007), indicating therefore that land use efficiencies may be higher. Thus, studies in developing country contexts are essential to shed light on these aspects.

Organic farming leads to healthier soils with reduced soil erosion (Hine *et al*., 2008) through enhancement of soil organic matter. Organic matter is instrumental in maintaining soil fertility (nutrients and soil diversity) and vital for soil functions (better water retention, nutrient uptake, buffering and filtering capacities), and provides ecosystem services like crop protection (IFOAM, 2006; Mondelaers *et al*., 2009; COM, 2002; Platteau, 2005; Pimentel *et al*., 2005). Soil organic matter and quality have been connected to organic systems demonstrating higher or similar yields to conventional systems (Herencia *et al*., 2008; Melero *et al*., 2006).

Organic systems have been predominantly found to improve species richness and abundance within species (Bengtsson, 2005; Hole, 2005). On-farm biodiversity adapted to local conditions is a core element in organic production systems. This feature not only enables greater conservation of genetic diversity and protection from disease and pests, but also over the time improves resilience in the system (IFOAM, 2006). Organic systems also show increased soil water content, water retention, and volume of water percolation indicating improved ground water recharge and reduced runoff when compared to conventional systems (Pimentel *et al*., 2005; Hine *et al*., 2008). On other indicators such as energy use, there is consensus that organic farming has lower energy requirements than conventional systems (Tuomisto *et al*., 2012) and high energy efficiency (Dalgaard *et al*., 2001). A review of farm level studies has also indicated a 6–30 % reduction in the global warming potential per kilo of product for organic products peaking at 41% (ITC-FiBL, 2007).

Organic systems perform better than conventional systems under extreme weather conditions like drought. This indicates the significance of organic production systems in the current context of climate variability, more so in developing countries that may be sensitive to climate extremes (Lotter *et al*., 2003; Gomiero *et al*., 2008).

Economic aspects

Profitability in organic production is usually determined through a combination of factors such as yields, prices/ premium, and production costs (IFOAM, 2006; Seufert, undated) that covers cost for inputs, labour, and certification (for certified farmers). Yields are also influenced by other factors such as production system characteristics, organic nutrient management, and other practices, farmer's knowledge and skills, time since conversion, and so on. Thus, it is difficult to generalize the impact of organic production on net returns and yields.

Yields

Although yields may decline approximately from 5–20% perhaps stretching to 30% in some crops (IAASTD, 2009; Forster *et al*., 2013) during initial conversion years in chemical input intensive farms (IFOAM, 2006), it may improve subsequently (IFAD, 2005). In contrast, in the case of small-scale farming systems in rain-fed areas or otherwise low-input, organic by default or degraded systems, productivity may improve substantially (IFAD, 2005; Hine *et al*., 2008). Yield increases have been documented in such systems in Africa, China, India, and Latin America (IFAD, 2003; IFAD, 2005; Gibbon and Bolwig, 2007; Hine *et al*., 2008). In comparison to low/zero input or traditional systems, farming systems following organic practices can in some cases demonstrate yield increases up to 170% (Badgley *et al*., 2007).[24]

Long-term farm trial comparisons between organic and conventional systems in places like the United States (US) indicate that yields in organic and conventional systems can be matched in cases of crops like corn, soya bean, wheat, although a relative drop in yields may occur in the initial years due to lower nitrogen or reduced nutrient levels (Pimentel, 2005; Rodale, 2011). Matching yields or lower yield gaps have been observed in trials in India for crops like sorghum, soyabean, wheat (UAS, Dharward) (UAS, Dharward 2011 as reported in TERI-NISTADS, 2013); in cotton, turmeric, potato, gram, onion, millet and even wheat (PAU, Jalandhar) (PDFSR, 2011); and also rice (Directorate of Rice Research, Hyderabad) (Surekha *et al*., 2010).

More significantly, organic farms achieve higher yields in comparison to conventional farms in drought conditions (Rodale, 2013) out-yielding conventional crops by even 70–90% in severe conditions (various studies compiled in Gomiero *et al*., 2008). Lower yield variability and greater system stability are also observed organic systems (Smolik *et al*., 1995; Lotter *et al*., 2003; Gomiero *et al*., 2008). In Karnataka, drought in 2001–2002 led to 50% and 58% loss in yields for rice and sugarcane, respectively, in conventional systems compared to 20% and 1% loss, respectively, in organic systems. This resulted in greater number of farmers adopting organic farming (IFAD, 2005).

A general trend provided by meta-analysis[25] of 1,000 observations across regions and production systems suggests that yield gaps between organic and conventional systems at 19 % is lower than previously considered. This may still be an overestimate due to the biasness towards studies reporting higher conventional yields relative to organic yields or also because of an over-representation of those conventional practices or crops that favour higher yields (Ponisio *et al*., 2015).[26] Also, a higher than usual yield gap in developing countries may also result from comparisons with "atypical conventional yields" which are substantially higher than local yield averages (Seufert *et al*., 2012).

Yield differences between organic and conventional systems may also be highly contextual, depending on site characteristics and may be lower under specific agroecological conditions. A meta-analysis study of 316 comparisons reveals lower yield gaps maybe possible under rain-fed conditions (–17 %), in weak acidic to weak alkaline soils (–20 %), on use of best organic management practices (–13%) or for specific crops like fruits (–3%), oil seed crops (–11%), rain-fed legumes on weak acidic/alkaline soils (–5%) (Seufert *et al*., 2012). Multicropping and crop rotations can reduce yields gaps to just 8% or 9% when compared to conventional monoculture systems (Ponisio *et al*., 2015). Wider yield gaps are usually reported for cereals although for vegetables the outcome is mixed (Ponisio *et al*., 2015; Seufert *et al*., 2012).

Organic production systems try and maximize productivity of the farm by growing multiple crops rather than maximize yields of single crops as in conventional farms. Therefore, productivity assessments must be based on total farm productivity rather than single crop yield estimates (IFOAM, 2006). Rather than focusing on biomass yield of single species, it may be more appropriate to measure human edible calories or net energy yield of systems (Seufert *et al*., 2012). In many cases, comparisons also utilize (in both systems) modern high yielding varieties that are tailored for demonstrating productivity under conditions of high inputs (especially, water and fertilizer) in industrialized systems and lack traits for the same in low input systems. This may result in a bias towards low yields in organic systems. On the other hand, improved varieties are yet to be developed for enabling greater productivity in organic systems (Lammerts van Bueren E, 2011; Ponisio *et al.,* 2015).

