The Implications of Agroecology and Conventional Agriculture for Food Security and the Environment in Africa

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1. Introduction

Agroecology is a form of agriculture that is dependent on natural systems of cultivation and minimum external inputs. Some of its properties include aspects of agriculture that are reliant on natural systems and very minimal external inputs, such as green manure, compost, crop rotation, and biological pest control. Agroecology also includes the use of pesticides and fertilizers generated from natural avenues, such as pyrethrin from flowers and bone meal from animals (Badgley et al. 2007). On the other hand, conventional agriculture is any form of agriculture that is based essentially on external inputs, such as inorganic fertilizers, pesticides, and herbicides, inter alia (Badgley et al. 2007; Seufert et al. 2012). Therefore, the key differences between agroecology and conventional agriculture are anchored on the fact that conventional farming is based on inorganic or synthetic fertilizers, pesticides, and plant growth catalysts, such as antibiotics and hormones, while agroecology is based on natural inputs (Badgley et al. 2007; Lindell et al. 2010a). In a nutshell, the major differences between agroecology and conventional agriculture are based on decentralization, independence, community, harmony with nature, diversity, and restraint (Lindell et al. 2010a, 2010b) (Figure 1).

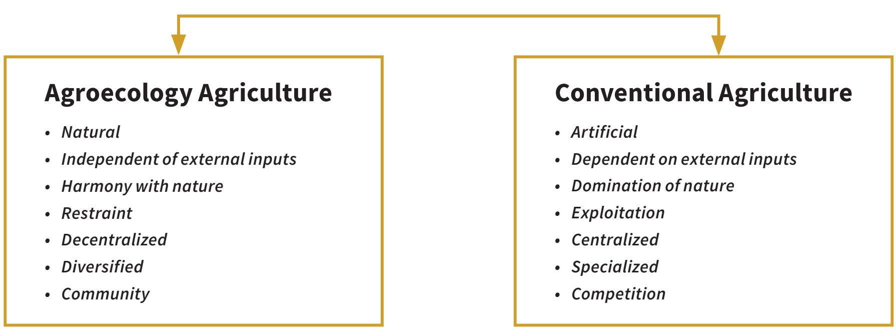

Figure 1. The differences between agroecology and conventional agriculture. Source: Figure by authors.

The global carrying capacity of the Earth is being affected by rapid population growth throughout the world. The ability of the Earth to feed a projected population of about 9 to 10 billion people by 2050 is being compromised by the galloping world population (Badgley et al. 2007). Thus, there is a pressing need to enhance global production and at the same time ensure that the environmental footprints of current and emerging production systems do not perturbate the promises of intergenerational sustainability (Seufert et al. 2012). Agroecology responds to the twin challenges aimed at producing food while at the same time reducing the environmental footprints of production activities. Despite the benefits of agroecology, the system has been criticized for being unbale to feed the global population when compared to conventional agriculture (Seufert et al. 2012). To ensure better yields and for farming systems under agroecology to level up and be parallel with current global conventional systems of production, it is necessary to bring more land into cultivation. The idea of expanding agricultural land through extensive farming heralds evidence-based repercussions on the environment through effects such as the loss of forests, biodiversity degradation, and inadequate organically acceptable farming procedures that can produce enough food without compromising the environmental strengths of agroecology (Trewavas 2001; Seufert et al. 2012; Epule 2019).

The prospects of brining more land into production in Africa is diminishing, as land expansion is becoming a limitation (Morris et al. 2007). A study by Badgley et al. (2007, p. 86) observes that agroecology has the potential of contributing quite substantially to the global food supply, while at the same time protecting the environment. The latter observation has been criticized by Seufert et al. (2012) on the grounds that 1. they included agroecology yields from farms with inputs of large amounts of nitrogen from manure; 2. they included less representative low conventional yields in their comparison; 3. they failed to consider yield reductions over time due to rotations with non-food crops; 4. the double counting of high agroecology yields; and 5. the extensive use of unverifiable data from the grey literature.

With all these criticisms in mind, it is a complex process to predict if agroecology will maintain its promise of producing more food and protecting the environment. Unfortunately, the Seufert et al. (2012) paper cannot be used to conclude this regarding Africa, as it fails to use data from the latter. Its conclusions cannot be generalized because it is more germane to say there are insufficient studies dwelling on this topic on an African scale except for (Epule 2019).

