

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

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1 **Organic Farming and Small-Scale Farmers: Main Opportunities and** 2 **Challenges**

3 **Abstract**

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

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

20 21 **1. Introduction**

22 According to the latest data from the FAO (2014), it is estimated that about 805 million people,
23 or one out of nine, around the world are un nourished. This statistic in sub-Saharan Africa is as

24 high as one out of four. When speaking in general, 98 percent of those suffering from hunger
25 live in developing countries, with the numbers reaching 526, 227 and 37 million of hungry
26 people in Asia, Africa and Latin America, respectively. Although these numbers have shown a
27 remarkable decline, specifically in Latin America as compared to the past, there is still a long
28 way to go on the road of eradicating hunger. As the population and subsequent consumption
29 around the world is growing, the demand for food, feed and fuel in the future will do the same.
30 Moreover, in the developing world, diets are changing and people are putting extra pressure on
31 natural resources as they consume more dairy products and meat (Godfray et al., 2010; Seufert
32 et al., 2012). It is estimated that by 2050, the demand for agricultural products will grow by
33 1.1% annually as the world's population reaches around 9 billion (Alexandratos and Bruinsma,
34 2012).

35 From a historical point of view, the Green Revolution has truly increased agricultural
36 production on a global level, but it has done so at the cost of the degradation of the
37 environment and natural resources (Altieri, 2009; Rundgren and Parrott, 2006; Bazuin et al.,
38 2011). Factors like lack of land, water and access to capital restricted food production in many
39 regions (Rundgren and Parrott, 2006). Moreover, studies show that, generally, technology
40 bypasses the poor who cannot benefit from agricultural technologies due to weak land
41 governance, difficulty to obtain inputs and credits, barriers that restrict their access to the
42 market and its opportunities as well as unfavorable policies like subsidies that discriminated
43 against them (Pingali, 2012).

44 Numerous studies suggest that small-scale farmers in developing countries play a crucial role in
45 food security (Altieri, 2009; Tscharntke et al., 2012; Azadi et al., 2015), even though they make
46 up the majority of people in the world who experience food insecurity (HLPE, 2013; Mwaniki,

47 2006). It is estimated that around half of the hungry people on Earth live on small farms
48 (IFPRI, 2015). In order to combat global food insecurity, we therefore ought to pay special
49 attention to those small-holders in developing countries. Though, when we refer to "small-scale
50 farmers" in developing countries, the term "small" can refer to different factors such as the
51 amount of capital invested, the number of workers or the size of the land. Although land size is
52 the most common factor, given different potential uses of lands around the world, there is no
53 unique size for this definition. Nevertheless, the FAO, in a broad definition, considers lands
54 around the world that are smaller than 2 (ha) as small-scale farms. In a more general definition,
55 IFAD (2013; p. 10) describes small-scale farmers as "marginalized people who have
56 difficulties to access resources, capital, information and technology", which is the definition for
57 small-scale farmers in developing countries we used in this paper.

58 According to the data published by the FAO, agriculture uses 11% of the world's land and 70%
59 of its freshwater resources. The lands suitable for agriculture around the world is unequally
60 distributed between high-income countries and low-income countries that have less than half of
61 the cultivated land per person in comparison (FAO, 2011). In some regions of the world like
62 Africa, the indigenous farming method is mainly based on the slash and burn method that
63 include fallow period that lasts for a couple of years. Yet due to population growth, farmers
64 allow their lands to fallow less and less with the majority of small-scale farmers planting
65 annually to keep up with demands, leading to serious soil erosion and nutrient degradation.
66 Consequently, these farmers must abandon their farms and move to new land to repeat the
67 process (Lotter, 2015). According to the FAO, the total amount of arable land per person has
68 decreased globally from 0.38 ha in 1970 to 0.2 ha in 2013 and it is predicted to decrease to
69 about 0.15 ha by 2050. Different studies suggest that the arable land and water supplies in

70 developing countries are significantly being reduced (UNEP, 2008; IFAD, 2007; Food security
71 in Asia and the Pacific, 2013). In the east and southeast of Asia, this figure is even less, at 0.10
72 ha by 2050 (Food security in Asia and the Pacific, 2013).

73 Another important issue facing farmers in developing world is climate change, which can be
74 detrimental to food production by small-scale farmers (Pingali, 2012), who are the most
75 vulnerable group to climate volatility (IFPRI, 2015). Many studies suggest that Africa is among
76 the most vulnerable regions in the world due to climate changes (de Sherbinin, 2014). It is also
77 predicted that major crop yields across Africa will decrease in the future as a result of climate
78 change (Wheeler and von Braun, 2013). Furthermore, apart from the agricultural aspects,
79 African countries would also have to deal with the issue of "food access". The majority of
80 studies on the relationship between climate change and social instability suggest that
81 fluctuations in climate and social instabilities have a positive correlation (Hsiang& Burke,
82 2014). Although their review shows that the association between climatological changes and
83 various conflict outcomes is casual, this hypothesis needs to be tested and justified in reality in
84 order to realize whether and to what extent climate change could be a catalyst of social conflict.
85 Maps provided by the global food policy report (IFPRI, 2015) illustrate that there is a
86 remarkable overlap between regions suffering from civil conflicts and weather-related events.
87 Which demonstrates that there is a correlation between fluctuations in climate and social
88 instabilities. For example, a period of drought can lead to water shortage and scarcity of
89 available resources which, in turn, sparks conflict in the society. Needless to say, food
90 insecurity is prevalent in these regions.