Nutrient availability, crop protection, and yields

The ability of organic nutrient management practices to adequately replenish soil nutrients, removed by crop harvests (IFPRI, 2002; IFIA, 1996), remains a contentious issue. While this has not been perceived as a problem by small holders in (former) low-input systems pursuing organic agriculture especially in integrated farming operations, it could be an issue in input intensive systems (Giovannucci, 2007; IFAD, 2005; IFOAM, 2006). Small-scale farming operations may not witness a rise in pests or diseases in comparison to conventional systems, although initial problems may be observed in input-intensive systems converting to organic production. Once the organic farming methods are established, pest and disease control also materialize as seen in specific developing country contexts (IFAD, 2005)[27]. The enhancement of biodiversity above and below the ground through organic practices optimizes pest and disease regulation, reducing attacks.

Ponisio *et al*. 2015 in their meta-analysis found a low yield gap of 9% when similar nitrogren levels were applied in organic and conventional fields. Others however indicate higher yield gaps (of approximately 30%) and argue that nitrogen availability limits yield in organic systems as plant available nitrogen is released slowly from organic sources like cover crops, compost, or manure to meet demand in "peak growing periods" (Seufert *et al*., 2012; Berry *et al*., 2002; Pang and Letey, 2000). Nevertheless, while nutrient deficiency may be of greater concern when shifting from input intensive to organic systems, it may be an issue for a limited duration, since in contrast to depletion in nutrients, soils in organic farms managed for long periods demonstrate an increase in organic matter and available nutrients like nitrogen that improves soil fertility (IFOAM, 2006; Pimentel, 2005). There are concerns about the limited availability of farm yard manure (Venkateswarlu, 2008). However, experience in India suggests that in subsequent years farming in organic systems may require substantially less nitrogen than conventional farms (IFAD, 2005). It is believed that after limited time period, soil microbial flora, indigenous or externally applied are able to release the nutrients in organic sources in available forms which leads to yield increases in organic systems (Rupela *et al.*, 2006).

Thus, any short-term nitrogen shortages (or other nutrient shortages like phosphorous) that may occur in some systems can be met through combinations of management practices that include increased inputs of (i) manure, (ii) leguminous crops (Pimentel, 2005), (iii) leguminous trees, (iv) microbial nitrogen fixers (Chappell, 2007), (v) compost, (vi) crop biomass, (vii) microbial inoculants (Venkateswarlu, 2008; Rupela *et al*., 2006)–all which can improve yield performance in organic systems (Seufert *et al*., 2012). Even in the absence of manure (believed to be a limiting factor in provision of adequate nitrogen in soils in organic systems) any of the other combinations maybe able to deliver adequate nutrient supply after a transitory period of low yields (Rupela *et al*., 2006)[28].

Mechanical, biological and cultural options for pest and disease control may also be utilized for crop protection. Institutional support for research on cropping practices as well as provision of timely and appropriate technical advice to farmers is vital for developing nutrient management and crop protection strategies aligned with the organic production system and for optimizing yields.

Production costs

Organic systems can bring down input costs and overall production costs in comparison to conventional farms (Eyhorn *et al*., 2007; Valkila 2009; Panneerselvam *et al*., 2011, Seufert, undated; IFOAM, 2006) as they encourage on-farm inputs over purchased inputs. However depending on the production system, in some cases, high entry costs may be experienced due to increased expenses on labour, certification, or external organic inputs costs (Bray *et al.*, 2002; Calo and Wise, 2005; Chongtham *et al.,* 2010; Seufert, undated). Labour costs may be higher during conversion years for enabling initial improvements in land or soil (IFOAM, 2006), even in the case of organic by default systems converting to systematic organic production (IFAD, 2003). Yet in traditional systems, higher labour costs can be offset by higher yields and net higher incomes (IFAD, 2005). Small farmers are also known to reduce labour costs by utilizing family labour. Other production costs can be lowered through institutional support for enhanced on-farm nutrient management, and also by mainstreaming Participatory Guarantee Systems (PGS), a low-cost institutional mechanism for guaranteeing organic integrity.

Prices

Where markets are present, organic agriculture can provide stable and even higher prices to farmers for their produce (Seufert, 2013; Bacon, 2005; Bolwig *et al*., 2009; Valkila 2009; IFAD, 2003). Whereas export of organic produce is known to generate farmer profits (Eyhorn *et al*., 2007; IFOAM, 2006) even domestic or local demand for organic food can generate profits for farmers, especially small land holders operating in low-input areas (which may experience rather expeditious yield increases on conversion) as they also avoid expenditure on conventional inputs that is financed by credit at high interest (IFOAM, 2006). Adequate support systems for certification and markets are however essential to ensure price realization, especially during conversion years, when premium prices may be awaited. Nevertheless, even in the absence of organic markets *per se* (or when organic produce is sold in the same markets as conventional produce), farmers (especially small holders) could experience comparable or net higher returns than conventional farmers due to reduced production costs.

Livelihoods

Profits in organic agriculture may vary based on various parameters such as location, time since conversion, and market availability. Yet organic agriculture can enhance farmer livelihoods by reducing economic vulnerabilities through lower input costs, price premiums, and price stability, risk diversification, improve resilience, and stable yields in extreme weather events (Seufert, Scialabba and Hattam, 2002; IFAD, 2003, IFAD, 2005; Lotter, 2003). Besides the main organic crop, alternative sources of income can also result from practices such as integrated farming or inclusion of livestock, or even maintaining crop diversity in addition to the main crop (e.g., mushrooms, herbs, or fruits) which reduces dependence on single crops (IFOAM, 2006; Seufert, undated). In some contexts, organic farming may provide employment to poor and vulnerable communities such as landless labourers (IFOAM, 2006). However, relying solely on export-oriented organic agriculture can make farmers in developing nations dependent on access to international markets, subject them to tedious and expensive regulations (defined by developed nations), consequently increasing their vulnerability, and widening inequalities between small and large farmers (Seufert, undated; Raynolds, 2004; Getz and Shreck, 2006). Developing local and domestic markets is essential for securing farmer livelihoods.

Social impacts

Organic agriculture can help address poverty in farming communities by improving profit margins. Lowered input costs, incomes from surplus produce, and premium prices are possible under organic farming systems. Small farmers can also avoid taking high interest loans as organic production systems rely on locally available inputs over synthetic agriculture inputs which can be expensive (Hine *et al*., 2008).

Organic agriculture promotes food security, especially for the small farmers operating in traditional or low-input systems through improvements in yields and incomes, enhancement of food availability through diversification and mixed farming as well as lower chances of crop failure in case of extreme climate events. On-farm diversity also facilitates the diversification in the diets of farming communities which may result in improved nutritional status (IFAD, 2005). Revival of traditional varieties and reintroduction of traditional foods into diets of farming communities through organic agriculture also promotes food cultures.