2. Methodology

The data used in this chapter are based on a review of the peer-reviewed and grey literature. A search for suitable publications was performed in the following search engines: Google Scholar, Scopus, Institute of Scientific Information (ISI), and Scientific Citation Index (SCI) Web of Science. It is believed that the data culled from these search engines are representative, as ground truthing did not result in any new studies. This work considers suitable literature in both French and English, and a total of 49 peer-reviewed and grey literature studies were included in this review. Of these 49 publications, only 6 were published by authors with affiliations in African universities or organizations. From these publications, 30 focused on agroecology while 19 focused on conventional agriculture. The time span of the papers selected was open, but all the studies included in the review had a focus on Africa or some African country. The search was conducted using keywords such as agroecology and conventional agriculture in Africa, benefits and challenges of agroecology and conventional agriculture in Africa, and food security implications of agroecology and conventional agriculture in Africa. From the resulting database, key themes were identified based on the objectives of this chapter.

3. Theoretical Foundations of Agroecology and Conventional Agriculture

Agricultural systems can be balkanized into two broad categories, which include agroecology and conventional agriculture. These farming systems represent two broad agricultural systems. For a long time, unless an agricultural system is being productive in terms of yields, using more inorganic fertilizers and pesticides in addition to resulting in cutting up more forest in favor of farmland expansion, it is said to be facing a decline. This emphasis on yields is often at the detriment of the environment, and a society is said to face a decline if it cannot keep up with yield demands at all costs and at the expense of environmental degradation, deforestation, and greenhouse gas emissions, inter alia. For a very long time, agricultural systems around the world have been based on conventional agriculture. This dominant or traditional system of farming places emphasis on the following aspects: 1. Inputs of inorganic fertilizers and hybrid sowing materials or seeds (Morris et al. 2007; Matson et al. 1997; Epule et al. 2012). 2. Mechanization or dependence on agricultural machinery. 3. Monoculture or the cultivation of single crops. 4. The commercialization of production through a huge market orientation as well as development and integration into a global economy (Figure 2a). Conventional agriculture has been associated with environmental degradation, with the Global South being more vulnerable due to poverty, accessibility, and general low adaptive capacities (Lindell et al. 2010a, 2010b; Matson et al. 1997; Rosegrant and Cline 2003; Snapp et al. 2010; Hossain and Singh 2000; Reid et al. 2003; Valenzuela 2016).

On the other hand, agroecology has been proposed as an alternative to conventional agriculture for the following benefits: 1. It enhances crop production. 2. It protects the environment by reducing environmental footprints due to its minimal dependence on external inputs. 3. It is easily accessible by poor farmers in the Global South since it is less dependent on synthetic external inputs. The key components of agroecology include the following: 1. It is based on the use of natural nutrient cycling with little or no synthetic substances (Badgley et al. 2007; Snapp et al. 2010; Kerr et al. 2007). 2. It ensures improvements in yield through the following options: 1. Nutrient cycling through natural processes and the accumulation of organic matter. 2. Natural control of pests and diseases using relationships such as predator–prey strategies rather than the use of pesticides, as well as the use of animal wastes as pesticides. 3. The conservation of environmental resources such as energy, soil, biodiversity, and water. 4. The enhancement of biodiversity, synergies, and interactions (Figure 2b). The fundamental principle behind this paradigm is anchored on resolving the debates around the dilemma related to feeding mankind while at the same time ensuring that the environment is protected.