91 Moreover, "water scarcity" in many food-insecure regions around the world continues to be an
92 important issue because when natural resources like water are scarce, poor farmers are put

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

106 In order to address all these issues, many researchers have considered low-external input
107 sustainable agriculture as a preferred development approach for the problem of food security
108 (Setboonsarng, 2006). Integrated, agro-ecological, pest management, and particularly organic
109 farming are the most important ‘sustainable’ agriculture systems introduced in recent years.
110 Nevertheless, organic farming might be practiced differently in different regions (Genghini et
111 al., 2006). In this regard, many researchers have proposed organic farming (OF) as an
112 environmentally friendly agricultural production system (Badgley et al., 2007; Chappell and
113 LaValle, 2011; Scialabba, 2000; Azadi et al., 2011; Schoonbeek et al., 2013; Seufert et al.,
114 2012). OF is thus a holistic production system that considers long-term environmental
115 sustainability and primarily aims to produce food in an environmentally friendly manner

116 (Seufert et al, 2012). Environmental benefits of OF include biodiversity conservation, better
117 quality of soil, reducing evaporation and water harvesting, strengthening adaptation strategies
118 and reducing greenhouse gas emissions as well as energy efficiency (Seufert et al, 2012;
119 Reganold and Wachter, 2016). Organic livestock farming is in line with the goals of
120 environmentally friendly production, improving animals health and welfare standards, and
121 promoting high quality products (Sundrum, 2001). According to a definition given by the
122 International Federation of Organic Agriculture Movements (IFOAM), OF is based on the four
123 basic principles of health, ecology, fairness and care for humans as well as ecosystems
124 (Rundgren and Parrott, 2006). There is compelling evidence that supports the argument that OF
125 can contribute to food security (Azadi and Ho, 2010), specifically in some regions like East
126 Africa (UNEP, 2008). On the other hand, in developing countries where the majority of farmers
127 are small scale, the conventional system of agriculture cannot meet the basic needs of resource-
128 poor farmers. This is rooted in the fact that they cannot afford expensive synthetic inputs such
129 as the extra labour of organic agriculture (Reganold and Wachter, 2016); demonstrating how
130 poverty and food insecurity often go hand in hand (Mwaniki, 2006). As about three-fourths
131 (70%) of the poor in the world are living in sub-Saharan Africa and Asia, investing in
132 agriculture is an effective strategy to improve their livelihood (Namara et al., 2010). OF also
133 increases social capital such as higher bargaining power, better access to credits and markets,
134 the chance to exchange knowledge and experiences, reduce certification costs and fascinating
135 contribution to policy institutions, increase employment opportunities in rural areas and allow
136 farmers to afford better education and health services due to higher incomes (UNEP, 2008;
137 Elzakker and Eyhorn, 2010). Studies show that farmers can get various economic benefits from
138 OF such as saving money by reducing input cost. They can also increase their income through

139 selling their byproducts and by entering organic markets with certified products and selling
140 their products in higher prices (UNEP, 2008; Rundgren and Parrott, 2006).

141 Despite such advantages and opportunities, small-scale farmers still experience some serious
142 challenges when they try to switch to an organic system. First and foremost, the yields of
143 organic farms are around 25% lower than conventional farms; although it is important to note
144 that this difference is very dependent on the context and on local characteristics (Seufert et al.,
145 2012). Some studies also argue that OF is not a feasible option for smallholder farmers in many
146 regions like Africa, who cannot produce sufficient amounts of compost and green manures.
147 Since soil management practices are time consuming, soil fertility is depleted. On average,
148 farmers need around 5 years to get the best return for their investment (Lotter, 2015). Farmers
149 who convert to certified organic products also must face the problem of risk management
150 during their three-year transitional period. During these three years before their certification,
151 farms should be managed organically, but farmers cannot sell their products at the higher prices
152 of certified organic foods. It is a challenging period during which yields usually decrease and
153 farmers need to invest money and time to get through it and achieve their organic certification,
154 (Hanson, 2004; Seufert, 2012).

155 As discussed thus far, small-scale farmers who go for OF face different opportunities and
156 challenges. This paper aims to review potentials and main challenges of OF for small-scale
157 farmers in developing countries. Accordingly, the paper will first discuss the environmental,
158 economic and social benefits of OF as well as the health and nutritional advantages of organic
159 foods. It will then address the main challenges of OF; including low yield, nutrient
160 management difficulties, certification and market issues and educational and research

161 problems. Finally, we will try to determine to what extent OF should be practiced and become a
162 priority for policy-makers to use in order to promote the livelihoods of small-scale farmers’.

163

164 **2. Opportunities**

165 **2.1. Environmental benefits**

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

184 Because biodiversity conservation and management is chiefly rooted in the fact that OF is
185 based on agroecology principles, IFOAM acknowledges the role that small organic holders
186 play in them (IFOAM, 2011). A meta-analysis by Rahmann (2011) found that biodiversity in
187 organic farms is higher than in conventional farms in that out of 396 relevant studies, 327 cases
188 showed higher levels of biodiversity in organic farms. Another meta-analysis study by
189 Bengtsson et al. (2005) reveals that on average in OF farms, species richness increased about
190 30% and the abundance of organisms was 50% higher in comparison with conventional
191 systems. Species richness in birds, plants, soil organisms and predatory insects increased while
192 pest and non-predatory insects did not.

