WIDER Working Paper 2014/051

Changes in land tenure and agricultural intensification in sub-Saharan Africa

Keijiro Otsuka[1] and Frank Place[2]

February 2014

Abstract: Due to increasing population pressure on limited cultivable land in many parts of sub-Saharan Africa (SSA), farm size has been shrinking, fallow periods have been shortened, and soil fertility has been declining. In accordance with the Boserupian evolutionary theory and the Hayami-Ruttan induced innovation theory, however, investments in land improvements have taken place, which leads to strengthened individual land rights and the intensification of farming systems in many other parts of SSA. Based on the literature review, this paper argues that such evolutionary and spontaneous changes should be supported by means of technology development and dissemination, formalization of land rights, and improvement of access to agricultural markets.

Keywords: population pressure, soil degradation, investments in land improvement, strengthened individual land rights, agricultural intensification

Notes: Tables and Figures are at the end of the paper.

[1]National Graduate Institute for Policy Studies, otsuka@grips.ac.jp; World Agroforestry Centre, f.place@cgiar.org

This paper was prepared for the 'Oxford Handbook of Africa and Economics' authors' conference in Beijing, 8-10 December 2013, implemented with UNU-WIDER.

ISSN 1798-7237 ISBN 978-92-9230-772-1

Typescript prepared by Anna-Mari Vesterinen at UNU-WIDER.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme from the governments of Denmark, Finland, Sweden, and the United Kingdom.

The World Institute for Development Economics Research (WIDER) was established by the United Nations University (UNU) as its first research and training centre and started work in Helsinki, Finland in 1985. The Institute undertakes applied research and policy analysis on structural changes affecting the developing and transitional economies, provides a forum for the advocacy of policies leading to robust, equitable and environmentally sustainable growth, and promotes capacity strengthening and training in the field of economic and social policy-making. Work is carried out by staff researchers and visiting scholars in Helsinki and through networks of collaborating scholars and institutions around the world.

UNU-WIDER, Katajanokanlaituri 6 B, 00160 Helsinki, Finland, wider.unu.edu

1 Introduction

Natural resources in sub-Saharan Africa (SSA) continue to deteriorate due to increasing population pressure on limited land. Natural forests and communal grazing areas have been declining and converted to crop fields (Meybeck and Place 2014). Deforestation is a major concern, as it is known to be a major cause for greenhouse gas emission in developing countries (Edenhofer et al. 2011). Soil fertility continues to be degraded in many places due to the intensification of farming systems without replenishment of sufficient amounts of nutrients, which threatens the sustainable development of agriculture in SSA (Meybeck and Place 2014). On the other hand, there are signs of natural resource restoration. First, more trees are naturally regenerated or planted by farmers. In Niger, as much as five million hectares have been regenerated by farmers on their own farm land (Reij et al. 2009). In more humid areas, farmers are planting trees as woodlots (Bamwerinde et al. 2006), mixed with crops in their fields (Garrity et al. 2010), and on the edges of crop fields (Holden et al. 2013). Second, some forests are managed by communities, which have contributed to the restoration of some degraded forests (Jumbe and Angelson 2006). Third, in forest margins, crop fields under shifting cultivation are replaced by fields growing commercial tree crops such as rubber, coffee, oil palm, and cocoa (Otsuka and Place 2001). Although commercial tree fields are much inferior to virgin forests in terms of the biomass and biodiversity, they are very productive and provide livelihood for poor smallholders. Fourth, in highly populated areas, intensive farming systems are widely practiced, in which manure is applied to crop fields and crop rotation with leguminous crops or intercropping of cereals and beans is practiced (e.g., Yamano et al. 2011). Nitrogen fixing trees are also more widely planted on crop fields now so that there is much greater use of organic nutrients to enhance soil fertility. Such farming practices contribute to maintaining and improving soil fertility and, hence, to the yield growth of maize and other upland crops in SSA (Otsuka and Larson 2013).

