Organic farming and small-scale farmers : main opportunities and challenges

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Organic Farming and Small-Scale Farmers: Main Opportunities and Challenges

Abstract

Producing enough food to meet the needs of a growing population has always been the greatest concern of food policy-makers around the world. Given the increasing attention to organic farming (OF), we conducted this study to investigate the main opportunities and challenges of the food production system of small-scale farmers in developing countries with an emphasis on their livelihoods. The study showed that the most significant advantages of OF are environmental protection and a higher resilience to environmental changes, increasing farmers' income and reducing external input cost, enhancing social capacity and increasing employment opportunities. A s well as enhancing food security primarily by increasing the food purchasing power of local people. However, the main challenges of this food production system include lower yields in comparison to conventional systems, difficulties with soil nutrient management, certification and market barriers, and the educational and research needs of small-holders. The paper concludes that even though OF might present some significant challenges to small-scale farmers, it could/should still be considered as a part of the solution and means of improving their livelihoods.

Keywords: Sustainable agriculture; Organic farming**;** Food security; Food safety; Population growth; Sustainable livelihood.

1. Introduction

According to the latest data from the FAO (2014), it is estimated that about 805 million people, or one out of nine, around the world are unnourished. This statistic in sub-Saharan Africa is as high as one out of four. When speaking in general, 98 percent of those suffering from hunger live in developing countries, with the numbers reaching 526, 227 and 37 million of hungry people in Asia, Africa and Latin America, respectively. Although these numbers have shown a remarkable decline, specifically in Latin America as compared to the past, there is still a long way to go on the road of eradicating hunger. As the population and subsequent consumption around the world is growing, the demand for food, feed and fuel in the future will do the same. Moreover, in the developing world, diets are changing and people are putting extra pressure on natural resources as they consume more dairy products and meat (Godfray et al., 2010; Seufert et al., 2012). It is estimated that by 2050, the demand for agricultural products will grow by 1.1% annually as the world's population reaches around 9 billion (Alexandratos and Bruinsma, 2012).

From a historical point of view, the Green Revolution has truly increased agricultural production on a global level, but it has done so at the cost of the degradation of the environment and natural resources (Altieri, 2009; Rundgren and Parrott, 2006; Bazuin et al., 2011). Factors like lack of land, water and access to capital restricted food production in many regions (Rundgren and Parrott, 2006). Moreover, studies show that, generally, technology bypasses the poor who cannot benefit from agricultural technologies due to weak land governance, difficulty to obtain inputs and credits, barriers that restrict their access to the market and its opportunities as well as unfavorable policies like subsidies that discriminated against them (Pingali, 2012).

Numerous studies suggest that small-scale farmers in developing countries play a crucial role in food security (Altieri, 2009; Tscharntke et al., 2012; Azadi et al., 2015), even though they make up the majority of people in the world who experience food insecurity (HLPE, 2013; Mwaniki, 2006). It is estimated that around half of the hungry people on Earth live on small farms (IFPRI, 2015). In order to combat global food insecurity, we therefore ought to pay special attention to those small-holders in developing countries. Though, when we refer to "small-scale farmers" in developing countries, the term "small" can refer to different factors such as the amount of capital invested, the number of workers or the size of the land. Although land size is the most common factor, given different potential uses of lands around the world, there is no unique size for this definition. Nevertheless, the FAO, in a broad definition, considers lands around the world that are smaller than 2 (ha) as small-scale farms. In a more general definition, IFAD (2013; p. 10) describes small-scale farmers as “marginalized people who have difficulties to access resources, capital, information and technology”, which is the definition for small-scale farmers in developing countries we used in this paper.

According to the data published by the FAO, agriculture uses 11% of the world’s land and 70% of its freshwater resources. The lands suitable for agriculture around the world is unequally distributed between high-income countries and low-income countries that have less than half of the cultivated land per person in comparison (FAO, 2011). In some regions of the world like Africa, the indigenous farming method is mainly based on the slash and burn method that include fallow period that lasts for a couple of years. Yet due to population growth, farmers allow their lands to fallow less and less with the majority of small-scale farmers planting annually to keep up with demands, leading to serious soil erosion and nutrient degradation. Consequently, these farmers must abandon their farms and move to new land to repeat the process (Lotter, 2015). According to the FAO, the total amount of arable land per person has decreased globally from 0.38 ha in 1970 to 0.2 ha in 2013 and it is predicted to decrease to about 0.15 ha by 2050. Different studies suggest that the arable land and water supplies in developing countries are significantly being reduced (UNEP, 2008; IFAD, 2007; Food security in Asia and the Pacific, 2013). In the east and southeast of Asia, this figure is even less, at 0.10 ha by 2050 (Food security in Asia and the Pacific, 2013).

Another important issue facing farmers in developing world is climate change, which can be detrimental to food production by small-scale farmers (Pingali, 2012), who are the most vulnerable group to climate volatility (IFPRI, 2015). Many studies suggest that Africa is among the most vulnerable regions in the world due to climate changes (de Sherbinin, 2014). It is also predicted that major crop yields across Africa will decrease in the future as a result of climate change (Wheeler and von Braun, 2013). Furthermore, apart from the agricultural aspects, African countries would also have to deal with the issue of "food access". The majority of studies on the relationship between climate change and social instability suggest that fluctuations in climate and social instabilities have a positive correlation (Hsiang& Burke, 2014). Although their review shows that the association between climatological changes and various conflict outcomes is casual, this hypothesis needs to be tested and justified in reality in order to realize whether and to what extent climate change could be a catalyst of social conflict. Maps provided by the global food policy report (IFPRI, 2015) illustrate that there is a remarkable overlap between regions suffering from civil conflicts and weather-related events. Which demonstrates that there is a correlation between fluctuations in climate and social instabilities. For example, a period of drought can lead to water shortage and scarcity of available resources which, in turn, sparks conflict in the society. Needless to say, food insecurity is prevalent in these regions.

Moreover, "water scarcity" in many food-insecure regions around the world continues to be an important issue because when natural resources like water are scarce, poor farmers are put under more pressure. For example, due to lack of access to appropriate water-storage systems, in many semi-arid regions in the world, during the dry months small-scale farmers cannot enter the market, a time that is the growing season for fruits and vegetables and the prices are at their highest levels (Namara et al., 2010). In most parts of the world, lack of water is a factor that crucially restricts agriculture, especially in the Middle and Near East, and North Africa; the latter being one of the driest regions on the earth. It is predicted that severe water shortage will be an issue for North Africa in the future that will cause direct and indirect negative effects on food security (FAO Fact Sheet, 2014; IFAD, 2007; IFPRI Research on MENA, 2015). Moreover, studies show that hunger and famine are most prevalent in sub-Saharan Africa where drought is frequent. Although different factors contribute to food security, many studies suggest that reliable access to water supplies can improve the livelihoods of small-scale farmers and has the remarkable potential to decrease food insecurity in this region (Burney et al., 2013; Merante et al., 2015).