Given it prohibits the use of synthetic pesticides, organic farming provides an opportunity to reduce environmental and health risks that may materialize from pesticide use (IFAD, 2005). For one, pesticide exposure amongst farmers and agricultural workers could be diminished in organic farming. Second, authentically cultivated organic produce can contain lower concentrations of pesticide residues and antibiotic resistance bacteria when compared to conventional produce (Smith-Spangler *et al*., 2012). Also although the superior nutritional value of organic food to conventional produce is contested (Dangour *et al*., 2009; Smith-Spangler *et al*., 2012) and is difficult to generalize (Magkos *et al*., 2003) organic food has may have higher levels of antioxidants and lower concentrations of toxic metal cadmium (Baranski *et al*., 2014; Dangour *et al*., 2009).

Organic agriculture promotes creation of social networks through the following interactions—farmer-to-farmer exchanges, interactions between farmers, NGOs, and extension workers as well as farmer-consumers relations in local communities. Community relationships can be strengthened through information sharing, joint marketing, or even natural resource management at watershed or landscape levels (IFAD, 2005). Small producers can also organize into cooperatives (Rice, 2001) leveraging their numbers as a group to bargain for prices, input costs, access to credit, and other facilities (Valkila, 2009; Mendez *et al*., 2010).

Women who generally find it difficult to access credit to purchase conventional inputs can find it easier to participate in organic modes of production (Tovignan and Nuppenau, 2004; Goldberger, 2008; Thapa and Rattanasuteerakul, 2011). Organic agriculture also provides an opportunity to effectively occupy and hire labourers in areas where the labour force is abundant or underemployed. In such places, it can contribute to rural stability and prevent migration to cities already experiencing overburdened services (IFAD, 2005).

Organic agriculture can generate appreciation for natural resources and ecosystem services that agroecological systems can provide and improve natural resource management at community levels. It also improves social capital by empowering farmers through valuing of indigenous knowledge, and integrating traditional knowledge into process/practices of organic production systems. Besides, organic agriculture also encourages farmer-led innovation, facilitates access to new knowledge, and provides opportunities to enhance farm management skills (IFOAM, 2006). Organic farming is however information and knowledge intensive. Farmer skills and knowledge on aspects such as nutrient management practices, certification and quality assurance structures, and locating market presence are essential to its success. This makes the role of extension providers and NGOs vital to its diffusion in developing contexts (Goldberger, 2008; Mendez *et al*., 2010).

Suggestions for a way forward

Policy, programme, and institutional aspects

The predominant focus of the development of organic sector in India, especially in the early years was towards the creation and expansion of an exports market for which an appropriate institutional framework was established. The National Programme for Organic Production (NPOP) was formulated. Standards and regulations for organic production, processing and handling, procedures for accreditation, guidelines for third-party certification were develop by APEDA, Ministry of Commerce and Industry. There has also been growth in the number of certification agencies. Recently, the establishment of traceability systems was also undertaken under the aegis of APEDA. While a nascent domestic market has also emerged as result, the primary emphasis of the subsequent national programme on organic farming (National Project on Organic Farming (NPOF)[29] under the Ministry of Agriculture) was to improve soil health management through facilitating the availability of organic inputs. More recently, the government has provided support and initiated a PGS programme at the national level for expanding the reach of organic agriculture to a larger farming community and tapping potential domestic markets.

Nonetheless, bolstering the role of organic agriculture from that of its present status—of contributing to a niche market and farming community—to an instrument for attaining balanced and inclusive growth in agriculture and rural communities necessitates a revisiting of the national organic programme and the ways in which it is (or is not) positioned within broader policy domains that also seek these outcomes.

Revisiting the objectives of the program on organic agriculture

In addition to its contribution to soil health and nutrient management, organic agriculture has implications and linkages to various other domains (i) **agriculture** (e.g., rain-fed farming and watershed development, agro-forestry) (ii) **environment** (e.g., resource efficiency, natural resource management, biodiversity conservation, climate change) (iii) **rural development** (e.g., livelihoods of small and marginal farmers; food security and nutrition, traditional knowledge), (iv) **food safety**. In light of its potential contributions to these domains, there is a need to revisit in a participatory fashion, the scope and objectives of the programme on organic agriculture in ways that it moves beyond its significant yet restricted role in soil health management to recognizing the diverse possibilities and interests in this sector.

Potential elements of the programme on organic agriculture

Based on multi-stakeholder consultations[30] and appropriate involvement, any plan for organic agriculture must delineate the purpose and intended outcomes from support to this sector. An in-depth assessment of the status of the sector, gap, needs, and opportunities may be undertaken to inform the programme, (UNEP-UNCTAD, 2008). Identifying suitable initiatives and measures for expansion and establishing suitable targets for adoption (UNEP-UNCTAD, 2008) would be essential. This exercise must be undertaken keeping in mind the varied agro-climatic, biophysical, as well as socio-economic-cultural contexts in India including the needs of disparate farmer communities. In addition to this, given the interest of state governments to organic agriculture, the national programme must customize location specific strategies rather than devising standardized packages. Proposals must be sought from the state/district level agencies for developing plans for organic systems in specific regions.

Developing an effective and flexible implementation strategy would also be essential to achieve programme goals. A dynamic balance must be cultivated for optimizing production expansion with the creation of market demand. Choice and sequence of administrating policy measures must be a deliberate exercise (UNEP-UNCTAD, 2008). Projects undertaken must be carried out after a detailed assessment of production and supply chain aspects in addition to market opportunities (IFAD, 2005).

Much investment and institutional support has been devoted to research on green revolution technologies and mainstreaming of associated practices through extension services. In contrast, only a fraction of this support has been devoted to organic agriculture. This has not only resulted in inadequate research and education in this domain, but also a general deficiency in the way state supported extension systems integrate organic practices. Clearly, greater financial resources and institutional support is required for expanding organic agriculture in the country. Key areas of focus include improving technical capacities of institutions, incentivizing participatory research and development, developing adequate extension services, and supporting farmer organizations.

Key areas of policy and institutional focus

For establishing organic production systems and expanding organic agriculture, the programme must promote a ‘systems’ approach that draws from agroecological thinking. The focus must be on encouraging the utilization and management of on-farm and local resources.

The national programme on organic agriculture must also recognize the criticality of the transitional phase for organic farmers when they convert from traditional/low input systems or input-intensive systems to organic cultivation. It is particularly in this period that many farmers disengage with organic practices, reverting to previous systems given the challenges they may face. These include the need for increased investments or capacity (knowledge and skills, inputs, labour, certification), reduced yields, or awaited premium prices. Access to adequate financial assistance/subsidies for inputs, certification, and availability of credit are vital and must be provisioned in this period (IFAD, 2005). Financial mechanisms to compensate farmers for yield loss during conversion period may also be considered, given the environmental benefits organic farming provides for instance maintaining/enhancing biodiversity and soil fertility. On the other hand, monetary support for NGOs assisting and supporting farmers in organic agriculture could also be provided.