193 Due to many small-holders living in degraded lands and practicing unsustainable agricultural
194 methods, the quality and quantity of their arable lands are on the decline. In the OF system, soil
195 has a key role in production (Scialabba and Hattam, 2002) and has the potential to improve soil
196 (IFOAM, 2011). The soil management methods in OF have the ability to restore degraded lands
197 and prevent further degradation in vulnerable regions, including sub-Saharan Africa (Seufert,
198 2012). The practices used to protect the soil in organic systems includes minimum or no tillage
199 of the land, contour cultivation, soil bunds, terraces, mulching, planting cover crops and
200 agroforestry (Kilcher, 2007). Studies show that the amount of organic soil matter in OF systems
201 is significantly higher than conventional systems (Gattinger et al., 2012). Organic matter
202 increases water penetration into the soil and thus reduce soil erosion by diversifying soil-food
203 webs that improve the nitrogen cycle within the soil (Pimentel, 2006), thus protecting water
204 supplies.

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

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

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

224 Finally, agriculture is very sensitive to the volatile nature of the climate, and regions which are
225 currently suffering from food insecurity, especially, are the most vulnerable to climate change
226 and how it will jeopardize food security in the future (Wheeler and von Braun, 2013). Due to
227 the fact that OF is based on ecological principles, it positively effects the environment by
228 strengthening adaptation strategies and reducing greenhouse gas emissions, effects that
229 specifically benefit small-holders in developing countries who have very limited options on the

230 table and can only work with the available resources on their farms and within their own
231 communities. Studies suggest that during extreme weather events like heavy rainfalls or
232 droughts, OF practices can protect the soil and water in the environment, something which is
233 crucially important during those events (Borron, 2006). Moreover, as the most important asset
234 of small-holders is their labor power, within the OF system, they are more flexible to new
235 environmental situations and consequently can change their product patterns and practices
236 more easily (Hazell et al., 2010). OF advocates adaptation strategies that are rooted in multi-
237 cultures, which can lower the risk of crop failure and increase resilience to extreme weather
238 events. Furthermore, by using indigenous knowledge, farmers are able to plant varieties of
239 well-adapted crops that are resistant to unfavorable conditions. With regard to mitigation
240 strategies, OF can also reduce the emission of greenhouse gases like N₂O and CO₂ and increase
241 soil carbon sequestration (Müller, 2009). In general, OF has the potential for both mitigation
242 and adaptation strategies, both of which enhance the environment's resilience to climate change
243 (Gattinger et al. 2012; Muller et al. 2013; Skinner et al 2014). However, studies reveal that the
244 environmental benefits and impacts of OF are more intense per product unit. Consequently,
245 they suggest that integrated systems which use the best practices of both conventional and OF,
246 can produce higher yields with the lowest environmental impacts (Tuomisto et al., 2012;
247 Trewavas, 2001).

248

249 **2.2. Economic benefits**

250 Organic industry is one of the fastest growing sectors of the food market as the global market
251 for organic food has increased from 15.2 billion USD in 1999 to 72 billion USD in 2013. The
252 main organic markets are the United States and the EU (together 90%) while developing

253 countries have very small organic markets (Willer and Lernoud, 2015). OF by its nature, is a
254 cost-effective system and through the use of local resources, it has great potential to contribute
255 specifically to sustainable development in the poorest regions of the world (Kilcher, 2007) and
256 is considered as a poverty reduction method especially for smallholder and resource restricted
257 farmers in developing countries (El-HageScialabba, 2007). A global meta-analysis by Crowder
258 and Reganold (2015) concerning the economic competitiveness of OF in five continents has
259 shown that despite lower yields in OF, its economic profitability is significantly higher (22-
260 35%) than others. According to their study, OF's profitability is due to the price premiums of
261 organic products. Another comparative study on the economic profitability of organic and
262 conventional farming in India reveals that although the crop productivity decreased by 9.2%,
263 due to the 20-40% price premium and 11.7% reduction in the production cost, OF still
264 increased the net profit of farmers by 22% (Ramesh et al., 2010). In developing countries, OF is
265 responsible for higher profitability due to higher yields, reduced costs and price premiums of
266 organic products (Nemes, 2009).

267 A number of successful organic projects for small-scale farmers like organic tea in China and
268 Sri Lanka (Qiao et al., 2015), rice in the Philippine (Panneerselvam et al., 2013), honey in
269 Ethiopia (Girma & Gardebroek, 2015), cotton in India (Fayet & Vermeulen, 2014) and
270 pineapple in Ghana (Kleemann, 2011) are some examples of this potential. Table 1
271 demonstrates these case studies. IFAD also conducted several studies in China and India that
272 were in favor of the fact that OF as a system that is economically beneficial for small-holders
273 (Giovannucci, 2005). Fourteen case studies on different crops have been selected from a vast
274 variety of agro-ecological situations (Giovannucci, 2006), in which the majority of farmers
275 were poor people with an income of less than one USD per day, working on a land mostly less

276 than one ha. The case studies included vulnerable groups like minorities, women and tribal
277 people. The results suggest that OF is a feasible option for small-holders, specifically for small-
278 holders that live in more difficult environmental situations. Another study of organic cotton
279 farmers in India reveals that OF increased farmers' income from 10 to 20%. Another example
280 is small-scale tea farmers in Kenya who increased their income by 40% as a result of adopting
281 OF practices (UNEP, 2008). In addition, due to intercropping legumes, the farmers could add
282 new crops to their food basket (Hohmann, 2004).