Land ownership rights and land tenure security are known to be major determinants of land use, investments in the land improvement, and intensification of farming (Otsuka and Place 2001). Where individualized rights are established on agricultural land, farmers invest in longer-term improvements, including tree planting, crop rotations, manuring, and soil conservation (Holden et al. 2009b, 2013; Deininger and Jin 2006 for Ethiopia; Deininger and Ali 2007 for Uganda). For example, tree cover as per cent of land area increased on farms and decreased off farms over a 30 year period in Uganda (Place and Otsuka 2000) and farmers now grow trees on the edge of crop fields in East Africa, because they have acquired secure individualized land use rights (Holden et al. 2013). Despite its importance, however, land tenure insecurity is still a major problem in many countries in SSA (Namubiru-Mwaura and Place 2013). Therefore, in order to restore natural resource environments, increase crop yields sustainably, and improve livelihoods of the poor rural population in SSA, how to strengthen land tenure security is a major policy issue.

This article reviews the literature on the role of evolutionary changes in land tenure in the intensification of farming systems in SSA. Section 2 provides a conceptual framework to understand the link between population growth, changes in land tenure, and agricultural intensification. In order to test the relevance of the conceptual framework, Section 3 examines the data on population pressure and land use changes and reviews the relevant literature, whereas Section 4 undertakes a review of the literature on agricultural intensification. Finally, Section 5 provides implications of this study for land tenure and agricultural development policies in SSA.

2 Conceptual framework

Traditionally, land was owned collectively by the community, clan, lineage, or extended family under customary land tenure systems in SSA, but they have been evolving toward individualized tenure (Bruce and Migot-Adholla 1994). As early as the 1960s, Boserup (1965) argued that increasing population density affects the evolution of farming system from an extensive, land-using system to an intensive, land-saving system. Her arguments were later elaborated by Ruthenberg (1980), Binswanger and McIntire (1987), and Pingali et al. (1987), among others. The essence of the Boserupean theory is no different from more formal analysis of induced innovations by Hayami and Ruttan (1985). However, while Boserup discusses only changes in the farming system or technological change, Hayami and Ruttan analyse not only induced technological change but also the induced institutional innovations that support the technological change. Indeed, whether intensified farming system can emerge without institutional changes is questionable because transition to intensified farming systems requires investment in land improvement and, hence, the institution to strengthen and protect property rights on land.

In our view, neither the Boserupean theory nor the Hayami and Ruttan framework is sufficient for fully explaining evolutionary changes in land tenure institutions in SSA. Boserup did not discuss how agricultural intensification takes place, whereas the inducement mechanism envisaged by Hayami and Ruttan is not strong enough to realize major gains in agricultural productivity. In our conceptual framework portrayed in Figure 1, we provide integrated links among population growth, evolutionary changes in land tenure institutions, and the intensification of farming systems.

When land is abundant, land-using, extensive farming systems, such as slash and burn farming, are practiced. As population grows, uncultivated land, e.g., forest land and woodland, is brought into cultivation. Typically land is held in under a customary system, in which uncultivated land is controlled by the chief on behalf of the community and cultivated land including fallow land is 'owned' by a group of kin-related people (e.g., lineage, clan, and extended family). Land use rights are secure under this system so long as the land is cultivated (Sjaastad and Bromley 1997; Bruce and Adholla 1994; Otsuka and Place 2001; Place 2009); otherwise, cultivators who have converted uncultivated land cannot reap the benefit of long-term land investments with assurance. After one to two seasons of cultivation, the soil quality declines and land is put into fallow for a few decades for complete restoration of soil quality. Since it is not clear whether the present cultivator is interested in cultivation of the same plot decades later, the leader of the family group controls this piece of land for temporary allocation and inheritance among family members.

If population growth continues, uncultivated land is gradually exhausted. This leads to shortened fallow periods, which, in turn, tends to lead to soil degradation until secure individualized land rights institutions are established to induce investment in the land Also, observed at this stage is increasing labour-farmland ratio and shrinking farm size. These are the signs of increasing scarcity of land, which is expected to lead to an intensified, land-saving farming system according to the theories of Boserup (1965) and Hayami and Ruttan (1985).