In order to address all these issues, many researchers have considered low-external input sustainable agriculture as a preferred development approach for the problem of food security (Setboonsarng, 2006). Integrated, agro-ecological, pest management, and particularly organic farming are the most important ‘sustainable’ agriculture systems introduced in recent years. Nevertheless, organic farming might be practiced differently in different regions (Genghini et al., 2006). In this regard, many researchers have proposed organic farming (OF) as an environmentally friendly agricultural production system (Badgley et al., 2007; Chappell and LaValle, 2011; Scialabba, 2000; Azadi et al., 2011; Schoonbeek et al., 2013; Seufert et al., 2012). OF is thus a holistic production system that considers long-term environmental sustainability and primarily aims to produce food in an environmentally friendly manner

(Seufert et al, 2012). Environmental benefits of OF include biodiversity conservation, better quality of soil, reducing evaporati on and water harvesting, strengthening adaptation strategies and reducing greenhouse gas emissions as well as energy efficiency (Seufert et al, 2012; Reganold and Wachter, 2016). Organic livestock farming is in line with the goals of environmentally friendly production, improving animals health and welfare standards, and promoting high quality products (Sundrum, 2001). According to a definition given by the International Federation of Organic Agriculture Movements (IFOAM), OF is based on the four basic principles of health, ecology, fairness and care for humans as well as ecosystems (Rundgren and Parrott, 2006). There is compelling evidence that supports the argument that OF can contribute to food security (Azadi and Ho, 2010), specifically in some regions like East Africa (UNEP, 2008). On the other hand, in developing countries where the majority of farmers are small scale, the conventional system of agriculture cannot meet the basic needs of resource-poor farmers. This is rooted in the fact that they cannot afford expensive synthetic inputs such as the extra labour of organic agriculture (Reganold and Wachter, 2016); demonstrating how poverty and food insecurity often go hand in hand (Mwaniki, 2006). As about three-fourths (70%) of the poor in the world are living in sub-Saharan Africa and Asia, investing in agriculture is an effective strategy to improve their livelihood (Namara et al., 2010). OF also increases social capital such as higher bargaining power, better access to credits and markets, the chance to exchange knowledge and experiences, reduce certification costs and fascinating contribution to policy institutions, increase employment opportunities in rural areas and allow farmers to afford better education and health services due to higher incomes (UNEP, 2008; Elzakker and Eyhorn, 2010). Studies show that farmers can get various economic benefits from OF such as saving money by reducing input cost. They can also increase their income through selling their byproducts and by entering organic markets with certified products and selling their products in higher prices (UNEP, 2008; Rundgren and Parrott, 2006).

Despite such advantages and opportunities, small-scale farmers still experience some serious challenges when they try to switch to an organic system. First and foremost, the yields of organic farms are around 25% lower than conventional farms; although it is important to note that this difference is very dependent on the context and on local characteristics (Seufert et al., 2012). Some studies also argue that OF is not a feasible option for smallholder farmers in many regions like Africa, who cannot produce sufficient amounts of compost and green manures. Since soil management practices are time consuming, soil fertility is depleted. On average, farmers need around 5 years to get the best return for their investment (Lotter, 2015). Farmers who convert to certified organic products also must face the problem of risk management during their three-year transitional period. During these three years before their certification, farms should be managed organically, but farmers cannot sell their products at the higher prices of certified organic foods. It is a challenging period during which yields usually decrease and farmers need to invest money and time to get through it and achieve their organic certification, (Hanson, 2004; Seufert, 2012).

As discussed thus far, small-scale farmers who go for OF face different opportunities and challenges. This paper aims to review potentials and main challenges of OF for small-scale farmers in developing countries. Accordingly, the paper will first discuss the environmental, economic and social benefits of OF as well as the health and nutritional advantages of organic foods. It will then address the main challenges of OF; including low yield, nutrient management difficulties, certification and market issues and educational and research problems. Finally, we will try to determine to what extent OF should be practiced and become a priority for policy-makers to use in order to promote the livelihoods of small-scale farmers'.

2. Opportunities

2.1. Environmental benefits

Many studies suggest that the rural poor are among the most vulnerable people group to environmental degradation as a large number of them are currently living in fragile ecosystems and their livelihoods greatly depend on natural resources. Any environmental degradation can reduce their income significantly, which consequently leads them to deplete their natural resources even more and become trapped in a cycle of poverty and environmental deterioration (Setboonsarng, 2006; Dasgupta et al., 2003). According to IFOAM, the ecological principles of OF create an organic production system based on natural ecological processes and cycles. OF is thus a holistic approach to agriculture that considers long-term environmental sustainability and primarily aims to produce food in an environmentally friendly manner (Seufert, 2012). Environmental benefits of OF include protecting biodiversity, better quality of soil, water and air, as well as energy efficiency. In general, studies suggest that OF positively effects the environment (Shepherd et al., 2003), which can be seen specifically in terms per unit area (Seufert, 2012). While a recent meta-analysis reveals that the environmental impacts of OF are generally positive per area unit, the same is not not necessarily true per product unit. In organic systems, nitrous oxide and ammonia emissions as well as nitrogen leaching are lower per area unit but higher per product unit. Although energy consumption was lower, more land is needed and the potential for eutrophication and acidification per product unit was higher (Tuomistoa et al., 2012).

Because biodiversity conservation and management is chiefly rooted in the fact that OF is based on agroecology principles, IFOAM acknowledges the role that small organic holders play in them (IFOAM, 2011). A meta-analysis by Rahmann (2011) found that biodiversity in organic farms is higher than in conventional farms in that out of 396 relevant studies, 327 cases showed higher levels of biodiversity in organic farms. Another meta-analysis study by Bengtsson et al. (2005) reveals that on average in OF farms, species richness increased about 30% and the abundance of organisms was 50% higher in comparison with conventional systems. Species richness in birds, plants, soil organisms and predatory insects increased while pest and non-predatory insects did not.