In general, a much greater focus is needed within the programme towards developing capacities of farmers to acquire/enhance knowledge on organic practices, understand its relevance and sustain its application over subsequent years in farming. Mechanisms to establish adequate systems for providing technical advice on organic farming through state, civil society, industry, farmer groups, or a combination of these agencies, as the situation demands is vital. Strengthening the PGS programme and expanding its outreach to various farmers is necessary to reduce certification costs and complexities for farmers. On the other hand, nurturing interdisciplinary and participatory research is imperative to enable better outcomes. Another key area which requires attention is the facilitation of market information, linkages, and strengthening of value chains (IFAD, 2005).

The Soil Health Management domain under NMSA includes a policy measure to adopt organic villages. Whether initiatives are undertaken at village or block levels, rural infrastructure and other activities of value chain (related to production, storage and distribution, processing and markets) must be consolidated and strengthened in regions envisaged for organic production.

Promotion of farmer organizations, producer groups and support for farmers to organize themselves into groups is imperative for the success for organic agriculture. Farmers organizations enable access to the advantages of economies of scale in acquiring farmers' training and support, procuring credit, pursuing collective marketing, establishing monitoring and compliance systems. These can generate benefits from lowering costs to better yields and premium prices. However besides needing key members to possess in-depth knowledge of organic agriculture, successful undertaking of farmer cooperatives also necessitates managerial and organizational skills in addition to adequate material and financial resources (IFAD, 2005; IFAD, 2003). Emphasis on human resource development and access to financial assistance for operationalizing farmers' collectives must be embedded in the organic programme.

There are various initiatives for organic agriculture going on in the country. The focus on the organic agriculture programme must also be to draw insights from these various models to be able to scale up such projects at a regional and national level. Examining and documenting the innovations, operations, successes, and challenges of these initiatives is vital for fostering scale up and diffusion of organic agriculture.

Coherence with agriculture policy and coordination between agencies

For the contributions organic agriculture can make to multiple domains, including agriculture, it is vital that the policy or programme on organic agriculture must not be developed or implemented in isolation. Organic agriculture must be anchored in the larger policy on agriculture at the national and state levels as one of the options for fostering sustainability and inclusive development in the agricultural sector. The national policy for agriculture must also reflect on environmental and health externalities of chemical input-energy intensive forms of agriculture, pointing to ways in which the resultant natural resource degradation and depletion can be captured through appropriate indicators (IFOAM, 2006).

In case organic agriculture is considered as a mainstream option in specific contexts, policy coherence between the general and organic agriculture polices is vital for favourable outcomes (UNEP-UNCTAD, 2008). Currently, incentives provided to farmers through agriculture schemes are tailored towards encouraging and supporting industrialized farming practices (e.g., subsidized chemical inputs, price, and procurement policies that favour mono-cropping of wheat and rice) which deter farmers from adopting organic agriculture. Prior to developing a programme to mainstream organic agriculture, the state must assess the impacts of current and planned agriculture policies and programmatic interventions on the development and competitiveness of the sector (UNEP-UNCTAD, 2008).

Besides the NMSA, other programmes/schemes providing support for organic agriculture or organic practices include RKVY, NHM, and Horticulture Mission for North East and Himalayan States (HMNEHS). There is a need for harmonization between such schemes and the main programme for organic agriculture in relation to the activities undertaken and documentation of outcomes. This would improve the efficacy of the schemes. In addition to focusing on rural contexts, the opportunity to utilize organic farming to promote urban and peri-urban agriculture could also be explored.

There is a potential for integrating organic agriculture with rain-fed farming and development of rain-fed areas. Organic agriculture may be embedded in the integrated watershed development framework that takes an ecosystem approach to natural resource development and considers agri- and non-agriculture land use patterns. However, given that low input agriculture now co-exists with chemical driven farming in such systems, there is a need to assess which regions and crops in these areas will be suitable to undertake organic farming. It would be preferable to identify clusters or contiguous blocks with no or low input use to promote organic farming through group certification (Venkateswarlu, 2008). Thus, the programme on organic agriculture must link up with programmes for integrated watershed management and rain-fed area development.

Coordination at district or block level between line departments, Agriculture Technology Management Agency (ATMA)/Krishi Vigyan Kendras (KVKs) as well as these agencies and State Agricultural Universities (SAUs) or NGOs will be crucial for the success of the adoption of organic agriculture. Inter-agency coordination between state/district/block level departments for agriculture, soil, and water conservation, rural development and other relevant departments will be vital for the execution of projects.

Synergies with other policy domains

In order to mainstream organic agriculture and given its potential benefits and synergies with other important domains, there is a need to integrate it within the policies for food security and nutrition, rural development, and poverty eradication as well as environmental protection (UNEP-UNCTAD, 2008). Linking up with the National Rural Livelihoods mission can also provide impetus for orienting organic agriculture for improving livelihoods of farmer communities.

The implications of land reform programmes on the diffusion organic agriculture must be considered. Since the benefits of organic agriculture (e.g., to soil, crop protection, and yields) are increasingly evident over medium to long-term and necessitate labour and knowledge investments by farmers stable land tenure are necessary. Re-visiting the nature of land tenures may also be necessary for facilitating the consolidation of fragmented land holdings and making organic agriculture remunerative for marginal farmers (IFOAM, 2006; IFAD, 2005).

Rethinking the functions of NCOF

National Centre for Organic Farming (NCOF) is the nodal agency for promoting organic agriculture. The NCOF had mainly prioritized commercial organic input production over other support mechanisms for organic farmers necessary for the holistic development of the sector. As noted under the operational guidelines of the NMSA, reinforcing these other measures, i.e., promotion of appropriate input management strategies, farmer training, and capacity building of stakeholders, strengthening PGS, development of market linkages, and awareness raising, is necessary within the activities of NCOF (MoA, 2014).

Effective interaction and coordination of the NCOF with other departments or ministries (for e.g., APEDA in the Ministry of Commerce and Industry; Department of Rural Development and Department of Land Resources under the Ministry of Rural Development; National Rain-fed Area Authority; Food Safety Standards Association of India) is key for the viability and expansion of organic agriculture. Liaising with international agencies and national organizations such as (Organic farming Association of India, Revitalizing Rain-fed Agriculture Network, and Millet Network of India) would also help promoting organic agriculture in the country. NCOF must also link up with as at state/district and block level extension agencies and with other stakeholders (civil society, industry) through its regional offices.