283 From an economic point of view, reducing external inputs and developing access to organic
284 markets by organic farmers and the opportunity to sell their products at premium prices are
285 among the most important economic advantages of OF for small-scale farmers (Giovannucci,
286 2006; Rundgren and Parrott, 2006; Kilcher, 2007). The price premiums for organic products are
287 between 10-300 percent and it is estimated that farmers get 44-50 percent of this price
288 premiums, thus increasing the potential OF has to eradicate poverty in developing countries
289 (Setboonsarng, 2006). By substituting chemical inputs with locally available organic inputs,
290 production costs within the OF system has the potential (Setboonsarng, 2006). Nevertheless,
291 OF is a labor intensive food production system and due to the fact that family members of
292 small-scale farmers are usually working on subsistence farms, the production cost can be even
293 lower (Kleemann, 2011). Another important issue that should be addressed is risk management.
294 In general, due to the lack of access to risk reduction tools like crop insurance, small-
295 holders' capacity to handle risk is typically low (Halberg and Muller, 2013). However, OF has
296 remarkable potential to positively affect small-scale farmers risks by diversifying of products
297 through agro forestry, intercropping and rotation to help them reduce the risk of main crop
298 failures (Giovannucci, 2006). In addition, by reducing input costs, small-scale farmers will be

299 less vulnerable to crop failure caused by climate change. Hence, OF as a low-risk strategy is a
300 feasible option for poor farmers (Müller, 2009).

301

302 **2.3. Social benefits**

303 According to recent data from the World of Organic Agriculture (2015), there were 2 million
304 producers of organic foods in the world in 2013, while more than 80% of them (1.7 million) as
305 well as around 25% of organic lands (11.7 million hectares) are in developing countries. In
306 Africa, OF producers are mainly small-holders (1-3 ha) who are export-oriented and mainly
307 supported by private sectors like NGOs rather than governmental sectors (FAO, 2013; UNEP,
308 2008). For example, in Uganda as the pioneer organic country in Africa with the largest area
309 under cultivation and biggest number of organic farmers, 90% are small scale farmers
310 (Reckling and Preißel, 2009). It should also be noted that because of unfavorable socio-
311 economic situations, and lack of factors like access to markets, appropriate technologies,
312 credits, natural resources and insecure land tenure, smallscale farmers tend to practice
313 unsustainable farming systems which can lead to more environmental degradation (FAO,
314 2011). While implementation of OF with an emphasis on local and indigenous knowledge, can
315 improve social capacity and gradually increases the quality and quantity of natural resources
316 within an environment (Rundgren and Parrott, 2006; UNEP, 2008; Kilcher, 2007). OF also
317 increases social capital by supporting social organizations and NGOs at local or regional levels
318 and defines new rules and responsibilities for managing resources by small-scale farmers
319 (UNEP, 2008). OF promotes farmers' organizations (UNEP, 2008) and small-holders can
320 obtain numerous benefits from these organizations. Such as higher bargaining power, better
321 access to credits and markets, the chance to exchange knowledge and experiences (HLPE,

322 2013) as well as reduce certification costs and facilitating contribution to policy institutions
323 (UNEP, 2008). Given that OF is a labour intensive system, it can increase employment
324 opportunities in rural areas (Elzakker and Eyhorn, 2010) and allow farmers to afford better
325 education and health services due to higher incomes provided by OF. For example, small-scale
326 tea farmers in Kenya were able to pay for school and medical expenses as a result of adopting
327 OF practices (UNEP, 2008).

328 [insert Table 1]

329 Pioneers of the organic movement in developed countries were inspired by traditional methods
330 of farming in Asia and Africa meaning that in many regions of developing world, organic
331 farmers can use their indigenous agricultural knowledge rather than learning new methods
332 (Seufert, 2012). OF is, by its nature, knowledge intensive, and not only is the utilization of
333 indigenous knowledge promoted, but farmers are also encouraged to share their knowledge
334 (Jordan et al., 2009). Although indigenous agro-ecological science is not OF, there is an
335 overlap between indigenous agro-ecological science and OF and thus highly promoted in OF.
336 Additionally, due to the fact that OF emphasizes multi-culture, farmers are usually involved in
337 a variety of activities rather than one tedious task (Ziesemer, 2007). OF in developing countries
338 can enhance social capital and can empower small-scale farmers through cooperative
339 organisation (Rice, 2001). It is also beneficial for women who are usually deprived of credits
340 and access to markets (Seufert, 2012; Rundgren and Parrott, 2006) because it has the potential
341 to promote women empowerment as well (Farnworth and Hutchings, 2009). It is estimated that
342 around half of indigenous agro-ecological science around the world is kept from being shared
343 and taught to women mainly due to the inherited marginalization of women's knowledge and
344 skills in agriculture. For example, considering the low-input nature of OF, women can plant

345 cash crops more easily than compared to their conventional counterparts and can consequently
346 earn extra income (Elzakker and Eyhorn, 2010). Since in many regions, rural women are
347 responsible for providing food for the household, their empowerment can lead to better
348 nutrition for the family (Farnworth and Hutchings, 2009).