As Otsuka and Place (2001) point out, in order to shift from an extensive farming system to an intensive farming system, e.g., sedentary farming with little or no fallowing, investments in land improvement are usually required. Examples are planting of commercial trees, the construction of irrigation facilities, drainage canals, terraces, and fences, and the application of manure and compost. In order to assure that investment benefits accrue to investors, not only land use rights but also transfer rights must be strengthened (Besley 1995). Transfer rights are important to provide proper investment incentives because the rights to rent out and sell land confer benefits of land investments under a variety of occasions when investors need cash. Our hypothesis is that investments in land improvement can also strengthen individual land rights, which lead to intensification of farming system (Otsuka and Place 2001; Holden and Otsuka forthcoming).

Western Ghana provides an example of individualization of land rights. In locations where uterine matrilineal inheritance system prevailed, men traditionally owned land and was expected to transfer it to his sisters' sons. Now inter vivos transfer of land is made from a man to his wife and children as a 'gift', including daughters, provided that wife and daughters helped the husband establish cocoa fields by engaging in weeding (Quisumbing et al. 2001). Gift land is characterized by strong individual land rights and accounted for roughly one-third of cocoa area in this region around 2000. In matrilineal and matrilocal society in Central Malawi, trees naturally grown on the crop field belong to the wife's family but trees planted by husband are owned by him, so that upon divorce or death of his wife, he can cut down his trees and sell them before going back to his home village (Place and Otsuka 2001). Similarly, wet land reclaimed by men by their hard work for vegetable production using primitive irrigation is owned by them with rights to sell in this matrilineal society. These examples demonstrate that investment in land improvement and farming intensification strengthen individual land rights. Brassell et al. (2002); Place and Otsuka (2002); and Baland et al. (1999), among others, also find in Burkina Faso and Uganda, respectively, that investments in trees lead to strengthened individual land rights.

In his review of the literature on land tenure and investment incentives in West Africa by Fenske (2011), he finds that while secure tenure is significantly associated with fallow and tree planting, the link between land tenure security and other investments is generally weak. One of the possible reasons for this weak link is attributed to the tendency that individual land rights are strengthened by investment. In other words, the expected returns to investment are high, even if land rights are weak ex ante, if investment enhances land rights ex post. Thus, weak tenure security may not discourage investment in land, if the latter strengthens tenure security. In our view, the simultaneous determination of land rights and investment is likely to blur the empirical link between land rights and investments.[1]

Place and Hazell (1993) found that tenure security did positively affect the adoption of some land investments, but did not find evidence that inputs are used more intensively on parcels of higher tenure security in Ghana, Kenya, and Rwanda. Benefits from inputs are often not long term and so tenure security is less important. It may also be that inputs are more or less equally intensively used on parcels of lower and higher tenure security, to the extent that higher input intensity, land investment, and ex post tenure security are positively correlated.

Population pressure therefore has unambiguously reduced farm sizes in Africa and led to greater individualization of land rights on these farms. The implications for tenure security are several. Individualization itself has generated greater tenure security for the farmers who increasingly acquire land through inheritance or purchase from farmers, rather than the conversion of uncultivated land, and can use and transfer the land as they wish.[2] On the other hand, because of the pressure on land and reduction in farm size, land rental markets have developed where tenants may not have long-term use rights. Moreover, land shortage creates heightened conflict over land resources among family members over inheritance and between neighbours disputing

[1] What matters is land rights after investment, not necessarily change in land right. Thus, if land right is secure from the beginning and unchanged, it provides strong investment incentives.

[2] Similarly, the conversion of uncultivated land into cultivated confers its strong usage right.

over boundaries. These causes for insecurity need to be managed and will be discussed in Section 5. It is also important to point out that the general trend towards increasing security of tenure is not equally shared by women or some migrant communities in SSA (Place 2009).