Presently, the financial and human resource capacities of the NCOF and Regional Centers for Organic Farming (RCOFs) are underdeveloped and must be enhanced for the success of the national organic programme. It may also be of interest to increase the number of RCOFs.

Support for enhancing knowledge, know-how, and building capacity

Research and education

At the institutional level, research on organic agriculture needs to be mainstreamed within Indian Council of Agricultural Research (ICAR) institutes and State Agricultural Universities. Organic agriculture demands the convergence of many disciplines for instance agronomy, entomology, soil science, animal husbandry, ecology, and economic and social sciences. It also requires knowledge exchange between farmers and grass-roots initiatives, extension workers, and researchers. Thus, fostering interdisciplinary enquiry alongside a decentralized and participatory approach to research is crucial. NMSA proposes separate departments for organic agriculture under State Agricultural Universities (SAUs), which must be developed with appropriate capacities. Furthermore, the Indian Council of Agricultural Research (ICAR) must also establish a research centre on organic agriculture that can coordinate research across the various state and non-state organizations.[31]

Similarly, whereas research on organic package of practices for specific cropping systems is suggested by the NMSA, investigations on many other aspects are due. These include studies on organic seeds development, suitable crop varieties, and region specific nutrient, pest or disease protection strategies. Additionally, assessment and validation of the efficacy of traditional inputs as well as commercial biofertilizer and biopesticide formulations is necessary. It is important that research on agro-ecological approaches is undertaken, besides focusing on commercial bio-inputs.

The question of sufficiency of soil nutrients (especially nitrogen) in organic systems is an important one. Field level research and analysis is required to understand the nutrient status of soils in organic farms, its evolution over time, and influence of various organic practices on soil fertility. Understanding the role of soil microflora in maintaining fertility here is the key. Investigations must also focus on determining if an assemblage of inputs and practices that optimizes nutrient cycles and improves soil fertility makes up for any deficiencies that may prevail in the presence of a limited strategy. Similarly, the role of spatial and temporal biodiversity (including soil biodiversity) in organic farms, which is believed to lower the incidence of pest attacks and disease outbreaks, must also be studied.

Studies that focus on natural resource management and sustainable avenues for productivity improvement are needed as are investigations on appropriate mechanization and economics of cultivation. Furthermore, investigations on local food systems, farmer innovations, value chain, and market assessments are necessary.

Comparisons on the impacts of organic and conventional farms on various parameters (ecological and resource efficiency, economic, social), the costs and benefits of each system to environment and well as climate; health; food production, security, and nutrition as well as livelihoods must be undertaken objectively. Here, there is a need to develop appropriate methodologies and indicators for holistic assessments that adequately capture and represent organic system's way of functioning vis-a-vis conventional systems (for example, farm productivity). Currently, data systems that facilitate collection, maintenance, aggregation, and integration of data in relation to these assessment indicators are absent.[32] For sound comparisons, these aspects must be addressed. Documentation of best practices, experiences, and research outcomes is also necessary.

Courses on organic agriculture and agro-ecological systems must be established in SAUs and other universities based on the development of an appropriate curriculum. NCOF also provides courses on the same, but can revisit the content if necessary. Efforts towards sensitization of children towards sustainable forms of agriculture and its implications for sustainable development and food security must be undertaken at the school level.

Extension

Since organic farming is knowledge intensive and locally adapted, access to technical and expert advice at regular intervals is imperative to develop farmer capabilities in various dimensions. These include aspects such as development of appropriate nutrient management and pest protection strategies, optimization of yields especially during the conversion period, information about certification processes as well as market opportunities. In relation to cropping practices and nutrient management, expert advice should be built on an understanding of local agro-ecological systems and must especially focus on enhancing spatial as well as temporal biodiversity. Extension services must support on-farm inputs training and prioritize utilization of local resources in addition to promoting integrated farming and the development of seed banks. Facilitating soil testing and soil health cards to organic farmers is essential as is providing knowledge on nutrient management. Extension services should also provide guidance on procedures for third-party certification as well as participatory guarantee systems, and help farmers locate opportunities for value addition of organic produce and identify market linkages.

Due to lack of emphasis on organic agriculture in state extension agencies, NGOs are the main sources of advice and information on many or all of these aspects. Whereas greater emphasis on organic practices and systems must be laid in the state extension agencies (including ATMA, KVKs), there is a need to reinforce efforts of existing extension services to promote the diffusion of organic agriculture. One of the ways may be to locate farmers/local youth/agriculture graduates displaying commitment, leadership, and interest or knowledge on organic farming, to be trained by state agencies or NGOs to deliver information and advice to organic farmers. Entrepreneurs interested in establishing agri-clinics and businesses could also become extension service providers and must be supported. The methods, successes, and challenges of various models of extension operationalized by farmer associations, NGOs and/or state organic farming agencies for organic agriculture (e.g., Community Managed Sustainable Agriculture in Andhra Pradesh/Telangana, organic farming by the Government of Karnataka) need to be identified and documented.

Capacity building

Building farmers capacities to undertake and sustain organic farming in the long run is vital. Periodic training through field demonstrations, participatory learning at farmer field schools, exposure to organic best practices at model farms are vital. Training on value-addition, processing and marketing, certification or other quality assurance options must also be given.

Besides farmers, capacity building of all stakeholders involved in the various aspects of organic farming— research and development, input production, extension, certification, processing and marketing— is necessary and must be addressed through effective training programmes. The knowledge and skills of personnel involved with input production, extension, and training or even PGS needs to be enhanced in keeping with latest developments so that they can effectively address needs of farmers. There is also a need to sensitize state and national level policymakers across domains of agriculture, rural development, watershed development, health and others on the relevance, benefits, and challenges in organic agriculture. Human resource development across the value chain is a key feature under the organic farming module of NMSA. It must be prioritized and streamlined within the institutional framework for organic agriculture especially at the level of proposed organic villages.

Inputs, nutrient management, and crop protection strategies

A variety of on-farm, traditional, and commercial organic inputs as well as practices[33] are utilized for nutrient management and crop protection. On-farm inputs and practices are influenced by local contexts and availability of resources whereas the supply and accessibility of commercial inputs determines their use. Farmers practicing organic cultivation tend to utilize diverse on-farm inputs and agricultural practices based on (i) the availability of inputs and their experience of improved outcomes, (ii) familiarity and convenience, (iii) human resources (labour) and financial resources (subsidy) that may be available.

At the level of farmer clusters or organic villages, cohesive input based nutrient management, and crop protection strategies must be developed in a participatory fashion involving farmers, NGOs, and state extension agencies. Strategies must be site and context specific and should promote agroecological approaches emphasising the development and use of on-farm and local resources. Wherever feasible, support for up-scaling input generation for specific inputs through community management could be provided for benefitting village/block level organic initiatives. However, establishing adequate mechanisms for scaling up and enhancing capacities of stakeholders would be necessary for its success. Here, insights from various experiences (e.g., Community Managed Sustainable

Agriculture by Society for Elimination of Rural Poverty (SERP), Andhra Pradesh, Telangana, Kudumbashree, Kerala) must be drawn.