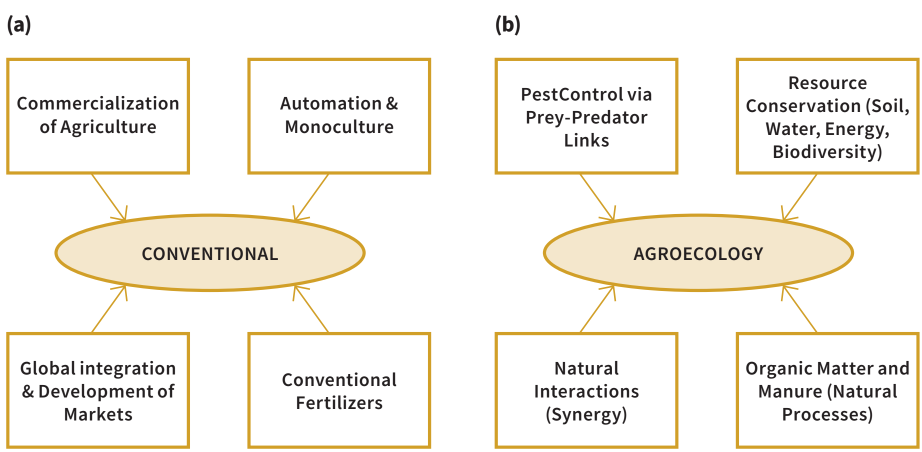

Figure 2. The paradigms of (**a**) the conventional paradigm and (**b**) agroecology. Source: Authors' compilation based on data from Epule et al. (2015).

4. Benefits and Challenges of Agroecology and Conventional Agriculture in Africa

4.1. Agroecology

One of the key benefits of agroecology is that most of its options are freely available. This aspect is of great importance in the African context because most agricultural production is in the hands of smallholder peasant farmers who often do not have enough money to invest in costly conventional agricultural inputs (Pichot et al. 1981; Bationo and Mokwunye 1991; Rosegrant and Svendsen 1993; Bado et al. 1997; Altieri 2009). With agroecology, manure and compost can easily be obtained from household waste, while animal droppings and urine can be used as fertilizers and pesticides (Snapp et al. 2010; Rosegrant and Svendsen 1993). Additionally, predator–prey relationships can be used to combat pests through the entomology technique of breeding insects that prey on other harmful pests on farms. All these options are freely available at little or no cost (Epule et al. 2012, 2015).

Furthermore, agroecology options are always environmentally friendly or compatible with natural environmental systems (Snapp et al. 2010; Rosegrant and Svendsen 1993). This is evident as composts, manure, and other natural inputs that make up agroecology do not pollute the soil, nearby streams, and other water resources (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). Instead, they help to enhance soil aeration and social organic carbon (Epule et al. 2012, 2015).

Again, as seen in the literature review, when agroecology is properly valorized it leads to improved yields. In fact, the low-level capabilities of agroecology in Africa are currently tied to the lack of valorization (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). This can be achieved through sensitization and the creation of pilot demonstration farms (Epule et al. 2012, 2015).

Finally, agroecology is open to the diversification of agriculture through either mixed cropping or mixed farming (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). In addition to the fact that this diversifies farmers' income when some crops are not successful, it also provides an opportunity for the introduction of livestock (Snapp et al. 2010; Rosegrant and Cline 2003). In fact, with livestock, agroecology can be enhanced because the waste from the animals can be used as manure and to control pests at the farm level, while some of the thrash from the crops can be decomposed to provide manure as well as be used as food for the animals (Epule et al. 2012, 2015).

One of the main disadvantages of agroecology is that it is often dependent on the incorporation of more land into agricultural systems (Epule et al. 2012, 2015). This is disadvantageous, because when more land is cultivated, it is likely that more trees will be cut down (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). In fact, the prospects of agroecology are highly limited in the context of farmland expansion, as there is currently evidence that there is less land for the continuous expansion of farms. Continuous deforestation exposes the land to various types of erosion and long-term soil degradation (Epule et al. 2012, 2015). This is the case in West, Central, and East Africa, as farmers in these regions depend mostly on farmland expansion to increase yields.

In addition, agroecology is currently not well-developed in Africa due to problems with the valorization of the systems (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). Most farmers cannot afford inorganics and end up farming under peasant conditions without exploring the elements of agroecology. This low level of valorization accounts for the often-low commercialization orientation of this type of agriculture (Snapp et al. 2010; Rosegrant and Cline 2003). If most countries in Africa valorize this system, as is the case in Malawi, it is likely that it might be able to provide yields that are parallel to those of conventional farms (Epule et al. 2012, 2015).

4.2. Conventional Agriculture

One of the benefits of conventional agriculture in Africa is that it is less dependent on land expansion (Snapp et al. 2010; Rosegrant and Cline 2003). In contrast to agroecology, which is often extensive and land-dependent, conventional agriculture is usually intensive, focusing on intensive inputs of fertilizers, machines, and pesticides, inter alia (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). The advantage of this is that there is less deforestation and soil degradation caused by different types of soil erosion (Epule et al. 2012, 2015).