Due to many small-holders living in degraded lands and practicing unsustainable agricultural methods, the quality and quantity of their arable lands are on the decline. In the OF system, soil has a key role in production (Scialabba and Hattam, 2002) and has the potential to improve soil (IFOAM, 2011). The soil management methods in OF have the ability to restore degraded lands and prevent further degradation in vulnerable regions, including sub-Saharan Africa (Seufert, 2012). The practices used to protect the soil in organic systems includes minimum or no tillage of the land, contour cultivation, soil bunds, terraces, mulching, planting cover crops and agroforestry (Kilcher, 2007). Studies show that the amount of organic soil matter in OF systems is significantly higher than conventional systems (Gattinger et al., 2012). Organic matter increases water penetration into the soil and thus reduce soil erosion by diversifying soil-food webs that improve the nitrogen cycle within the soil (Pimentel, 2006), thus protecting water supplies.

Other effective strategies for water conservation in OF include reducing evaporation and water harvesting by planting cover crops and practicing efficient irrigation methods (Kilcher, 2007).

In addition, due to the fact that chemical pesticides and fertilizers are banned in OF, the risk of water, soil and air contaminations by chemical inputs is much lower than in conventional systems (Shepherd et al., 2003). Results from a study in East and Southern Africa showed that addressing nitrogen deficiency by planting leguminous trees, farmers could increase their staple food yields two to four times. In Western Kenya, small-scale farmers cultivate maize on 80% of the land and commonly deal with the problem of phosphorus deficiency. Using phosphate rock could possibly provide the soil with an adequate amount of P and consequently cause their yields of maize to increase by two to three times (Sanchez, 2002).

Compared to conventional systems in regard to energy use, the OF system has a remarkable advantage. For example, in organic corn production, fossil energy inputs were 31% lower than conventional farms and 17% lower in soybean production (Pimentel, 2006). Another study on OF in Central Europe showed that the energy use and fertilizer inputs reduced by 34 to 53% (Mäder et al., 2002). The urgent need to convert to more sustainable agricultural practices in general and OF in particular, has become more sensible considering high fuel prices which recently have caused an increase in food prices (UNEP, 2008). Given the fact that small-scale farmers are subsistence farmers and are restricted in terms of resources, a lower energy cost means a lower input investment for them.

Finally, agriculture is very sensitive to the volatile nature of the climate, and regions which are currently suffering from food insecurity, especially, are the most vulnerable to climate change and how it will jeopardize food security in the future (Wheeler and von Braun, 2013). Due to the fact that OF is based on ecological principles, it positively effects the environment by strengthening adaptation strategies and reducing greenhouse gas emissions, effects that specifically benefit small-holders in developing countries who have very limited options on the table and can only work with the available resources on their farms and within their own communities. Studies suggest that during extreme weather events like heavy rainfalls or droughts, OF practices can protect the soil and water in the environment, something which is crucially important during those events (Borron, 2006). Moreover, as the most important asset of small-holders is their labor power, within the OF system, they are more flexible to new environmental situations and consequently can change their product patterns and practices more easily (Hazell et al., 2010). OF advocates adaptation strategies that are rooted in multi-cultures, which can lower the risk of crop failure and increase resilience to extreme weather events. Furthermore, by using indigenous knowledge, farmers are able to plant varieties of well-adapted crops that are resistant to unfavorable conditions. With regard to mitigation strategies, OF can also reduce the emission of greenhouse gases like N_2O and CO_2 and increase soil carbon sequestration (Müller, 2009). In general, OF has the potential for both mitigation and adaptation strategies, both of which enhance the environment's resilience to climate change (Gattinger et al. 2012; Muller et al. 2013; Skinner et al 2014). However, studies reveal that the environmental benefits and impacts of OF are more intense per product unit. Consequently, they suggest that integrated systems which use the best practices of both conventional and OF, can produce higher yields with the lowest environmental impacts (Tuomistoa et al., 2012; Trewavas, 2001).

2.2. Economic benefits

Organic industry is one of the fastest growing sectors of the food market as the global market for organic food has increased from 15.2 billion USD in 1999 to72 billion USD in 2013. The main organic markets are the United States and the EU (together 90%) while developing countries have very small organic markets (Willer and Lernoud, 2015). OF by its nature, is a cost-effective system and through the use of local resources, it has great potential to contribute specifically to sustainable development in the poorest regions of the world (Kilcher, 2007) and is considered as a poverty reduction method especially for smallholder and resource restricted farmers in developing countries (El-HageScialabba, 2007). A global meta-analysis by Crowder and Reganold (2015) concerning the economic competitiveness of OF in five continents has shown that despite lower yields in OF, its economic profitability is significantly higher (22-35%) than others. According to their study, OF's profitability is due to the price premiums of organic products. Another comparative study on the economic profitability of organic and conventional farming in India reveals that although the crop productivity decreased by 9.2%, due to the 20-40% price premium and 11.7% reduction in the production cost, OF still increased the net profit of farmers by 22% (Ramesh et al., 2010). In developing countries, OF is responsible for higher profitability due to higher yields, reduced costs and price premiums of organic products (Nemes, 2009).

A number of successful organic projects for small-scale farmers like organic tea in China and Sri Lanka (Qiao et al., 2015), rice in the Philippine (Panneerselvam et al., 2013), honey in Ethiopia (Girma & Gardebroek, 2015), cotton in India (Fayet & Vermeulen, 2014) and pineapple in Ghana (Kleemann, 2011) are some examples of this potential. Table 1 demonstrates these case studies. IFAD also conducted several studies in China and India that were in favor of the fact that OF as a system that is economically beneficial for small-holders (Giovannucci, 2005). Fourteen case studies on different crops have been selected from a vast variety of agro-ecological situations (Giovannucci, 2006), in which the majority of farmers were poor people with an income of less than one USD per day, working on a land mostly less than one ha. The case studies included vulnerable groups like minorities, women and tribal people. The results suggest that OF is a feasible option for small-holders, specifically for small-holders that live in more difficult environmental situations. Another study of organic cotton farmers in India reveals that OF increased farmers' income from 10 to 20%. Another example is small-scale tea farmers in Kenya who increased their income by 40% as a result of adopting OF practices (UNEP, 2008). In addition, due to intercropping legumes, the farmers could add new crops to their food basket (Hohmann, 2004).