Land titling, certification, or registration may or may not strengthen individual land rights (Bruce and Migot-Adholla 1994). Place and Migot-Adholla (1998) find no effect of land title on investment and productivity in Kenya. We support the observation of Deininger (2003) that moves toward establishing formal tenure systems have also resulted in increased tenure insecurity in many countries, because of the conflicts between traditional rights and newly created legal land rights. That is to say, if land titling was implemented before land rights are individualized spontaneously, titling is likely to create conflicts among family members, who collectively 'own' the same piece of land. Once the individualization of land rights has been achieved endogenously, land registration is likely to strengthen land rights because of the absence of overlapping land rights among family members. Indeed, many studies in Ethiopia, where individual cultivation rights have been established, e.g., Holden et al. (2009a), find that land registration and certification has resulted in more investment and higher land productivity.

We hypothesize that the availability of improved technology and improved market access will stimulate investment in land by enhancing its rate of return. This, in turn, will enhance individual land rights and facilitate intensification of farming systems. Hayami and Ruttan (1985) argue that in the case of Asia, the Green Revolution was induced to take place precisely when land had become scarce relative to labour in the late 1960s. The inducement process, however, is not simple because public-sector research and extension systems had to be greatly improved to realize a Green Revolution. In our view, lack of development of appropriate technologies (e.g. as in the case of maize) or an effective extension system (e.g. for lowland rice) is often observed to impede investment and intensification in SSA (Otsuka and Larson 2013). On the other hand, improved market access leads to the production of such high value and profitable crops as flowers, vegetables, and fruits in some parts of SSA, possibly because improved technologies are often imported and less dependent on domestic research systems.

The intensification of farming systems confers an advantage to smallholder farmers over large farmers. As Hayami and Otsuka (1993) argue, the monitoring cost of hired labour is quite high in spatially diverse farm environments, so that labour-abundant smallholders relying on family labour is more efficient than large land-abundant farmers relying on hired labour. Consequently, an inverse relationship between farm size and productivity, particularly crop yield, has been widely observed in South Asia (Otsuka 2007). To our knowledge, however, such an inverse relationship had seldom been reported in SSA until recently, at least partly because the farming system was relatively extensive, requiring little hired labour. If an extensive farming system, such as slash and burn farming, is practiced, we can hardly expect to observe any correlation between *cultivated* farm size and productivity. Recently, however, the inverse relationship is found by numerous studies in SSA (e.g., Holden et al. 2009b; Carletto et al. 2013; Larson et al. 2014; Holden and Fisher 2013). Unless the farming system is sufficiently intensified and demand for labour is significantly increased, we hardly expect to observe such an inverse relationship.

The intensification of farming system increases the value of land, so that allocation of land from less productive to more productive producers becomes important. Since land transfer rights are relatively well established and the inverse relationship between farm size and productivity has emerged, land markets tend to develop. According to the latest surveys of the literature by Holden et al. (2013) and Holden and Otsuka (forthcoming), land markets, both land rental and land sales, have become active in many African countries where population density is high. Furthermore, they find that both land rental and sales transactions are pro-poor, meaning that land-abundant farm households tend to rent out or sell land to land-poor households, who are generally poor. This is consistent with the observed inverse relationship. However, the fact that the inverse relationship is observed implies that land markets are not working fully efficiently so as to wipe out any productivity gap. In Ethiopia where land rights have been strengthened by the land certification programme, land renting has become more common, suggesting that successful policy intervention can also potentially stimulate land market transactions.

Based on the conceptual framework on the evolutionary changes in land rights and intensification of farming systems shown in Figure 1 we review the empirical literature and statistical data on population growth, changing land use, and agricultural intensification in the following two sections, before discussing the policy options in the final section.