Secondly, another advantage of conventional agriculture is that it is highly market-dependent and pro-commercialization (Snapp et al. 2010; Rosegrant and Cline 2003). In other words, most production in highly intensive farms and its associated investments are often aimed at a huge market orientation (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). The benefits of commercial agriculture are that it provides an income for famers and makes agriculture a primary industry that operates beyond subsistence (Epule et al. 2012).

In addition, conventional agriculture is often intensive and mechanized. This means that farmers under this system more often use machines, which go a long way to enhance production (Snapp et al. 2010; Rosegrant and Cline 2003). This is in contrast to most agroecology-related approaches, which often depend on natural systems and human labor (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). The incorporation of machines into conventional agriculture is an illustration of the valorization of conventional agriculture and, evidently, the occurrence of higher crop yields under this system of cultivation (Epule et al. 2012).

In terms of the challenges, it is important to note that the inputs into conventional farming systems are often not compatible with natural environmental systems (Snapp et al. 2010; Rosegrant and Cline 2003). This is seen in the case of inorganic fertilizers, which may enhance yields but, on the other hand, pollute streams and other underground water resources if they are not properly managed (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). Recent research has even shown that inorganic fertilizers and pesticides, in addition to other hormones found in the latter, have been described as partly responsible for several illnesses, such as cancer (Epule et al. 2012).

Furthermore, conventional agriculture is often monocultural, meaning that often only a single crop is cultivated (Snapp et al. 2010; Rosegrant and Cline 2003). The limitation of this is that, when there are crop failures, farmers might have many difficulties in recovering from the loss as they might not have suitable alternatives (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). Additionally, monocultural farms are often more susceptible to changes in climate and are therefore more easily affected when bad climatic conditions occur (Epule et al. 2012). This is evident as the farmers involved might not have suitable alternatives, as they depend on a single crop.

Finally, conventional agriculture is often characterized by inorganic fertilizers, pesticides, and fungicides, and is hugely machine-intensive (Pichot et al. 1981; Bationo and Mokwunye 1991; Bado et al. 1997, 2007). These key components of agroecology are expensive and not readily accessible in most African countries, as most farmers are poor and unable to afford them (Snapp et al. 2010; Rosegrant and Cline 2003). In cases where governments have invested to enhance access, rife rates of corruption have resulted in having these resources end up in the wrong hands (Epule et al. 2012).

5. Agroecology and Conventional Agriculture: Food Security Implications in Africa

According to the Malthusian population perspective, global food production was going to be unable to sustain the galloping world population. As a result of this, the debate is now around the potential of agroecology- and conventional-farming-related approaches to meet global food needs in general and especially food needs in the Global South. The initial hypothesis is that conventional agriculture can produce higher yields, in contrast to agroecology (Badgley et al. 2007; Epule et al. 2015). Indeed, conventional agriculture has witnessed major technological advancements in the last six decades. These changes were necessitated by the pressure imposed by the doubling of the human population in the past 40 years and have resulted in the production of more food. However, the problem now is one associated with the distribution of the food gains as well as the toll that these practices exert on the environment (Badgley et al. 2007; Abedi et al. 2010). Within this distribution chain, it can be observed that the Global South is still faced with problems of rife food insecurity and associated increased vulnerability to climate stressors. With an increase in the global consumption of meat and a decline in grain production, it is more important than ever to tilt production towards more sustainable methods. This is because conventional systems do not only degrade the environment through a strong dependence on external inputs but have also not been able to solve the problems of food insecurity in many parts of the world, including Africa (Altieri 1995, 2002; Uphoff 2003).