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

357

358 **2.4. Health and nutrition benefits**

359 Since OF is based on using of local resources and knowledge efficiently, it has the potential to
360 improve food security and sustainable access by poor and resource-restricted farmers (Sligh
361 Christmann, 2007) as OF can produce a variety of foods at low cost (Halberg and Muller
362 2013). Specifically in challenging environments like dry regions, small-scale farmers can
363 increase their food production by adopting OF practices (Jordan et al., 2009). A study
364 conducted by UNEP-UNCTAD (2008) on 114 organic or near organic projects in 24 African
365 countries, showed that the average yield increased by 128%. In some regions like Africa, the
366 majority of farmers are small-holders who produce crops with no or very little chemical inputs,
367 hence converting to OF is a feasible option for them to increase their yields and access to food

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

376 Regarding food safety and quality issues in food and farm, studies reveal that organic foods
377 compared to the non-organic had the least amount of chemical residues (Baker et al., 2002).
378 Moreover, the concentration of nitrate is lower in organic products (Lairon, 2010; Williams,
379 2002). It is also important to note that, through elimination of synthetic inputs in farms, OF
380 reduces the risk of farmers being exposed to chemical pesticides (Seufert, 2012). Studies reveal
381 that 99% of pesticide fatalities in the world occur in developing countries where illiteracy and
382 poverty among rural population are widespread and farmers are usually poor and have very
383 little knowledge of the safety protocols of chemical pesticide usage (Kesavachandran et al.,
384 2009). With respect to nutritional quality, according to a review study on nutritional quality of
385 organic food conducted by the French Agency for Food Safety (AFSSA), the amount of dry
386 matter, minerals like Fe and Mg and anti-oxidant micronutrients, is higher in organic plant
387 products. In addition, the amount of polyunsaturated fatty acids in organic animal products was
388 higher than conventional products (Lairon, 2010). Furthermore, a recent meta-analysis based on
389 343 studies found that there are considerable nutritional differences between organic and
390 conventional foods. According to this study, the concentration of antioxidants in organic foods

391 is higher while at the same time, the level of toxic heavy metals like cadmium and pesticides
392 residues are lower in organic foods (Barański et al., 2014; Średnicka-Tober et al. 2016).
393 Despite the great advantages of health and nutrition benefits from OF, the willingness of
394 consumers to afford organic products still remains low that might need complementary public
395 and governmental supports. Table 2 summarizes the opportunities of OF in developing
396 countries.

397 [insert Table 2]

398 **3. Challenges**

399 **3.1. Low yield**

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

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

415 Despite the fact that lower yield in OF is a debatable issue rather than a universal phenomenon,
416 there is a large body of literature concerning it. It is worth mentioning that, we did not cite
417 studies that were focused exclusively on the yield gap in developed countries. A comparative
418 study of organic and conventional systems on 362 published analyses reveals that OF yields are
419 around 80% of conventional yields. In this study which was conducted at the field level,
420 researchers arrived at higher yield gaps given the difficulties in management of nutrients in the
421 soil (de Ponti et al., 2012). Moreover, according to a comprehensive meta-analysis of 66 studies
422 by Seufert et al. (2012), the average yield of organic production is 25% lower than
423 conventional systems. This study also found that the OF performance declined about 43 and
424 20% in developing and developed countries, respectively. Similarly, Kirchmann et al. (2008)
425 claim that scientific studies reveal that the yields of organic systems around the world are 25 to
426 50 percent lower than conventional systems. They also argue that the amount of available
427 animal manure is crucially important in this regard. Aune (2012) also states that the yield in OF
428 is 30-50% lower than conventional and conservation agriculture. In addition, a new study on
429 the yield gap between two systems shows that under improved management practices, organic
430 yields are on average 19.2% lower than conventional systems (Ponisio et al., 2015).

431 Although many food policy makers and scientists believe that the total food production in OF
432 could be enough to feed the global population (Tscharntke et al., 2012; Badgley et al., 2007),
433 low yield in OF is one of the most important issues regarding the ability of OF to improve food
434 security. Therefore, a higher yield is not the absolute solution to the problem of food insecurity
435 and there are multiple social, political and economic contributing factors in this regard (Ponisio

436 et al., 2015; Vasilikiotis, 2000). As evidenced by different studies, lower yield in OF is a
437 controversial issue. While some studies argue that the yield of OF systems is higher than
438 conventional systems (UNEP, 2008; Auerbach et al., 2013; Badgley et al., 2007), others
439 suggest lower (Seufert et al., 2012; Ponisio et al., 2015; Bergström et al., 2008; Aune, 2012;
440 Kirchmann et al., 2008; Connor, 2013). It is also worth mentioning that the yield gap between
441 OF and conventional farming is highly dependent on region as well as the crops (de Ponti et al.,
442 2012; Seufert et al., 2012). A comparative review study on the productivity of organic and
443 conventional farming in the tropics and sub-tropics reveals that while the average yields of OF
444 in highly developed countries is 15% lower than conventional systems, in developing and less
445 developed countries the average yield of OF system is 16% and 116% higher than conventional
446 systems, respectively (Te Pas & Rees, 2014). As noted before, yield gap varies among regions.
447 For example, small-scale coffee producers who had converted conventional production to OF,
448 have experienced a gradual yield increase from 15% in Mexico to 67% in Guatemala (Perfecto
449 et al., 2005), while in Costa Rica, organic yields were 22% lower than conventional production
450 (Lyngbaek and Muschler, 2001).