From an economic point of view, reducing external inputs and developing access to organic markets by organic farmers and the opportunity to sell their products at premium prices are among the most important economic advantages of OF for small-scale farmers (Giovannucci, 2006; Rundgren and Parrott, 2006; Kilcher, 2007). The price premiums for organic products are between 10-300 percent and it is estimated that farmers get 44-50 percent of this price premiums, thus increasing the potential OF has to eradicate poverty in developing countires (Setboonsarng, 2006). By substituting chemical inputs with locally available organic inputs, production costs within the OF system has the potential (Setboonsarng, 2006). Nevertheless, OF is a labor intensive food production system and due to the fact that family members of small-scale farmers are usually working on subsistence farms, the production cost can be even lower (Kleemann, 2011). Another important issue that should be addressed is risk management. In general, due to the lack of access to risk reduction tools like crop insurance, small-holders' capacity to handle risk is typically low (Halberg and Muller, 2013). However, OF has remarkable potential to positively affect small-scale farmers risks by diversifying of products through agro forestry, intercropping and rotation to help them reduce the risk of main crop failures (Giovannucci, 2006). In addition, by reducing input costs, small-scale farmers will be less vulnerable to crop failure caused by climate change. Hence, OF as a low-risk strategy is a feasible option for poor farmers (Müller, 2009).

2.3. Social benefits

According to recent data from the World of Organic Agriculture (2015), there were 2 million producers of organic foods in the world in 2013, while more than 80% of them (1.7 million) as well as around 25% of organic lands (11.7 million hectares) are in developing countries. In Africa, OF producers are mainly small-holders (1-3 ha) who are export-oriented and mainly supported by private sectors like NGOs rather than governmental sectors (FAO, 2013; UNEP, 2008). For example, in Uganda as the pioneer organic country in Africa with the largest area under cultivation and biggest number of organic farmers, 90% are small scale farmers (Reckling and Preißel, 2009). It should also be noted that because of unfavorable socio-economic situations, and lack of factors like access to markets, appropriate technologies, credits, natural resources and insecure land tenure, smallscale farmers tend to practice unsustainable farming systems which can lead to more environmental degredation (FAO, 2011). While implementation of OF with an emphasis on local and indigenous knowledge, can improve social capacity and gradually increases the quality and quantity of natural resources within an environment (Rundgren and Parrott, 2006; UNEP, 2008; Kilcher, 2007). OF also increases social capital by supporting social organizations and NGOs at local or regional levels and defines new rules and responsibilities for managing resources by small-scale farmers (UNEP, 2008). OF promotes farmers' organizations (UNEP, 2008) and small-holders can obtain numerous benefits from these organizations. Such as higher bargaining power, better access to credits and markets, the chance to exchange knowledge and experiences (HLPE,

2013) as well as reduce certification costs and fascilating contribution to policy institutions (UNEP, 2008). Given that OF is a labour intensive system, it can increase employment opportunities in rural areas (Elzakker and Eyhorn, 2010) and allow farmers to afford better education and health services due to higher incomes provided by OF. For example, small-scale tea farmers in Kenya were able to pay for school and medical expenses as a result of adopting OF practices (UNEP, 2008).

[insert Table 1]

Pioneers of the organic movement in developed countries were inspired by traditional methods of farming in Asia and Africa meaning that in many regions of developing world,organic farmers can use their indigenous agricultural knowledge rather than learning new methodds (Seufert, 2012). OF is, by its nature, knowledge intensive, and not only is the utilization of indigenous knowledge promoted, but farmers are also encouraged to share their knowledge (Jordan et al., 2009). Although indigenous agro-ecological science is not OF, there is an overlap between indigenous agro-ecological science and OF and thus highly promoted in OF. Additionally, due to the fact that OF emphasizes multi-culture, farmers are usually involved in a variety of activities rather than one tedious task (Ziesemer, 2007). OF in developing countries can enhance social capital and can empower small-scale farmers through cooperative organisation (Rice, 2001). It is also beneficial for women who are usually deprived of credits and access to markets (Seufert, 2012; Rundgren and Parrott, 2006) because it has the potential to promote women empowerment as well (Farnworth and Hutchings, 2009). It is estimated that around half of indigenous agro-ecological science around the world is kept from being shared and taught to women mainly due to the inherited marginalization of women's knowledge and skills in agriculture. For example, considering the low-input nature of OF, women can plant cash crops more easily than compared to their conventional counterparts and can consequently earn extra income (Elzakker and Eyhorn, 2010). Since in many regions, rural women are responsible for providing food for the household, their empowerment can lead to better nutrition for the family (Farnworth and Hutchings, 2009).

With respect to the social benefits of OF, there are some concerns over the impacts of OF on female farmers. Although, OF can provide them with the opportunity to increase their income by planting cash crops with low inputs, it can also increase their workload and consequently, they might shift the extra work on their daughters. Moreover, extra income from OF can lead to a better household nutrition situation only if women have enough bargaining power and can participate in decision making processes within the family (Setboonsarng, 2006). Furthermore, according to Worldwatch Institute (2006), the yield increase from shifting to organic farming is more consistent in remote areas that can result in maintaining poor-farmers in those areas.

2.4. Health and nutrition benefits

Since OF is based on using of local resources and knowledge efficiently, it has the potential to improve food security and sustainable access by poor and resource-restricted farmers (Sligh Christmann, 2007) as OF can produce a variety of foods at low cost (Halberg and Muller 2013). Specifically in challenging environments like dry regions, small-scale farmers can increase their food production by adopting OF practices (Jordan et al., 2009). A study conducted by UNEP-UNCTAD (2008) on 114 organic or near organic projects in 24 African countries, showed that the average yield increased by128%. In some regions like Africa, the majority of farmers are small-holders who produce crops with no or very little chemical inputs, hence converting to OF is a feasible option for them to increase their yields and access to food

(UNEP, 2008). Because food shortage in rural areas is usually the result of crop failures in monoculture systems, OF advocates multi-culture and which consequently decreases the risk of crop failure and food insecurity (Setboonsarng, 2006). With regard to nutrient deficiencies, due to the multi-culture nature of OF, the dietary diversity of subsistence farmers also increases (Seufert, 2012) along with food access, another important issue that should be considered. Studies suggest that OF can improve food access of small-holders through the gradual increase of yield as well as improved income for small scale farmers, which leads to better purchasing power (Halberg and Muller, 2013).