However, it has been argued that the alternative of conventional agriculture, which is agroecology, is still not capable of ensuring production to attain levels that equate to those of conventional production. In addition, agroecology requires more land and renders this approach unsustainable, as it often results in deforestation and consequent land degradation through different forms of erosion (Stoop et al. 2002; Tilman et al. 2002; Bumb and Groot 2004). Badgley et al. (2007) verified the criticisms against agroecology through two models of food production under agroecology conditions. The first model used agroecology: non-agroecology yield ratios based on developed world studies. It is argued that when converted into agroecology, low-intensity agriculture, which is a phenomenon of most of the developing world, will produce similar or slightly lower yields as obtained in the developed world. The subsequent model used other yield ratios derived from the developed world as well as yield ratios culled from studies on the developing world and applied them to food production in the developing world. The latter study found that agroecology can indeed contribute to feed the current and future world populations with little or no environmental concerns. These results are said to under-represent the real yields in agroecology, as several farms were reported for individual crops because many agroecology systems use multiple cropping approaches, within which the total output is often higher when compared to single crops (Badgley et al. 2007).

Since more research has focused on conventional agriculture, there are more opportunities to increase agroecology, as much remains unknown. Therefore, if the same emphasis that has been placed on conventional agriculture is placed on agroecology, agroecology is likely to result in additional yields. Furthermore, the yield per unit seems to be higher for agroecology-based systems of production for smaller than bigger farms in both the developed and developing world. This means that an increase in the number of small farms will further enhance global food production (Seufert et al. 2012; Bado et al. 2007). These results do not imply that yields under agroecology exceed yields under conventional yields but suggest rather that under certain conditions agroecology has the potential to enhance crop yields (Badgley et al. 2007).

The results that show that agroecology can feed the world's population have been debunked and criticized by Seufert et al. (2012). These criticisms are anchored on the justification that the authors of those findings used data from crops that were not purely under agroecology, and therefore were erroneous in their comparison of yields. In their study, Seufert et al. (2012) performed a comprehensive meta-analysis of the literature on agroecology and conventional agriculture. The principal findings showed that conventional agriculture is more capable of feeding the world's population when compared to agroecology (Seufert et al. 2012).

There is a variation in agroecology yields according to different crop types. For example, yields under agroecology for oil seeds and fruits show a very small but significant difference when compared to conventional yields. Additionally, vegetables and cereals witnessed significantly lower yields than conventional crops (Seufert et al. 2012; Bationo and Mokwunye 1991; Bado et al. 2007; Tilman et al. 2002; Bumb and Groot 2004). From a time, perspective, agroecology-related yields are usually low during the first year and gradually increase with time due to enhancements in soil fertility. Under rain-fed conditions, agroecology yields are higher than those under irrigation. Considering a global perspective, agroecology yields are said to be higher in the developed world than in the developing world. However, the general conclusion of the Seufert et al. (2012) paper is that agroecology-based systems of agriculture generally have lower yields when compared to conventional yields.

In Africa, there are several studies that have assessed the performance of agroecology and conventional agriculture in the context of their impacts on crop yields (Altieri 1995, 2002; Pretty 1995; Gliessman et al. 1998; Kerr et al. 2007; Dorward et al. 2008; Snapp et al. 2010; Ayuke et al. 2011). There is evidence from Gambia, Madagascar, and Sierra Leone that the mean yields of rice under conventional farming are much lower than those under agroecology (Uphoff 2003, 2013). In Gambia, for example, conventional rice yields were reported at 2.3 t/ha, while those under agroecology recorded 7.1 t/ha (Uphoff 2003, 2013). Madagascar, on its part, recorded conventional rice yields of 2.6 t/ha, while agroecology recorded 7.2 t/ha; in Sierra Leone, conventional rice yields recorded 2.3 t/ha, and agroecology recorded 5.3 t/ha (Figure 3) (Uphoff 2003, 2013). Between 1994 and 1999 in Madagascar, the mean yields were higher for conventional farms, which recorded 8.55 t/ha, while peasant or agroecology farms recorded 2.36 t/ha (Uphoff 2003). Based on these initial examples, it can be said that the yields under agroecology are generally higher in the context of the countries under consideration, except for Madagascar.