3 Population pressure and changing land use

The majority of countries in SSA are agriculture-based despite several decades of significant net migration to urban areas. The proportion of rural population ranges from 70 to 80 per cent in most countries in the first decade of this century (see Table 1). The annual growth rate of rural population is generally high, exceeding 2.0 per cent per year in many countries, which has led to an expansion of crop land, pastures and rangeland ('arable' land). In the case of the Sahelian countries of Mali, Burkina Faso, and Niger, arable land has expanded by about 20 per cent between 1990 and 2009. Yet, arable land per person has declined in many countries, with major exceptions being Burkina Faso, Mali, and Sierra Leone among countries listed in Table 1. In SSA as a whole, arable land per person has been continuously declining over the last 50 years and by 2010 it has become nearly a half of the level in 1960 (Figure 2). Although arable land per person in SSA is still much higher than in Southeast and South Asia, cultivated area per person would not be substantially different between densely populated countries in SSA and most countries in Asia, because of the vast rangeland area in SSA, as shown in Table 2. According to Headey and Jayne (forthcoming), the average density of population relative to cultivated farm land in twelve high population density countries in SSA (172 persons per square kilometre), including the three largest countries of Nigeria, Ethiopia, and Democratic Republic of Congo (DRC), is comparable to that in East Asia (199 persons per square kilometre) in 2010.

Cultivated land area expanded partly because of the expansion of arable land area and partly because of the conversion of pastures and rangeland into cultivated land. The rate of expansion of cultivated land was particularly high in Mali and Sierra Leone, where arable land per person was also high, indicating that cultivated area expanded mainly because of the conversion of pasture and rangeland in these countries (Table 2). Indeed, in countries where cultivation area increased only modestly from 1990 to 2011 (e.g., Kenya, Liberia, Nigeria, Rwanda, Tanzania, Uganda, and Zambia), arable area per person in rural area declined or at best remained constant.

Arable land area has expanded importantly because of the conversion of forest land and woodland. Table 3 shows that forest area accounts for roughly 30 per cent of total land area in SSA in 2010 but it has been decreasing rapidly over the last two decades. Meybeck and Place (2014) point out that 'the increasing competition for land use, including agricultural expansion, is a major driver of deforestation.' Hertel (2011) argues that productivity growth on existing farmland is needed to ease the demand for new farmland being brought into cultivation and to help conserve the world's remaining forest from being destroyed to meet rising food demand. Under customary land tenure systems, uncultivated land, including forests, woodland, and communal grazing land, has historically been 'available' for cultivation, in view of the fact that village chiefs tend to approve the request of village people to convert them to cultivated fields (Otsuka and Place 2001). Therefore, increasing population growth, food demand, food insecurity, or rising food prices would accelerate the pace of deforestation, even though the remaining forest areas have shrunk.

Reflecting increasing scarcity of land, small farmers account for a sizable share of agricultural production and in many instances their contribution is growing. For example, over 75 per cent of the total agricultural outputs in Kenya, Tanzania, Ethiopia, and Uganda are produced by smallholder farmers with average farm sizes of about 2.5 hectares (Salami et al. 2010). In countries in West Africa, e.g., Burkina Faso, Mali, and Niger, the farm sizes are relatively large with average size of three hectares and above. Differences in agro-ecological conditions, rural population density, and farming systems explain why some countries have larger farm sizes than others (Namubiru-Mwaura and Place 2013). Comparable time series data on farm size is available only for a few countries, and even in those cases, the data are unreliable due to inconsistency of measurement. According to Jayne et al. (2012), which use nationally representative survey data, average farm size declined from 2.28 hectares in 1997 to 1.86 hectares in 2010 in Kenya, and from 1.20 hectares in 1984 to 0.71 hectares in Rwanda. They also point out that 'roughly 40 per cent of Kenya's rural population resides on five per cent of its arable land.' Thus, at least in relatively high population density countries in SSA, farm size has been declining and rural population tends to be concentrated in agro-ecologically favourable areas.