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

459 However, Seufert et al. (2012) argue that due to the lack of appropriate and well-controlled
460 studies on the yields of OF for smallholder farmers in developing countries, there is not enough
461 evidence to accept nor to reject this statement. It is also worth mentioning that, sufficient access
462 to organic manure can provide OF farmers with the opportunity to increase their yield (Aune,
463 2012; Connor, 2013) and have a yield similar to their conventional counterparts; but producing
464 enough manure on the farm without access to a vast pasture is not possible (Aune, 2012).
465 Moreover, if higher yield in OF is due to the importation of huge amounts of manure from
466 conventional systems, then the higher organic yield cannot be considered as the proof of higher
467 OF productivity (Kirchmann et al., 2008).

468

469 **3.2. Nutrient management**

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

477 Some researchers (Badgley et al. 2007) claim that leguminous cover crops have the potential to
478 provide enough nitrogen to do so, while others have rejected their opinion. Critics argue that
479 organic nutrient supplies are limited in many regions around the world and that they cannot be
480 used as the substitute for chemical fertilizers. The production of organic nutrient supplies needs

481 more resources like land, labor, nutrients and water which are not available in many regions
482 (Connor, 2008; 2013).

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

497 Organic matters are also crucial to soil fertility (Altieri, 2002). However, in some regions, like
498 sub-Saharan Africa, small-scale farmers do not have access to sufficient amounts of organic
499 residues in order to add organic matters to their land and improve their soil. There is also a
500 competition over the use of these scarce resources, specifically in regions where livestock feed
501 is unavoidable (Vanlauwe et al., 2014). In general, studies suggest that in Africa, manure
502 application cannot provide the soil with adequate organic matter and it is not a feasible
503 approach to sustain soil fertility. In addition, insufficient fertilizer application for a period of

504 time can lead to soil degradation and if the use of fertilizer restarts later, crop productivity
505 cannot be restored (Tittonell and Giller, 2013). Moreover, in sub-Saharan Africa, there is a high
506 correlation between soil degradation and poverty (Tittonell and Giller, 2013). Small-holders
507 usually cannot afford to pay for compost or extra manure and due to the subsistence nature of
508 their farms, they cannot wait for a couple of years to get a return on their investment in OF.
509 Hence, OF per se, might not be a realistic approach to improve soil and address food security in
510 Africa (Lotter, 2015).

511

512 **3.3. Certification and market**

513 In general, there are two different systems of OF. Certified production with premium price
514 which is mostly for organic markets in developed countries and non-certified production
515 mainly for local markets in developing countries. It is important to note that certified products
516 of developing countries are chiefly export oriented (Rundgren and Parrott, 2006). Certification
517 is costly because it needs infrastructures for monitoring and documenting producers, therefore,
518 many small-scale and resource-restricted farmers cannot afford them (Gómez et al., 2011).
519 Moreover, it should also be mentioned that certification has almost no advantage for
520 subsistence farmers nor for those who are living in a region with no reliable organic market
521 (Rundgren and Parrott, 2006). Nevertheless, in some cases, certified products are even less
522 profitable than non-certified products. For example, a study on 327 of Nicaragua's organic, fair
523 trade and conventional coffee producers over a decade reveals that despite the fact that certified
524 coffee prices were higher at the farm gate, due to lower productivity, organic producers became
525 poorer in comparison to conventional producers. Premium prices for organic and organic-fair
526 trade certified coffee were 8% and 11% higher than conventional coffee price respectively. The

527 premium was around 0.2 US\$/kg, which could never cover the cost of required extra labor and
528 land. Organic farmers need to hire laborers because family members were not enough to cover
529 the labor requirement fully (Beuchelt and Zeller, 2011). Studies show that labor costs in OF are
530 7-13% higher than conventional systems while, generally, the profitability of OF is dependent
531 on the price premiums applied to organic products which are usually between 29 to 32%
532 (Crowder & Reganold, 2015). This can explain, to some extent, why certified organic coffee
533 was not profitable in Nicaragua. Another study on small-scale coffee farmers in Uganda,
534 reveals that certified farmers in comparison to their conventional counterparts have higher
535 living standards. However, organic certification did not have a significant positive impact on
536 the livelihood of farmers. Whereas, a fair-trade certification improves the household's living
537 standards by 30% and reduces the farmers' vulnerability (Chiputwa & et al., 2015). This can be
538 explained by different factors. Fair-trade farmers receive price guarantees and have more
539 freedom regarding the marketing of their products. In addition, fair-trade farmers sell their
540 products after milling, while organic farmers sell their coffee in unprocessed forms for export
541 (Chiputwa & et al., 2015).

542 Access to market is another important issue that should be addressed. It is estimated that only
543 43% of people in rural areas of developing countries can reach markets within 2 hours by
544 motorized transport. This trend in some regions like sub-Saharan Africa is as low as 25% of the
545 population (Smale et al., 2011). In addition, the economic growth and urbanization in some
546 regions of developing world like Latin America, parts of South-East Asia and to some extent in
547 China have changed the marketing chains of food. Super markets have become the dominant
548 power in the food market and it is difficult for small-holders to meet the required conditions of
549 them regarding the quality, quantity, traceability, timeliness and flexibility that super markets

550 required, small-holders who are usually resource and education restricted, cannot compete with
551 rich farmers (Hazell et al., 2010). Concerning the export market, due to relatively strict
552 standards and high expectations of consumers and supermarkets in developed countries for high
553 quality food, only a limited number of farmers in developing countries can reach such markets
554 (Kirsten and Sartorius, 2002).