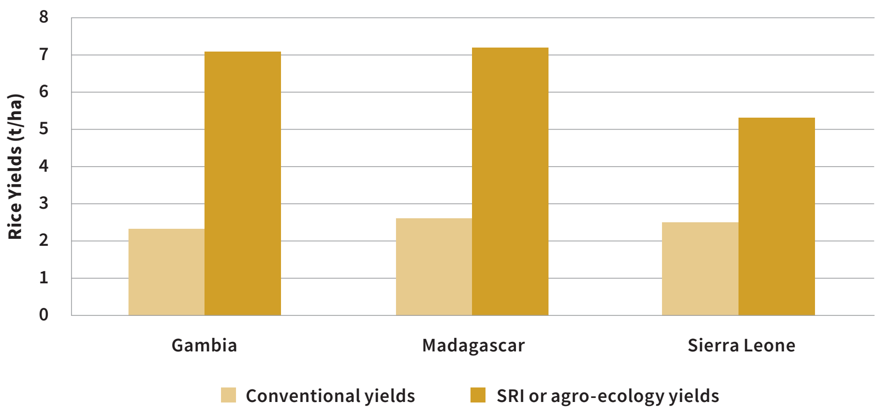

Figure 3. Mean rice yields under agroecology and conventional farming. Source: Authors' compilation based on data from Uphoff (2003, 2013).

These days, agriculture in Africa is being modernized, as seen in the increased use of improved varieties of planting materials, machines, pesticides, and inorganic fertilizers, among other aspects. It has been stated that the full capabilities of improved varieties are often much more effective when other external inputs, such as inorganic fertilizers, are employed (IFAD 1986). Therefore, most food security campaigns in Africa have emphasized the modernization of agriculture through inorganic inputs, and therefore conventional agriculture. It has been argued that, in Cameroon, agroecology nutrients are often not available for crops when compared to inorganic nutrients under conventional farming. Additionally, it has been argued that organic sources are unable to trigger an agricultural revolution in Africa because of the lack of valorization (IFAD 1986; Epule et al. 2012). It has been added that all attempts at increasing productivity in Cameroon without external inputs are likely to fail, because the optimal scenario for yield enhancement includes a scenario that combines both agroecology farming and conventional farming (FAO 1987). In most African countries, yield improvements are often based on increasing farm sizes. Agroecology will further reinforce this equation by taking up more land, while conventional agriculture drives intensive agriculture and therefore reduces the yield–land dilemma (Lindell et al. 2010a, 2010b; Jayne et al. 2003). However, conventional agricultural options, such as inorganic fertilizers, are more likely to pollute water resources (Lindell et al. 2010a, 2010b; Epule 2019).

For agroecology to be successful in Africa, its components need to be adequately valorized. For the twin challenges of improving yields and protecting the environment to be achieved through agroecology, all of the processes involving the enhancement of organic manure, compost, the use of prey–predator relationships to control pests, and the dependence on natural cycles must be valorized to levels parallel to those of conventional agriculture. With a few exceptions to the leading role of agroecology-related yields in Africa presented above, most reports on the success of agriculture in Africa are often linked to the role of the conventional options of agriculture. Africans need to be educated on how to valorize agroecology, and pilot agroecology projects need to be established in various countries. Countries such as Malawi, with some of the well-known agroecology projects, still indulge in the intensification of agriculture through external inputs in bids aimed at enhancing food security (Borlaug 2000; Denning et al. 2009). This is seen as Malawi has addressed food insecurity by enhancing investments in N fertilizers and high-yielding varieties, as well as by enhancing access to these (Dorward et al. 2008; Mäder et al. 2002; Gregory et al. 2005). It has been argued that the moderate application of fertilizer, of about 35 kg N ha^{-1}, doubled the grain production of an initially unfertilized farm: from 1.05 Mg ha^{-1} to about 2.17 Mg ha^{-1} (Snapp et al. 2010). Even in the Songani and Ekwendeni research sites in Malawi, agroecology-based yields of maize increased after the introduction of conventional inorganic fertilizers (Snapp et al. 2010). Much of this increase was attributed to external inputs. More evidence from Malawi shows that agroecology can only meet the twin challenges of feeding an increasing population and protecting the environment if aspects of access and scale are adequately valorized (Gregory et al. 2005). While there is enough information on conventional agricultural inputs, such as organic fertilizers, there is little information on the use of agroecology-related organic fertilizers. On the other hand, the rate of inorganic fertilizer use in Africa is generally lower when compared to the developed world due to issues related to costs, the absence of sufficient credit facilities, and unfavorable policies (Jayne et al. 2003). In Kabate, Central Kenya, reports hold that agroecology-related inputs are unable to sustain crop yields as well as the environment at their current level of valorization (Ayuke et al. 2011; Borlaug 2000; Denning et al. 2009; Chivenge et al. 2009).