Yet, according to FAO (2012), Africa has still significant areas of suitable land for agriculture which is uncultivated, i.e., about 70 per cent of total land area. Currently, 183 million ha of land is under cultivation, while there is approximately 452 million hectares of additional suitable land which is not cultivated. Indeed, in the case of the case of Mali, Burkina Faso, and Niger, the change in cultivated area has exceeded 50 per cent between 1990 and 2009 (see Table 2). Similarly high expansion rates are also found in Ghana, Sierra Leone, and Malawi. FAO (2012), however, predicts a slowing of cultivated area expansion in SSA due to a variety of factors such as the low fertility of the uncultivated land. While there remains a significant amount of suitable but uncultivated land, the FAO baseline scenario to 2050 predicts an expansion of a modest 50 million hectares under cultivation.

The question is whether overall land is still abundant in SSA. There may be scope for more land expansion in the larger countries of Sudan, DRC, Angola, and Mozambique, but in many other countries such as Kenya, Nigeria, and Rwanda the land frontier has already largely been closed. Thus, it must be understood that various countries in SSA are at different stages of the evolution of land tenure institutions and land management. It must be also recognized that much of the remaining land suffers from various constraints such as ecological fragility, low fertility, and lack of infrastructure (Meybeck and Place 2014). Moreover, to date in many African countries, the state continues to own a large portion of valuable land, even though evidence has shown that this is conducive to mismanagement, underutilization, and corruption (Namubiru-Mwaura and Place 2013). Jayne et al. (2012) add that 'since the rise of world food prices after the mid-2000s, many African governments have made concerted efforts to transfer land out of customary tenure systems (where the majority of rural people reside) to the state or to private individuals who, it is argued, can more effectively exploit the productive potential of the land.' Such state land policies are bound to worsen both access to land and the security of tenure on that land of smallholders, particularly in land scarce countries.

Consistent with our conceptual framework, Dreschel et al. (2001) confirm a significant relationship between population density, reduced fallow periods, and soil nutrient depletion in SSA farming system. Although there are relatively few studies which identify the impact of population pressure on soil fertility, there are a large number of studies reporting soil degradation. The degradation can occur in several ways; it can be soil erosion, physical degradation, or loss of organic matter. Then, nutrient depletion and chemical degradation of the soil may occur. A recent study based on trends in net primary productivity suggests that 24 per cent of areas were degrading between 1981 and 2003, including many areas that were not previously classified as degraded (Oldeman et al. 1991). Of the degrading area, about 20 per cent is cropland, which occupies about 12 per cent of surface area (Bai et al. 2008). FAO (2011) has developed a land degradation assessment methodology (LADA), which finds 25 per cent of land being classified as highly degraded or affected by a high degradation trend.

Globally, only half the nutrients which crops take from the soil are replaced, with particularly significant nutrient depletion in many Asian countries. Henao and Banaante (2006) estimate that 85 per cent of African farmland had nutrient mining rates of more than 30 kilograms/hectare of nutrients annually. In some Eastern and Southern African countries, annual depletion is estimated at 47 kilograms/hectare of Nitrogen), 6 kilograms/hectare of phosphorus, and 37 kilograms/hectare of potassium (FAO 2011). When farming systems do not include fertilization or nitrogen fixation, losses from nutrient mining and related erosion are even higher (Sheldrick et al. 2002). FAO (2011) data suggests that by 1996, 550 million hectares of land were degraded through agricultural mismanagement.

The productivity loss due to soil degradation is pronounced in SSA (Meybeck and Place 2013). As much as 25 per cent of land productivity has been lost due to degradation in the second half of the twentieth century in Africa (Oldeman 1998). Because of the importance of agriculture to African economies, this has cost between one per cent and nine per cent of gross domestic product (GDP), depending on the country (Dregne et al. 1991; Dreschel et al. 2001). When soils become highly degraded, the use of conventional inputs such as mineral fertilizer can become ineffective as demonstrated on maize in western Kenya (Marenya 2008). Globally, Tan et al. (2005) note that the ratio of crop yield to NPK fertilizer application has fallen dramatically between 1961 to 2000, from 494 to 71, which, in part, reflects the negative effects of reduction in soil fertility.