555

556 **3.4. Education and research**

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

564 With respect to the issue of research, it should be noted that not only is the overall amount of
565 OF research is globally less than research of conventional systems (Ponisio et al., 2015), but the
566 majority of researches have also conducted their studies mainly in developed countries rather
567 than the developing world (Seufert et al., 2012). Moreover, small-holders are usually neglected
568 in research and extension policies and programs, while it is extremely important for small-scale
569 farmers to receive appropriate research and investments that concentrate on their specific needs
570 in order to change their situation (HLPE, 2013). For example investment in agroecological
571 studies can lead to a gradual increase in organic yield through breeding (Murphy et al., 2007) or
572 crop rotation and multi cropping (Ponisio et al., 2015) and consequently, can increase the

573 overall yield. It is also vital that participatory studies that emphasize locally appropriate soil
574 management techniques, specifically in regions with unfavorable climates where access to
575 biomass is very limited (Zundel and Kilcher, 2007). Table 3 collects the main challenges of OF
576 in developing countries.

577 [insert Table 3]

578 **4. Discussion and conclusion**

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

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

590 To synthesize results and put them into some broader context, a framework has developed to
591 explain under what conditions (context) and for which farmers (small-scale farmers) organic
592 farming is appropriate (Figure 1). According to the framework, in many regions, factors such as
593 lack of land, water and capacity have restricted food production. Moreover, because of
594 unfavorable socio-economic situations of small-scale farmers, they tend to practice
595 unsustainable farming systems which can cause more environmental degradation. OF with an

596 emphasis on local and indigenous knowledge, can improve social capacity, poverty reduction
597 and gradually increases the quality and quantity of natural resources. Despite such advantages
598 and opportunities, there are some challenges faced by small-scale farmers to switch to organic
599 system, including low yield, nutrient management difficulties, certification and market issues as
600 well as educational and research needs. Low yield is among the most important issues in this
601 regard. Nevertheless, and given the controversial results on the OF yield, this aspect still needs
602 further investigations in which the yields resulted from different OF practices could be
603 compared in the long-run. Regarding regional priority for OF, different studies reveal that OF
604 can result in highest profitability in dry, water-scarce and least developed regions (Te Pas &
605 Rees, 2014; Jordan et al., 2009). Moreover, OF is in particular beneficial under uncertainty
606 condition, like climate changes (Scialabba & Müller-Lindenlauf, 2010). Different studies
607 suggest that under extreme weather related events like drought, the performance of OF is better
608 than conventional farming (Borron, 2006; Reganold & Wachter, 2016).

609 In sum, considering all the opportunities and challenges and despite the fact that OF might have
610 some important challenges for small-scale farmers, it could/should still be considered as a part
611 of the solution to improve their livelihood within an integrated approach which uses the best
612 practices of different production systems. OF can be considered as an effective development
613 strategy in order to reduce poverty and empowering small scale farmers in developing countries
614 (Setboonsarng, 2006; Bennett & Franzel, 2013; Vaarst, 2010; Te Pas & Rees, 2014). OF can
615 improve the livelihood of small-scale farmers through three main mechanisms: increasing
616 yields, reducing costs and providing premium prices. The initial farming system and the market
617 integration degree, determine the potential of each mechanism in this regard (Bennett &
618 Franzel, 2013). Different studies show that in developing countries, transition from resource

619 restricted and subsistence farming to OF, can increase the yield (Te Pas & Rees, 2014; FAO
620 website; Badgley et al., 2007; Pretty et al., 2006; Halberg, et al., 2006; UNEP, 2008;
621 Giovannucci, 2005). Consequently, poor farmers can increase their yield by applying OF
622 practices which are mostly based on agroecological principles.

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

627 Finally, certification provides farmers with the opportunity to achieve organic market and
628 benefit from the price premiums of their products. With regard to certified organic products and
629 its premium price, some critics claim that export markets are feasible only for large farmers or
630 just very few are well organized small-farmers and the benefits of organic products mostly go
631 to middlemen and traders (Abele, et al., 2007). Nevertheless, in order to facilitate smallholders'
632 access to organic certification and market, IFOAM promoted some tools and strategies like
633 group certification via Internal Control Systems (ICS) and Participatory Guarantee Systems
634 (PGS) which are based on social trust and exchanging knowledge. In addition, some studies
635 suggest that contract farming can provide small-scale farmers with the opportunity to
636 participate in the market (Kirsten and Sartorius, 2002). For example, a study on export-oriented
637 rice contract farming in Cambodia suggests that through increasing profitability, contract
638 farming can be an effective strategy to reduce rural poverty specifically for farmers living in
639 remote areas and has potential to empower subsistence farmers (Cai et al., 2008). Moreover,
640 since the majority of poor farmers in remote areas do not have access to chemical inputs and
641 their products are almost organic, they can shorten the transition period and hence can get

642 benefits from certified products easier than non-organic farmers (Setboonsarng, 2006). Yet,
643 some critics argue that the current version of OF, which is mostly dependent on the external
644 organic inputs and has special emphasis on the certification and export markets, has almost
645 nothing to offer to the smallholders in developing countries (Altieri, 2009). In general, given
646 the fact that almost 90% of certified organic products are sold in the EU and US markets
647 (Willer and Lernoud, 2015), certification can be justified only if farmers have access to the
648 export markets (Bennett & Franzel, 2013).