The availability of quality commercial organic inputs has been a challenge and this issue must be taken up urgently. The national programme on organic agriculture has focused on quality assurance of biofertilizers through establishment of quality control centres and also strengthening existing facilities. However, the protracted nature of the problem necessitates an in-depth and holistic assessment of issues from the perspective of input manufacturers and input suppliers, quality control agencies and organic farmer groups besides engagement with policymakers located at agriculture and fertilizer departments to identify solutions. Supply of commercial inputs in some regions is problematic and adequate production facilities by the government might address this problem. There is an opportunity to undertake compost generation from solid waste on barren lands; however, many issues including appropriate segregation and pollutant loads in waste need to be addressed before this can be pursued as a viable option.

The availability of organic seeds is also an issue. Therefore, programmes and incentives for seed production and establishment of seed banks are essential. Documenting the experiences of Beej Swaraj by Navdanya in Uttarakhand as well as other organic farming groups could provide an understanding of the benefits and challenges.

Certification

Third-party certification systems have posed challenges to farmers including high costs, lengthy and complicated procedures. The processes in these systems are also alien to most farmers in the Indian context since they are based on developed country experiences. Using joint consultations amongst stakeholders (e.g., third-party certifiers, farmer groups, NGOs, APEDA and other policy makers), there is a need to develop mechanisms that make third-party certification systems more farmer friendly. In case of small and marginal farmers and in rain-fed areas, it would be preferable to identify clusters or contiguous blocks with no or low input use to promote organic farming through group certification.

The PGS as an alternative to third-party certification is being promoted by the Government of India and the civil society movement, i.e., Organic Farmers Association of India. While there are many advantages to this alternative, it also presents some challenges such as sustaining farmer participation and leadership for the long term, efficiency of institutional mechanisms to deliver quality assurance, and others. There is much to learn from the initiatives and pilots undertaken by the OFAI and the government as well as international experiences. A through review of these initiatives must be undertaken for informing the expansion of the PGS in India.

APEDA has established the TraceNet System to track organic produce across the supply chain and document quality assurance data as entered by operators'/producers' groups or certification agencies.[34] Yet there are challenges as in some instances, quality assurance is not being met in produce from organic certified farms.[35] Strengthening internal control systems and developing stringent mechanisms for maintaining quality of organic produce are vital. While ensuring that farmers comprehend the processes and significance of certification or other quality assurance systems is necessary, it is also important to develop adequate mechanisms to bolster the integrity of the certification/quality assurance process.

Market Development

A domestic market for organic produce is critical to be able to expand organic production and organic agriculture in general. The domestic market in India is nascent but growing with speciality organic stores and retail shop sales emerging in some cities. However to be able to increase sales and interest in organic produce, there is a need to generate awareness about food safety, options to conventional produce as well as organic agriculture in general in the public space. While some NGOs do occupy this space, mass awareness and publicity for organic produce through government supported awareness campaigns in cities and towns, in educational institutions, hospitals, etc., is essential. While nurturing retail interest in certified organic produce can help anonymous markets, encouraging local consumption of organic produce close to where it is produced and where trust building mechanisms can be developed in communities is essential to stimulate local markets. Campaigns in print, visual, and electronic media could also prove useful to promote awareness on healthy eating habits, safe food, and alternatives like organic produce.

Public procurement of organic produce for mid-day meals at schools and by other agencies such as hospitals or premium hotels offers opportunities to develop markets. Tapping urban vegetable gardening initiatives to promote the cultivation of organic produce may also be pursued.

Strengthening markets also necessitates the consolidation of fragmented value chains and access to market information. Organic agriculture projects need to focus on rural development and value chain enhancement from input supply to market linkages. Consumers demand consistency in supply and adequate range of organic produce making planning in production as well as distribution a key aspect. Infrastructure development for storage (collection centres, warehouses, and cold storage) and processing of organic produce is vital. Additionally, transport and logistics support is also important especially at village, block, and district level to cater to emerging markets. On the other hand, farmers must be encouraged to engage in primary processing which adds value to their produce. Collective processing centres at the village level may also be considered for support.

Encouragement and support for farmers associations is a must especially for small farmers to access markets, establish national and global contacts, and obtain better prices. Formation of cooperatives also helps access credit, develop adequate compliance mechanisms, and lower certification costs.[36] However, there is a need for strengthening human resource capacities for compliance operations and logistics within farmer groups (IFAD, 2005). Provision of some sort of financial assistance may also be necessary in the initial years. Information technologies present a significant opportunity to connect farmers with markets in the organic sector; therefore, this resource needs to be tapped.

Premium prices have been at the centre of many debates on affordability of organic produce by common masses. The expansion and success of the PGS programme is vital to optimize prices. State organic agencies may also facilitate retail of organic produce to lower prices.[37]

Conclusion

Although the adverse social and environmental externalities of industrial agriculture have been apparent, fears of not being able to meet the increased demand for food production in the future perpetuates the favouring of high energy-input intensive systems over sustainable alternatives. Whether organic agriculture can feed the world is still debated with arguments for and against its ability to generate the yields necessary to sustain future population growth. It is however becoming increasingly clear that no one production system will alone produce sufficiently to feed a growing population. Different approaches to foster sustainability in agriculture exist and must be explored for their capacity to balance ecological security with productivity and inclusive growth in varied agroecological contexts. Furthermore to address hunger, undernourishment, and malnutrition structural reforms in food systems will be essential. Moving away from unsustainable agricultural practices in the face of meeting food security needs may also invite changes in other areas such as dietary changes e.g., decreasing meat consumption, reducing food waste, and developing alternate feed stocks for biofuels, where even incremental changes could help improve food availability (Folly et al., 2011).

Organic agriculture based on agroecological principles offers a comparative advantage to small and marginal farmers (IFAD, 2003) operating in low-input systems in countries like India. Organic agriculture may also be appropriate in select areas in rain-fed system and in the northeast regions. For these farmers and perhaps even for others interested in sustainable farming systems in India, organic agriculture can provide a range of benefits, including restoring soil fertility, improving yields and livelihoods, enhancing food security as well as social and human capital amongst others. Despite operating on a fraction of the investment and support provided by the state to industrialized production systems there is evidence of the ability of organic agriculture to contribute to addressing poverty, hunger, and inequality besides developing healthy ecosystems. Thus, organic agriculture would be a useful option to explore and develop to achieve the goal of sustainable agriculture development. However to materialize the expansion of organic agriculture in India, the right kind of policy and institutional support must be provided (Box 5).