Regarding food safety and quality issues in food and farm, studies reveal that organic foods compared to the non-organic had the least amount of chemical residues (Baker et al., 2002). Moreover, the concentration of nitrate is lower in organic products (Lairon, 2010; Williams, 2002). It is also important to note that, through elimination of synthetic inputs in farms, OF reduces the risk of farmers being exposed to chemical pesticides (Seufert, 2012). Studies reveal that 99% of pesticide fatalities in the world occur in developing countries where illiteracy and poverty among rural population are widespread and farmers are usually poor and have very little knowledge of the safety protocols of chemical pesticide usage (Kesavachandran et al., 2009). With respect to nutritional quality, according to a review study on nutritional quality of organic food conducted by the French Agency for Food Safety (AFSSA), the amount of dry matter, minerals like Fe and Mg and anti-oxidant micronutrients, is higher in organic plant products. In addition, the amount of polyunsaturated fatty acids in organic animal products was higher than conventional products (Lairon, 2010). Furthermore, a recent meta-analysis based on 343 studies found that there are considerable nutritional differences between organic and conventional foods. According to this study, the concentration of antioxidants in organic foods is higher while at the same time, the level of toxic heavy metals like cadmium and pesticides residues are lower in organic foods (Barański et al., 2014; Średnicka-Tober et al. 2016). Despite the great advantages of health and nutrition benefits from OF, the willingness of consumers to afford organic products still remains low that might need complementary public and governmental supports. Table 2 summarizes the opportunities of OF in developing countries.

[insert Table 2]

3. Challenges

3.1. Low yield

Some researchers argue that a large-scale shift to OF could reduce crops' yield by 40% globally; an estimated amount of crop failure that is required to feed about 2.5 billion people. Consequently, they claim this conversion could lead to a serious global famine (Kirchmann et al., 2008). They reason that agricultural practices around the year 1900 were similar to OF with low external inputs that could feed only about three billion. We are faced with more than twice that population and at present have made considerable improvements in our diets and significant increase in our daily calorie intake (Aune, 2012). Insufficient nutrients in soil and limited options to enrich soil as well as poor management of diseases, pests and weeds are mentioned as the chief reasons for low yield in OF systems (Kirchmann et al., 2008). Moreover, some researchers argue that low agricultural production in developing countries is mainly caused by lack of access to adequate chemical fertilizers as well as insufficient crop and water protection technologies. Thus, if a new agricultural production system aims to improve the yields of agricultural crops, it should address these three issues (Bergström et al., 2008).

Given the fact that chemical fertilizers and pesticides cannot be used for organic crops, then OF cannot be considered as an appropriate solution for this problem.

Despite the fact that lower yield in OF is a debatable issue rather than a universal phenomenon, there is a large body of literature concerning it. It is worth mentioning that, we did not cite studies that were focused exclusively on the yield gap in developed countries. A comparative study of organic and conventional systems on 362 published analyses reveals that OF yields are around 80% of conventional yields. In this study which was conducted at the field level, researchers arrived at higher yield gaps given the difficulties in management of nutrients in the soil (de Ponti et al., 2012). Moreover, according to a comprehensive meta-analysis of 66 studies by Seufert et al. (2012), the average yield of organic production is 25% lower than conventional systems. This study also found that the OF performance declined about 43 and 20% in developing and developed countries, respectively. Similarly, Kirchmann et al. (2008) claim that scientific studies reveal that the yields of organic systems around the world are 25 to 50 percent lower than conventional systems. They also argue that the amount of available animal manure is crucially important in this regard. Aune (2012) also states that the yield in OF is 30-50% lower than conventional and conservation agriculture. In addition, a new study on the yield gap between two systems shows that under improved management practices, organic yields are on average 19.2% lower than conventional systems (Ponisio et al., 2015).

Although many food policy makers and scientists believe that the total food production in OF could be enough to feed the global population (Tscharntke et al., 2012; Badgley et al., 2007), low yield in OF is one of the most important issues regarding the ability of OF to improve food security. Therefore, a higher yield is not the absolute solution to the problem of food insecurity and there are multiple social, political and economic contributing factors in this regard (Ponisio et al., 2015; Vasilikiotis, 2000). As evidenced by different studies, lower yield in OF is a controversial issue. While some studies argue that the yield of OF systems is higher than conventional systems (UNEP, 2008; Auerbach et al., 2013; Badgley et al., 2007), others suggest lower (Seufert et al., 2012; Ponisio et al., 2015; Bergström et al., 2008; Aune, 2012; Kirchmann et al., 2008; Connor, 2013). It is also worth mentioning that the yield gap between OF and conventional farming is highly dependent on region as well as the crops (de Ponti et al., 2012; Seufert et al., 2012). A comparative review study on the productivity of organic and conventional farming in the tropics and sub-tropics reveals that while the average yields of OF in highly developed countries is 15% lower than conventional systems, in developing and less developed countries the average yield of OF system is 16% and 116% higher than conventional systems, respectively (Te Pas & Rees, 2014). As noted before, yield gap varies among regions. For example, small-scale coffee producers who had converted conventional production to OF, have experienced a gradual yield increase from 15% in Mexico to 67% in Guatemala (Perfecto et al., 2005), while in Costa Rica, organic yields were 22% lower than conventional production (Lyngbaek and Muschler, 2001).

Nevertheless, Murphy et al. (2007) noted that comparisons between conventional and organic yields in some studies are not accurate and tend to be biased towards higher yields in conventional systems, because the crop species and varieties were adapted only for conventional high input systems. It is also important to note that currently, around 95% of organic production is based on conventional crop varieties and animal breeds and that there is a need to introduce new and suitable varieties for low input organic farming products (van Bueren et al., 2011). Furthermore, many studies show that the transition from conventional to organic farming can lead to higher yields (Auerbach et al., 2013; Badgley et al., 2007).

However, Seufert et al. (2012) argue that due to the lack of appropriate and well-controlled studies on the yields of OF for smallholder farmers in developing countries, there is not enough evidence to accept nor to reject this statement. It is also worth mentioning that, sufficient access to organic manure can provide OF farmers with the opportunity to increase their yield (Aune, 2012; Connor, 2013) and have a yield similar to their conventional counterparts; but producing enough manure on the farm without access to a vast pasture is not possible (Aune, 2012). Moreover, if higher yield in OF is due to the importation of huge amounts of manure from conventional systems, then the higher organic yield cannot be considered as the proof of higher OF productivity (Kirchmann et al., 2008).

3.2. Nutrient management

There is a strong link between the health of the soil and the growth of a crop. In general, soil management methods that farmers apply based on agroecological principles lead to the enhancement of the plant's resistance to pests and disease (Altieri, 2002). On the other hand, soils which are poor in nutrients cause low yields and consequently, may exacerbate hunger and poverty (Kirchmann et al., 2008). Therefore, good soil is essential to maintaining farm productivity. Due to the fact that importing synthetic materials is prohibited in organic farms, maintaining the balance of output and input of nutrients in soil is crucially important.