New research is showing that the most feasible scenario of improving the crop yield in Africa now is through a combination of agroecology and conventional agricultural options (Figure 4) (Ayuke et al. 2011; Hafidi et al. 2012). This is because agroecology alone cannot enhance production to meet the food needs in Africa based on the current population growth and increased vulnerability to climate change. Agroecology, however, remains critical for small-scale farmers in the Global South due to their inability to secure large quantities of inorganic fertilizers (Heisey and Mwangi 1996; Demelash et al. 2014).

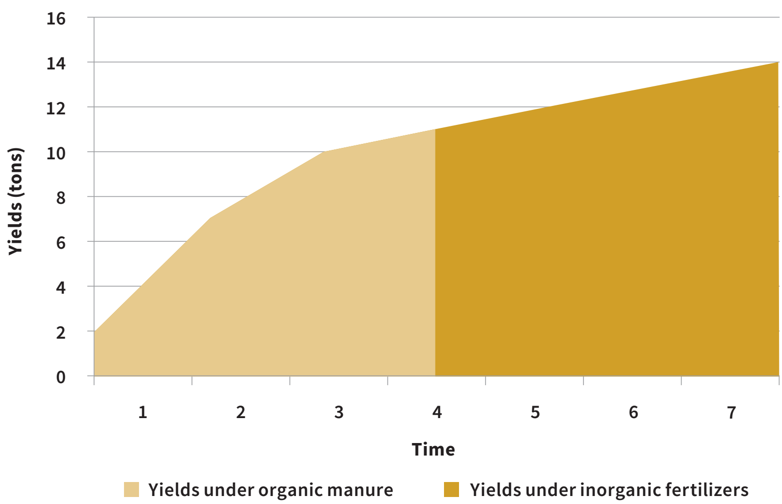

Figure 4. Evolution of yields under agroecology and conventional agriculture in Africa. Source: Authors' compilation based on data from Epule et al. (2015).

Though the best combination for yield improvements in Africa now involves a combination of agroecology and conventional agricultural practices, it is still important to report here that the increase is often minimal. A study carried out in Central Kenya shows that when agroecological inputs are added to maize farms, the yields increase and flatten out at some point, even if more inputs are added, whereas the introduction of conventional inputs, such as nitrogen fertilizers, was able to trigger the maize yield curve to rise further, though marginally (Gregory et al. 2005;

Heisey and Mwangi 1996; Demelash et al. 2014; Pereira et al. 2018). In Africa, most farming systems that do not employ the use of agroecology or conventional farming options usually experience low yields. Invariably, the optimal scenario for yield improvements is a combination of both agroecology and conventional inputs (Bationo and Mokwunye 1991; Bado et al. 1997, 2007). In Burkina Faso, for example, inputs of conventional fertilizers, such as nitrogen, calcium, and potassium (NKP), combined with agroecology-based options, such as manure, triggered higher yields during the years 2000, 2001, and 2003 (Figure 5). The alternatives show that in a scenario with only the use of NKP, the resultant yields were intermediate during the same period, while the "control" scenario with neither agroecology or conventional inputs showed high grain yields in the beginning because the soils had been left to fallow, and in later years showed a decline in yields (Figure 5). Similar results have been reported in Ethiopia (Demelash et al. 2014).

Agroecology needs to be valorized in Africa because of its enormous potentials. Compost, for example, has positive impacts on the physicochemical and biological properties of soils, which in turn help in driving improved soil quality and yields (Demelash et al. 2014). Unfortunately, as seen in the cases presented here, agriculture in Africa will continue to be driven by conventional inputs if agroecology is not valorized and issues of access to resources are not properly handled (Snapp et al. 2010; Rosegrant and Cline 2003; Razanakoto et al. 2021). Despite the prospects of agroecology in Africa, the system still has a lot of challenges. Since agriculture in Africa is mostly in the hands of smallholders, production is generally under natural conditions driven by limited access to conventional production inputs (Razanakoto et al. 2021). The valorization of agroecology to levels that are parallel to the status of conventional agriculture mandates a synergy between all agricultural stakeholders. The question should no longer be "can agroecology feed Africa's population", but instead be one focused on "how can agroecology be valorized to increase crop yields and protect the environment?" Evidently, there seems to be no easy way out of this agroecology–conventional agriculture dilemma. Perhaps the fact that these systems are driven by several drivers working together in the context of Africa makes this puzzle even more difficult (Mugwanya 2019). In the final part of this chapter, an examination of the benefits, limits, and challenges of these two broad paradigms is examined.