Organic agriculture provides a significant opportunity to incorporate sustainability and resilience in agriculture production systems. It also can serve to empower small and marginalized farmers thereby contributing to inclusive rural development. It must be given a fair chance and utilized as a concrete measures for addressing some of the challenges in the Indian agriculture sector.

BOX 5 SUGGESTIONS FOR A WAY FORWARD: AT A GLANCE

- Revisit the focus of the organic programme using multi-stakeholder involvement to (i) reflect the potentially multiple contributions and diverse linkages of organic agriculture across sectors, recognizing diverse possibilities, and interests (ii) locate suitable targets and measures for expansion with the provision of adequate financial assistance (iii) develop an effective implementation strategy optimizing organic production with the creation of market demand.
- Appropriately, anchor organic agriculture in the agriculture policies of the centre and state, developing coherence between these policies. Undertake harmonization between the various programmes and schemes providing support for organic agriculture. Link organic agriculture with rain-fed area development, integrating initiatives in a watershed development framework.
- Utilize a systems approach, drawing from agroecological science, and practice for expanding organic production.
- Explore mechanisms for providing financial assistance to farmers during conversion and also for providing monetary support for farmer associations and NGOs supporting organic agriculture.
- Specific project initiatives must be based on informed need assessments, feasibility analysis, and executed with the involvement of stakeholders. Pilot initiatives in varied agro-climatic and ecological contexts must be undertaken before scaling–up is envisaged.
- For the holistic development of organic agriculture, attention must be paid to other support mechanisms besides input production. Greater focus and institutional support is needed for—undertaking interdisciplinary and participatory research and development, providing adequate extension services, capacity building of farmers and various stakeholders, encouraging farmer associations and producer groups, expanding PGS, consolidating value chains, cultivating domestic and local markets, raising public awareness, and sensitizing policymakers.
- Focus on developing location specific nutrient and crop protection strategies, encouraging use and management of on-farm and local resources. Explore community based input generation approaches. Strengthen mechanisms to improve quality and availability of commercial inputs.
- Invest in and undertake research in organic agriculture in various aspects. Mainstream research on organic agriculuttre in universities and ICAR institutes. Mechanisms to coordinate research across state and non-state organizations are essential.
- Improve extension services for organic agriculture and reinforce efforts of state agencies and NGOs through other locally available means.
- Develop rural infrastructure and facilities needed to strengthen value chains especially for collection, storage, and processing. Encourage primary processing by farmer groups.
- Strengthen and expand PGS to reduce certification costs and stimulate domestic markets. Establish state organic agencies to promote retail at appropriate prices.
- Mass awareness programmes and publicity for organic cultivation and produce is necessary in the public sphere. Public procurement of organic produce must be explored as should sale to hospitals, hotels and other institutions. Urban and rural vegetable gardening initiatives must be tapped for promoting organic cultivation.
- There is much to learn from the existing initiatives on organic agriculture and farmer innovations. Their experiences and best practices must be documented.
- Strengthen the financial, managerial, and technical capacities of national and state agencies, farmers groups and associated non-governmental organizations promoting organic agriculture. It is imperative that NCOF links up with various other ministries, national and international agencies, and civil society besides improving its association with state level agencies.

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Endnotes

1 Industrial agriculture envisions farm as a factory and is based on an input (chemical inputs) output

(crops) model. In PAN North America, Industrial Agriculture, Pesticide Action Network. Available at http://www.panna.org/issues/food-agriculture/industrial-agriculture

2 According to Kanayo F. Nwanze, Director, IFAD,"There are some 500 million smallholder farms worldwide; more than 2 billion people depend on them for their livelihoods. These small farms produce about 80 per cent of the food consumed in Asia and sub-Saharan Africa"(Nwanze, 2011)

3 Food security is as much about access to food (affordability, allocation and preference), satisfactory nutrition, and food safety as it is about adequate availability (production, distribution and exchange) (C Erikson, 2008).

4 Ministry of Environment and Forests, 2010, India: greenhouse gas emissions 2007**,** MoEF New Delhi. Available at http://moef.nic.in/downloads/public-information/Report_INCCA.pdf, last accessed on 25 June 2015.

5 Neha Madaan, 2014, Traces of pesticide in fruits, veggies. *The Times of India*. Available at http://timesofindia.indiatimes.com/home/science/Traces-of-pesticide-in-fruits-veggies/articleshow/31445588.cms, last accessed on 25 June 2015.

6 *Economic Times*, 2015, Food safety being compromised due to use of pesticide: Centre for Science and Environment. Available at articles.economictimes.indiatimes.com/2015-04-07/news/60902913_1_food-safety-junk-food-packaged-food-products, last accessed on 25 June 2015.

7 GDP contribution of Agriculture and allied sector decreased from 17.8 % in to 13.9% in between 2007-08 and 2012-13, whereas for agriculture itself it reduced from 16.3% to 11.8% in the same period (GoI, 2014b; GoI 2009).

8 The recent findings from the 70th NSSO survey in India reports that 17% of agriculture households possess land size between 1-2 ha (small land holdings). Also 69.4% of the agriculture households possesss land size between 0.01- 1 ha (marginal land holdings (NSSO,2014)

9 Only 0.41% of the farming households are large farmers owning larger than 10 ha of land (NSSO, 2014). Also according to Rukmini S, April 23, 2015, 'More than 50% of farm households in debt', *The Hindu*, Most of the large farmer are absentee landlords. Available at http://www.thehindu.com/news/national/more-than-50-of-farm-households-in-debt/article6711414.ece, last accessed on 25 June 2015.

10 Sanjay Kumar and Pranav Gupta, April 3 2015, Land Acquisition Bill: Missing the big, bleak picture, *The Hindu*. Available at http://www.thehindu.com/opinion/op-ed/land-acquisition-bill-missing-the-big-bleak-picture/article7061853.ece, last accessed on 25 June 2015.

11 Livemint, March 13, 2014, The State of Indian Farmer. Available at http://www.livemint.com/Politics/tVWn9xU6Nqgt3ZLZJcHvBO/The-state-of-Indias-farmers.html, last accessed on 25 June 2015.

12 Over 50 % farmers are in debt according to 70th NSSO survey (NSSO, 2014)

13 Of the total number of agriculture households in debt, approximately 82 % households possess small and marginal landholdings as (GoI, 2014a)

14 Sanjay Kumar and Pranav Gupta, April 3 2015, Land Acquisition Bill: Missing the big, bleak picture, *The Hindu*. Available at http://www.thehindu.com/opinion/op-ed/land-acquisition-bill-missing-the-big-bleak-picture/article7061853.ece, last accessed on 25 June 2015.