Some researchers (Badgley et al. 2007) claim that leguminous cover crops have the potential to provide enough nitrogen to do so, while others have rejected their opinion. Critics argue that organic nutrient supplies are limited in many regions around the world and that they cannot be used as the substitute for chemical fertilizers. The production of organic nutrient supplies needs more resources like land, labor, nutrients and water which are not available in many regions (Connor, 2008; 2013).

Crop rotation is the most important technique in order to maintain soil fertility in organic systems (Watson et al., 2002). However, this method has some limitations as cover crops cannot be used as a substitute for nitrogen fertilizer (Connor, 2008). For example, maize is the main source of calories in Africa (Smale et al., 2011) and the uptake of nitrogen by maize is very high. Studies show that small-holders in east Africa who keep livestock, could only recover around 7% of excreted nitrogen in their soil. The average amount of livestock manure in Africa ist usually not sufficient to provide soil with the amount of nitrogen that is needed for maize. Although legume have the potential to provide enough nitrogen in the soil, there are some limitations in their use as well. This method not only needs a couple of years to achieve its goals but also require mineral phosphorus inputs (Lotter, 2015). It is worth mentioning that the availability of enough nitrogen during growth seasons is the most important limiting factor for yield in OF. In addition, from an agronomic point of view, since the nitrogen release and crop demands are not synchronized in OF, the efficiency of organic nitrogen is relatively low (Kirchmann et al., 2008; Aune, 2012).

Organic matters are also crucial to soil fertility (Altieri, 2002). However, in some regions, like sub-Saharan Africa, small-scale farmers do not have access to sufficient amounts of organic residues in order to add organic matters to their land and improve their soil. There is also a competition over the use of theses scarce resources, specifically in regions where livestock feed is unavoidable (Vanlauwe et al., 2014). In general, studies suggest that in Africa, manure application cannot provide the soil with adequate organic matter and it is not a feasible approach to sustain soil fertility. In addition, insufficient fertilizer application for a period of time can lead to soil degradation and if the use of fertilizer restarts later, crop productivity cannot be restored (Tittonell and Giller, 2013). Moreover, in sub-Saharan Africa, there is a high correlation between soil degradation and poverty (Tittonell and Giller, 2013). Small-holders usually cannot afford to pay for compost or extra manure and due to the subsistence nature of their farms, they cannot wait for a couple of years to get a return on their investment in OF. Hence, OF per se, might not be a realistic approach to improve soil and address food security in Africa (Lotter, 2015).

3.3. Certification and market

In general, there are two different systems of OF. Certified production with premium price which is mostly for organic markets in developed countries and non-certified production mainly for local markets in developing countries. It is important to note that certified products of developing countries are chiefly export oriented (Rundgren and Parrott, 2006). Certification is costly because it needs infrastructures for monitoring and documenting producers, therefore, many small-scale and resource-restricted farmers cannot afford them (Gómez et al., 2011). Moreover, it should also be mentioned that certification has almost no advantage for subsistence farmers nor for those who are living in a region with no reliable organic market (Rundgren and Parrott, 2006). Nevertheless, in some cases, certified products are even less profitable than non-certified products. For example, a study on 327 of Nicaragua's organic, fair trade and conventional coffee producers over a decade reveals that despite the fact that certified coffee prices were higher at the farm gate, due to lower productivity, organic producers became poorer in comparison to conventional producers. Premium prices for organic and organic-fair trade certified coffee were 8% and 11% higher than conventional coffee price respectively. The premium was around 0.2 US$/kg, which could never cover the cost of required extra labor and land. Organic farmers need to hire laborers because family members were not enough to cover the labor requirement fully (Beuchelt and Zeller, 2011). Studies show that labor costs in OF are 7-13% higher than conventional systems while, generally, the profitability of OF is dependent on the price premiums applied to organic products which are usually between 29 to 32% (Crowder & Reganold, 2015). This can explain, to some extent, why certified organic coffee was not profitable in Nicaragua. Another study on small-scale coffee farmers in Uganda, reveals that certified farmers in comparison to their conventional counterparts have higher living standards. However, organic certification did not have a significant positive impact on the livelihood of farmers. Whereas, a fair-trade certification improves the household's living standards by 30% and reduces the farmers' vulnerability (Chiputwa & et al., 2015). This can be explained by different factors. Fair-trade farmers receive price guarantees and have more freedom regarding the marketing of their products. In addition, fair-trade farmers sell their products after milling, while organic farmers sell their coffee in unprocessed forms for export (Chiputwa & et al., 2015).

Access to market is another important issue that should be addressed. It is estimated that only 43% of people in rural areas of developing countries can reach markets within 2 hours by motorized transport. This trend in some regions like sub-Saharan Africa is as low as 25% of the population (Smale et al., 2011). In addition, the economic growth and urbanization in some regions of developing world like Latin America, parts of South-East Asia and to some extent in China have changed the marketing chains of food. Super markets have become the dominant power in the food market and it is difficult for small-holders to meet the required conditions of them regarding the quality, quantity, traceability, timeliness and flexibility that super markets required, small-holders who are usually resource and education restricted, cannot compete with rich farmers (Hazell et al., 2010). Concerning the export market, due to relatively strict standards and high expectations of consumers and supermarkets in developed countries for high quality food, only a limited number of farmers in developing countries can reach such markets (Kirsten and Sartorius, 2002).

3.4. Education and research

Given the fact that OF is a knowledge intensive system rather than input intensive (Giovannucci, 2006; Zundel and Kilcher, 2007), knowledge and capacity building is crucially important in this system (Scialabba, 2000). Although OF encourages application of indigenous knowledge and many believe that small-scale farmers in developing countries can learn OF more easily because it has a lot in common with their traditional knowledge, farmers still need to be educated (Kleemann, 2011). Specifically, in regard to appropriate agroecological practices and the certification process as well as essential information about marketing.

With respect to the issue of research, it should be noted that not only is the overall amount of OF research is globally less than research of conventional systems (Ponisio et al., 2015), but the majority of researches have also conducted their studies mainly in developed countries rather than the developing world (Seufert et al., 2012). Moreover, small-holders are usually neglected in research and extension policies and programs, while it is extremely important for small-scale farmers to recieve appropriate research and investments that concentrate on their specific needs in order to change their situation (HLPE, 2013). For example investment in agroecological studies can lead to a gradual increase in organic yield through breeding (Murphy et al., 2007) or crop rotation and multi cropping (Ponisio et al., 2015) and consequently, can increase the overall yield. It is also vital that participatory studies that emphasize locally appropriate soil management techniques, specifically in regions with unfavorable climates where access to biomass is very limited (Zundel and Kilcher, 2007). Table 3 collects the main challenges of OF in developing countries.