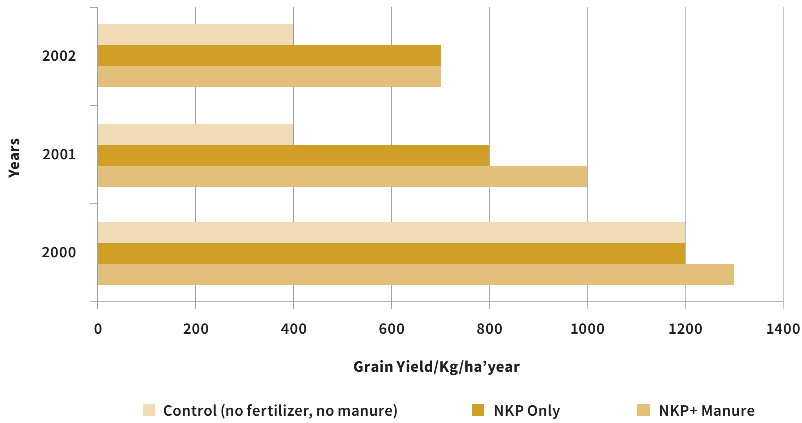

Figure 5. Evolution of grain yields under three scenarios in the Guinean zone of Burkina Faso. Source: Authors' compilation based on data from Bado et al. (2007); Demelash et al. (2014).

Therefore, as can be seen above, agroecology is good for the environment, but its current level of valorization does not make it able to overcome the food security crises that the continent is witnessing. For agroecology to fill the twin gaps of food security and environmental resilience, it should be valorized, as seen in the successful case studies presented above. On the other hand, conventional farming currently holds more prospects of reducing food insecurity, because under this approach greater yields are currently being obtained. However, the paradox is that despite the food security benefits that this approach currently offers, it is flawed due to its daunting effects on the environment. Consequently, the future of African agriculture rest in the valorization of agroecology to levels at which it can sustain actual and future food production needs, while at the same time reducing environmental degradation to a minimum.

6. Conclusions

This chapter has shown that agroecology has the potential of being more sustainable for the African environment when compared to conventional agriculture. However, the status of agroecology in Africa is one that needs valorization to ensure that its yields can be parallel to those of conventional agriculture. Even though agroecology has minimal effects on the environment, its overdependence on land expansion is likely to expose the environment to more deforestation and its accompanying effects. In fact, there are results that show that, in Africa, smallholder farmers in West, Central, and East Africa depend mostly on expanding their farm sizes to improve yields (Epule et al. 2022). Conventional agriculture, on the other hand, currently produces higher yields in the current African context, while unfortunately being less suitable for the environment. Therefore, the goal at this juncture will be to valorize agroecology to a level where it can sustain the twin benefits of ensuring food security while also sustaining the environment. In Africa, since most agricultural production is in the hands of smallholder farmers, the current access to conventional agricultural options is highly limited, thus affecting food security. Most of these smallholders cultivate without any major inputs and without well-valorized knowledge of agroecology. The bigger agro-industrial organizations are the main users of major conventional agricultural options, since these organizations can afford such conventional inputs. Such organizations would also benefit from the advantages of the valorization of agroecology. In the context of future research, new ways must be researched and developed on how to make conventional agriculture cleaner and more sustainable, while pilot farms that will drive the valorization of the components of agroecology should also be accentuated. This implies that all stakeholders, including smallholder farmers, should be included in the design, elaboration, execution, evaluation, and monitoring of such efforts in attempts at creating ownership, which is a key element of success and acceptance. Therefore, a policy approach that is both top-down and, most importantly, bottom-up will go a long way to ensure success. The main weakness of this work is that it mainly uses a review approach that uses both peer-reviewed and grey literature. Grey literature is non-standardized, and therefore less reliable and acceptable. As a result, it is important for more field-based studies to be conducted to investigate these initial literature-driven results at different scales across Africa.

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