649

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653

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

Country	Practice	Mechanism to improve livelihood	Reference
Philippine	Organic rice	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Reducing the investments required • Providing premium prices 	Qiao et al., 2015
Ethiopia	Organic honey	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Reduction of the production cost • Improving payment condition 	Fayet & Vermeulen, 2014
Ghana	Organic pineapple	<ul style="list-style-type: none"> • Reduction of the production cost • Selling products with the premium price 	Kleemann, 2011

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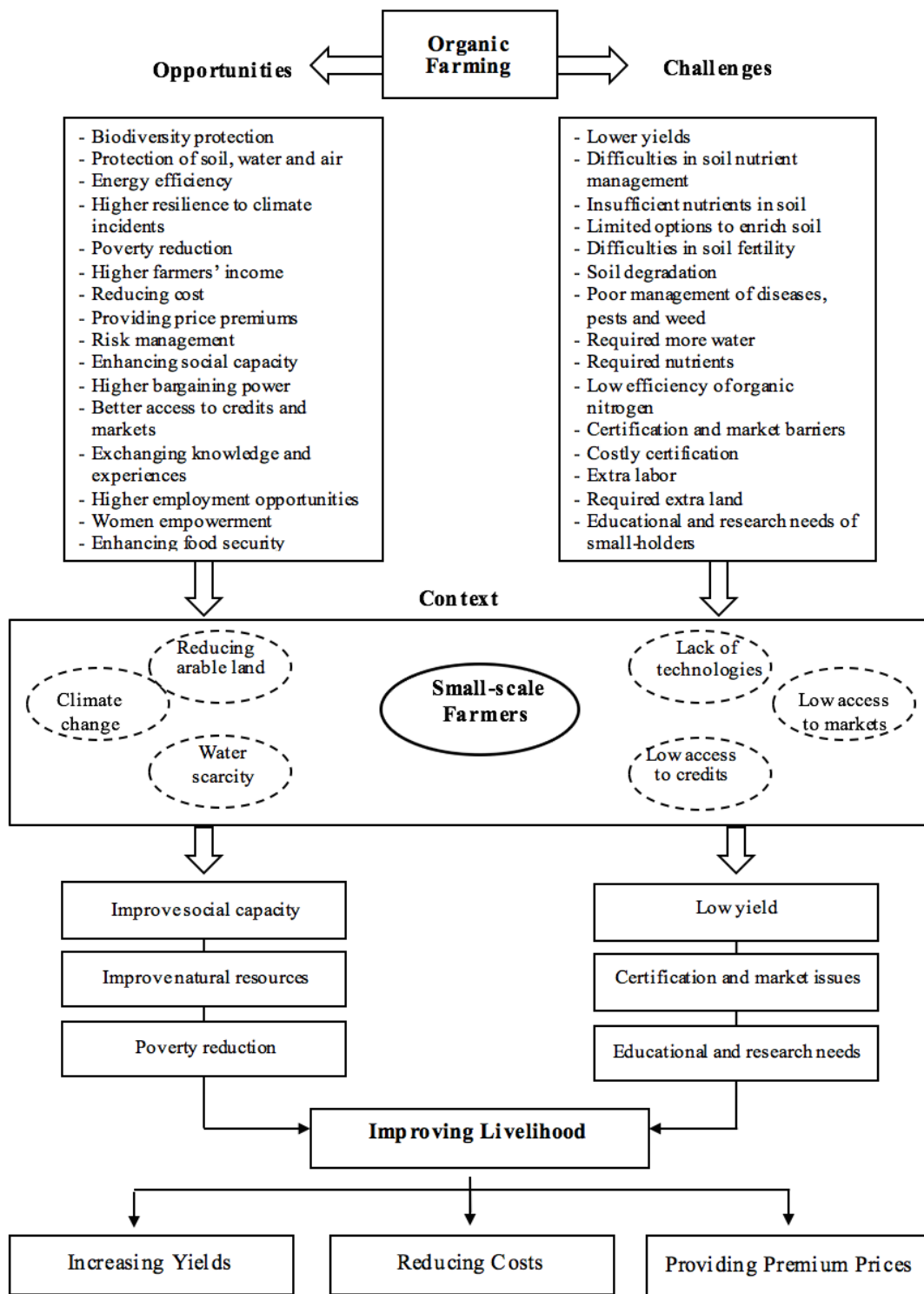
971 Table 2. The main opportunities of organic farming in developing countries.

Opportunity	Descriptions	References
Environmental benefits	<ul style="list-style-type: none"> • Biodiversity conservation • Soil protection • Water supplies protection • No risk of water, soil and air contamination by chemical inputs • No fossil energy inputs • High environmental resilience against climate change 	<p>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; Tuomisto et al., 2012; Gattinger et al., 2012.</p>
Economic benefits	<ul style="list-style-type: none"> • 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 	<p>Crowder & Reganold, 2015; Nemes, 2009; Kilcher, 2007; El-Hage Scialabba, 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.</p>
Social benefits	<ul style="list-style-type: none"> • Enhancing social capacity • Promoting farmers' organizations • Increasing employment opportunities in rural areas • Improving educational and health conditions • Promoting indigenous knowledge • Empowering rural women 	<p>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.</p>
Health and nutrition benefits	<ul style="list-style-type: none"> • 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 	<p>Sligh Christmann, 2007; Setboonsarng, 2006; Seufert, 2012; Halberg and Muller, 2013; Lairon, 2010; Baker et al., 2002; Williams, 2002; Barański et al., 2014; Seufert, 2012.</p>

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	Gómez et 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.