[insert Table 3]

4. Discussion and conclusion

In order to develop, agricultural growth and reduce hunger and poverty on a global scale is necessary (Hazell et al., 2010). This is seen in places like sub-Saharan Africa, where small-scale farmers make up the majority of the population in rural areas and the economy is highly dependent on agriculture. Therefore, it is crucial to empower small-holders in order to develop the policies in this region (IFPRI, 2015).

Around the world, policy makers have different options on the table in regards to improving the livelihoods of smallholder in developing countries and each of these approaches has pros and cons (Azadi and Ho, 2010). Given the increasing attention to organic farming, this paper has reviewed the environmental, economic, social and nutritional benefits of OF. We also discussed whether or not organic farming could contribute to food security in developing countries as well as the major challenges of OF.

To synthesize results and put them into some broader context, a framework has developed to explain under what conditions (context) and for which farmers (small-scale farmers) organic farming is appropriate (Figure 1). According to the framework, in many regions, factors such as lack of land, water and capacity have restricted food production. Moreover, because of unfavorable socio-economic situations of small-scale farmers, they tend to practice unsustainable farming systems which can cause more environmental degradation. OF with an emphasis on local and indigenous knowledge, can improve social capacity, poverty reduction and gradually increases the quality and quantity of natural resources. Despite such advantages and opportunities, there are some challenges faced by small-scale farmers to switch to organic system, including low yield, nutrient management difficulties, certification and market issues as well as educational and research needs. Low yield is among the most important issues in this regard. Nevertheless, and given the controversial results on the OF yield, this aspect still needs further investigations in which the yields resulted from different OF practices could be compared in the long-run. Regarding regional priority for OF, different studies reveal that OF can result in highest profitability in dry, water-scarce and least developed regions (Te Pas & Rees, 2014; Jordan et al., 2009). Moreover, OF is in particular beneficial under uncertainty condition, like climate changes (Scialabba & Müller-Lindenlauf, 2010). Different studies suggest that under extreme weather related events like drought, the performance of OF is better than conventional farming (Borron, 2006; Reganold & Wachter, 2016).

In sum, considering all the opportunities and challenges and despite the fact that OF might have some important challenges for small-scale farmers, it could/should still be considered as a part of the solution to improve their livelihood within an integrated approach which uses the best practices of different production systems. OF can be considered as an effective development strategy in order to reduce poverty and empowering small scale farmers in developing countries (Setboonsarng, 2006; Bennett & Franzel, 2013; Vaarst, 2010; Te Pas & Rees, 2014). OF can improve the livelihood of small-scale farmers through three main mechanisms: increasing yields, reducing costs and providing premium prices. The initial farming system and the market integration degree, determine the potential of each mechanism in this regard (Bennett & Franzel, 2013). Different studies show that in developing countries, transition from resource restricted and subsistence farming to OF, can increase the yield (Te Pas & Rees, 2014; FAO website; Badgley et al., 2007; Pretty et al., 2006; Halberg, et al., 2006; UNEP, 2008; Giovannucci, 2005). Consequently, poor farmers can increase their yield by applying OF practices which are mostly based on agroecological principles.

Another group of farmers are those who apply external inputs. Due to the fact that using synthetic inputs is not allowed in OF, these farmers can reduce their production costs through conversion to OF (Rundgren & Parrott, 2006; Setboonsarng, 2006). Moreover, they also can benefit from organic certification and market after the transition period.

Finally, certification provides farmers with the opportunity to achieve organic market and benefit from the price premiums of their products. With regard to certified organic products and its premium price, some critics claim that export markets are feasible only for large farmers or just very few are well organized small-farmers and the benefits of organic products mostly go to middlemen and traders (Abele, et al., 2007). Nevertheless, in order to facilitate smallholders' access to organic certification and market, IFOAM promoted some tools and strategies like group certification via Internal Control Systems (ICS) and Participatory Guarantee Systems (PGS) which are based on social trust and exchanging knowledge. In addition, some studies suggest that contract farming can provide small-scale farmers with the opportunity to participate in the market (Kirsten and Sartorius, 2002). For example, a study on export-oriented rice contract farming in Cambodia suggests that through increasing profitability, contract farming can be an effective strategy to reduce rural poverty specifically for farmers living in remote areas and has potential to empower subsistence farmers (Cai et al., 2008). Moreover, since the majority of poor farmers in remote areas do not have access to chemical inputs and their products are almost organic, they can shorten the transition period and hence can get benefits from certified products easier than non-organic farmers (Setboonsarng, 2006). Yet, some critics argue that the current version of OF, which is mostly dependent on the external organic inputs and has special emphasis on the certification and export markets, has almost nothing to offer to the smallholders in developing countries (Altieri, 2009). In general, given the fact that almost 90% of certified organic products are sold in the EU and US markets (Willer and Lernoud, 2015), certification can be justified only if farmers have access to the export markets (Bennett & Franzel, 2013).

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Table 1. Examples of improved livelihoods of small-scale farmers through practicing OF.

Country	Practice	Mechanism to improve livelihood	Reference
Philippine	Organic rice	• Reduction of the production costs up to 49% • Shifting from subsistence production to cash crop rice production	Panneerselvam, Et al, 2013
China and Sri Lanka	Organic tea	• Reducing the investments required • Providing premium prices	Qiao et al., 2015
Ethiopia	Organic honey	• Improving the quality and prices of honey through contract farming • Connection to international markets and benefit from premium prices	Girma & Gardebroek, 2015
India	Organic cotton	• Reduction of the production cost • Improving payment condition	Fayet & Vermeulen, 2014
Ghana	Organic pineapple	• Reduction of the production cost • Selling products with the premium price	Kleemann, 2011

Table 2. The main opportunities of organic farming in developing countries.