15 Recent all India survey conducted by CSDS, with over 5000 households on the State of Indian farmer revealed that approximately six out of 10 farmers respondents or 61% would leave farming if alternate jobs were available in the city. Whereas 36% farmers revealed they would not like their children to take up farming 76% of the youth interviewed in the households also felt the same (CSDS, 2014).

16 According to FAO, 2009,Feeding the world 2050 "Cross-country analysis shows that GDP growth originating in agriculture is, on average, at least twice as effective in benefiting the poorest of a country's population as growth generated in non-agricultural sectors" Available at ftp://ftp.fao.org/docrep/fao/meeting/018/k6021e.pdf, last accessed on 25 June 2015.

17 Sanjay Kumar and Pranav Gupta argue that **"**The high level of dissatisfaction among farmers cannot be considered as an excuse for promoting other sectors at the cost of agriculture." Also that "The need to reduce disguised unemployment in the sector by promoting alternative jobs or businesses does not negate the need for government action to revive agriculture." In Sanjay Kumar and Pranav Gupta

April 3 2015, Land Acquisition Bill: Missing the big, bleak picture, *The Hindu*. Available at http://www.thehindu.com/opinion/op-ed/land-acquisition-bill-missing-the-big-bleak-picture/article7061853.ece, last accessed on 25 June 2015.

18 Sanjay Kumar and Pranav Gupta, April 3 2015, Land Acquisition Bill: Missing the big, bleak picture, *The Hindu*. Available athttp://www.thehindu.com/opinion/op-ed/land-acquisition-bill-missing-the-big-bleak-picture/article7061853.ece, last accessed on 25 June 2015.

19 IFOAM, Definition of Organic Agriculture. Available at http://www.ifoam.org/growing_organic/definitions/doa/index.html

20 IFOAM position paper, P02, Position on the full diversity of Organic Agriculture - What we call Organic. Available at http://infohub.ifoam.bio/sites/default/files/page/files/full-diversity-organic-agriculture.pdf, last accessed on 25 June 2015.

21 For example contradicting results have been observed in relation to specific aspects such as carbon sequestration as well as environmental benefits per unit output.

22 Nitrogen and phosphorous leaching is responsible for surface and ground water pollution and eutrophication

23 According to Gattinger *et al.*, 2012, these are systems in which net import of organic matter does not occur or in case of stock less farms, the import of organic matter may occur from elsewhere but only to that extent which is supported by the productivity of their system.

24 There are however criticisms by some on the methodology and conclusions of this study. Such high yield increases were observed precisely since comparisons were made between low yielding crops in organic systems (receiving organic nutrients through external sources) and conventional systems (which however were exposed mainly to low/zero levels of fertilizer). See DJ Connor, 2008.

25 Results from individual studies as well as experiences greatly vary in relation to yield gaps. Meta- analysis studies synthesize information from various studies, comparing crop yields from various regions around the world, to figure out broad level patterns (Reganold, 2012) in relation to yield gaps and the factors influencing yield outcomes. While providing general insights and trends, meta analysis studies may be limited by modeling considerations, studies available (Ponisio et al 2015) and selection criteria (Reganold, 2012). On the other hand field experience is useful to understand performance in specific contexts, conditions and crops. Yet it provides a limited view to draw broad level deductions on performance of organic systems in general. Therefore it is perhaps useful to also examine meta- analysis studies as well as local experiences to draw a balanced view in relation to productivity aspects.

26 Seufert *et al.* 2012 reported 34% yield gaps when organic and conventional systems are most comparable – when similar N inputs and crop rotations were utilized. However Ponisio *et al.* point to methodological and data related flaws that may have led to higher yield gap results in previous studies including Seufert *et al.* 2012, Ponti *et al.*, 2012. Reganold, 2012 also points out that Seufert *et al.* 2012 and Ponti *et al*., 2012 observed greater average yield gaps in comparison to Stanhill, 1990 and Badgley *et al.* 2007 due to a more restrictive selection criteria, which in the case of Seufert *et al.* included excluding 268 studies as they failed to report either sample size or standard error estimates.

27 Organic farming does not aim to entirely eliminate pests from production systems, the aim is to achieve an equilibrium created due to the biodiversity and beneficial fauna on the farm such that as pest numbers are maintained below threshold levels.

28 As reported by Rupela, *et al.* 2006, this has been observed in farm trials using biomass, compost, microbial inoculants in which organic systems showed comparable or low yield gaps (maximum 14%) to conventional systems in subsequent years after 35-62% reduced yields were observed in year 1.

29 The National Program on Organic Agriculture program has been subsumed under the Soil Health Management component of National Mission of Sustainable Agriculture

30 May include a wide breadth of stakeholders—policy makers with national and state government agencies, farmer groups, associations and cooperatives; non-governmental organizations and civil society; academia, development practitioners, technology developers; industry (input suppliers, certification bodies, domestic organic companies, export groups).

31 Recommendation from the Brainstorming session on Policy and institutional Support for Organic

Agriculture, conducted on 25th August 2012 undertaken as part of the TERI-NISTADS project "Policy and Institutional Support for Organic Agriculture: Enabling Pathways for Inclusive and Sustainable Development"

32 Recommendation from the Brainstorming session on Policy and institutional Support for Organic Agriculture, conducted on 25th August 2012 undertaken as part of the TERI-NISTADS project "Policy and Institutional Support for Organic Agriculture: Enabling Pathways for Inclusive and Sustainable Development"

33 On farm inputs and practices for nutrient management include farm yard manure, composts, green manuring, mulching, whereas traditional formulations like Jeevamrit, Panchagavya and others are also utilized. Commercial biofertilizers and soil health promoters include commercial composts, microbal/fungal formulations (phosphate solubilizing bacteria, mycorrhiza). Organic biopesticides include on farm prepared or commercial neem-based pesticides or mechanical traps and others. Practices for nutrient management comprise of crop rotation, intercropping, leguminous trees, etc.

34 APEDA, TraceNet, Available at http://apeda.gov.in/apedawebsite/TracenetOrganic/TraceNet.htm, last accessed on 25 June 2015.

35 ET Bureau, 2014, Study says 33% of organic food contain pesiticides, Economic Times. Available at http://articles.economictimes.indiatimes.com/2014-12-17/news/57154628_1_pesticides-residues-vegetables

36 Through group certification and developing internal control systems

37 Recommendation from the Brainstorming session on Policy and institutional Support for Organic Agriculture, conducted on 25th August 2012 undertaken as part of the TERI-NISTADS project "Policy and Institutional Support for Organic Agriculture: Enabling Pathways for Inclusive and Sustainable Development"

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