Opportunity	Descriptions	References
Environmental benefits	• Biodiversity conservation • Soil protection • Water supplies protection • No risk of water, soil and air contaminationby chemical inputs • No fossil energy inputs • High environmental resilience against climate change	IFOAM, 2011; Rahmann, 2011; Bengtsson et al., 2005; Seufert, 2012; Kilcher, 2007; Pimentel, 2006; Shepherd et al., 2003; Mäder et al., 2002; Borron, 2006; Hazell et al., 2010; Müller, 2009; Müller & Gattinger, 2012; Tuomistoa et al., 2012; Gattinger et al., 2012.
Economic benefits	• Contribution to sustainable development & poverty reduction • Increasing farmers' income • Reducing external inputs cost • Access to organic market with premium price • Reduction the risk of main crop failures	Crowder & Reganold, 2015; Nemes, 2009; Kilcher, 2007; El-HageScialabba, 2007; Hohmann, 2004; Giovannucci, 2006; Rundgren& Parrott, 2006; Setboonsarng, 2006; Kleemann, 2011; Halberg and Muller, 2013; Müller, 2009; Fayet & Vermeulen, 2014; Panneerselvam et al., 2013; Qiao et al., 2015; Girma & Gardebroek, 2015; UNEP, 2008.
Social benefits	• Enhancing social capacity • Promoting farmers' organizations • Increasing employment opportunities in rural areas • Improving educational and health conditions • Promoting indigenous knowledge • Empowering rural women	Rundgren & Parrott, 2006; UNEP, 2008; Kilcher, 2007; HLPE, 2013; Elzakker and Eyhorn, 2010; Seufert, 2012; Jordan et al., 2009; Farnworth and Hutchings, 2009; Setboonsarng, 2006.
Health and nutrition benefits	• Enhancing food security through improving income and consequently increasing food purchasing power for the poor • Decreasing nutrient deficiencies • Improving diverse and nutritious diet • No heavy metals and pesticide residues in food • Reducing the risk of chemical exposure by farmers	SlighChristmann, 2007; Setboonsarng, 2006; Seufert, 2012; Halberg and Muller, 2013; Lairon, 2010; Baker et al., 2002; Williams, 2002; Barański et al., 2014; Seufert, 2012.

973 Table 3. The main challenges of organic farming in developing countries.

Challenge	References
Low yield	Seufert et al., 2012; de Ponti et al., 2012; Ponisio et al., 2015; Lyngbaek & Muschler, 2001; Cai et al., 2008; Kleemann, 2011; Kirchmann et al., 2008; Bergström et al., 2008; Aune, 2012; Connor, 2013; Lyngbaek and Muschler, 2001; Murphy et al., 2007; van Bueren et al., 2011.
Nutrient management	Lotter, 2015; Vanlauwe et al., 2014; Tittonell& Giller, 2013; Kirchmann et al., 2008; Aune, 2012; Connor, 2013; Connor, 2008.
Certification and market	Gómezet al., 2011; Beuchelt& Zeller, 2011; Smale et al., 2011; Hazell et al., 2010; Kirsten & Sartorius, 2002; Crowder & Reganold, 2015; Chiputwa & et al., 2015.
Education and research	Giovannucci, 2006; Scialabba, 2000; Kleemann, 2011; Ponisio et al., 2015; HLPE, 2013; Ponisio et al., 2015; Seufert et al., 2012; Zundel & Kilcher, 2007.

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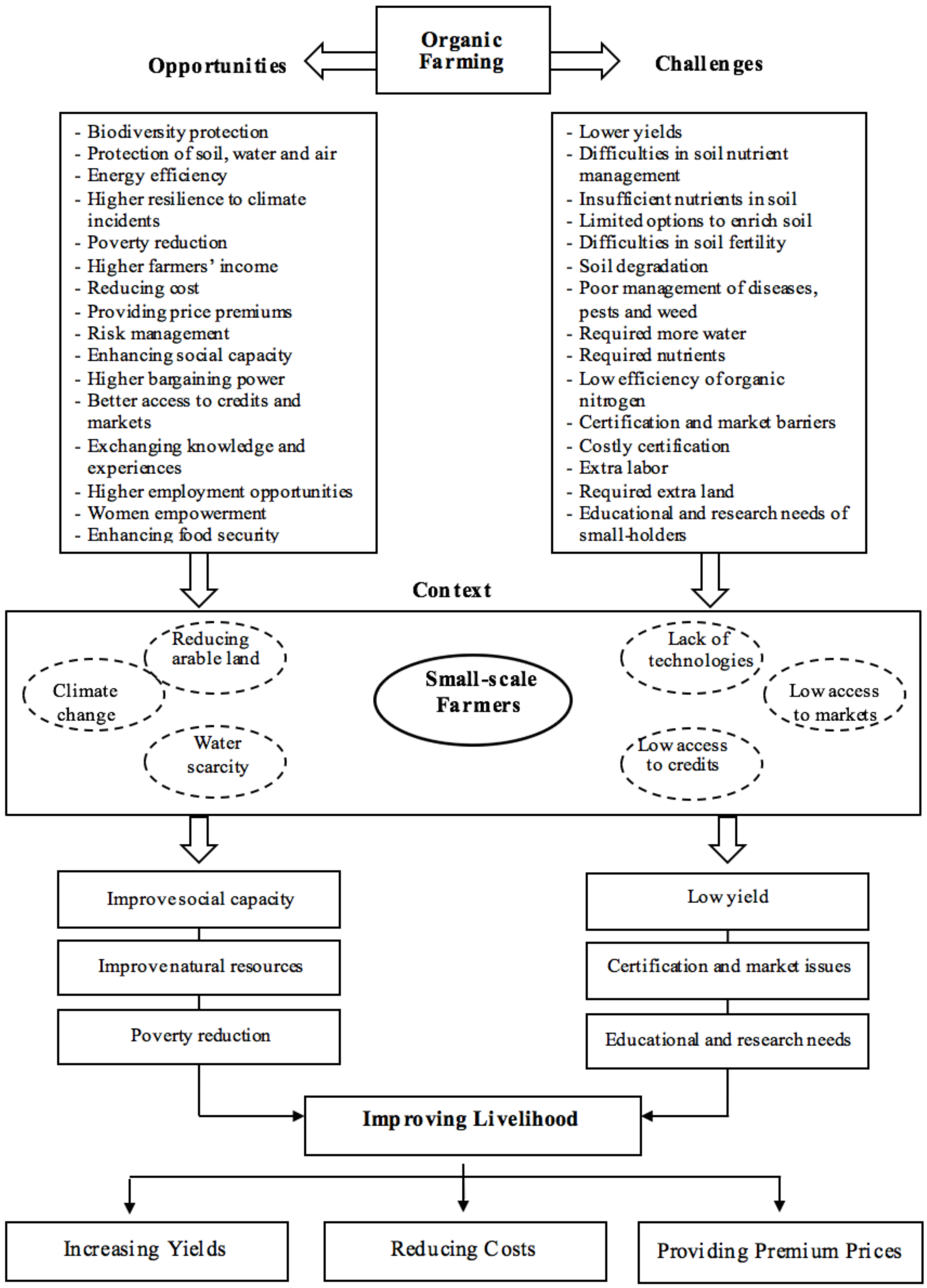

Figure 1. A framework to analyze the potential challenges and opportunities of organic farming for small-scale farmers.