Although many of the studies cited above did not assess the impact of population pressure directly, they attribute the recent soil degradation to reduction in the fallow period and inadequate vegetative cover coupled with lack of nutrient inputs. In all likelihood, the continued population pressure has resulted in the exhaustion of uncultivated land in many customary land areas in SSA, which has led to shrinking farm size, shortened fallow periods, and soil degradation.

4 Land tenure and agricultural intensification

It is a logical consequence of the induced innovation theory formalized by Hayami and Ruttan (1985) that the tension caused by increasing scarcity of resources stimulates technological change to save those resources as well as new institutions that support such technological change. It is difficult to think of situation that fits this scenario better than the contemporary situation of African farming, particularly in densely populated areas. The incentives for induced innovation have been created by population pressure on limited land resources and are clearly reflected in soil degradation. In order to escape from such adverse conditions, what is needed is investment in land improvement, e.g., the construction of terraces, irrigation and drainage systems, application of manure and compost, and planting of nitrogen fixing legumes and trees. Such investment leads to the intensification of the farming system, which brings about larger amount of outputs from a given area of land. In order to support such investments, secure land tenure institutions or strong individualized land rights must be induced to be established so as to ensure that investor reaps the future benefits accrued from current investment. If the theory of induced innovation works in the African context, we should be able to observe *simultaneously* (1) investments in land improvement; (2) strengthened individual land rights; and (3) intensification of farming system.

While we admit that the direct evidence is weak, we would like to point out that numerous new changes are observed in the landscape of African farming, which is unlikely to be understood without considering the simultaneous changes in investment, land rights, and farm intensification. They include (i) fairly active investments in land improvement; (ii) intensification of farming system; (iii) inverse relationship between farm size and productivity; and (iv) the development of land markets.

According to the cross-country study by Headey and Jayne (forthcoming), changes in capital per hectare, which includes land structures, irrigation, plantation crops, livestock and livestock structures, machinery and other farm equipment, is significantly boosted by increase in population density. According to their analysis, this holds in SSA as in other regions. Positive association between population density and tree planting and negative association between population density and fallow period are also found by Otsuka and Place (2001). Place et al. (2006) found a significant number of investments made by Kenyan farmers in densely populated highland areas, including terracing, water management and tree planting, especially by those in areas with better market access. A number of important land investments are found to have been made in Ethiopia and Uganda (Deininger and Jin 2006; Deininger and Ali 2007) and investment in tree crops remains high among hundreds of thousands of farmers in many countries (e.g. coffee in Ethiopia, Kenya and Uganda; cocoa in Côte d'Ivoire and Ghana; rubber in Liberia and Nigeria).

Headey and Jayne (forthcoming) also find that changes in a large number of indicators of agricultural intensification, including nitrogen application per hectare, cropping intensity, and total value of crop output per hectare, are positively associated with changes in population density. There are also numerous examples of the use of woody and herbaceous legumes, which fix atmospheric nitrogen, and the use of soil and water conservation practices and crop residues in densely populated areas in SSA (Reij et al. 2009). Such practices tend to improve soil fertility and intensify crop production (Place and Binam 2013). There are noted cases of intensified soil fertility management throughout SSA, with higher fertilizer use especially in Kenya (Jayne et al. 2003) and through use of integrated soil management practices (Place et al. 2003) and some of this intensification has been found to be facilitated by improved tenure security afforded by permanent land acquisition (e.g. Manyong and Houndekon 2000).

In densely populated highlands in Kenya, Yamano et al. (2011) observe that traditional zebu cows have been gradually replaced by cross-bred cows between traditional and European cows. These cows are several times as productive as traditional cows in terms of not only milk production but also production of manure. Cross-bred cows are stall-fed by cultivated feed grasses and other supplements, and cow manure or compost is applied to crop fields. This observation is important, because stall-feeding of cows, production of feed crops, and application of manure/compost are the essence of the agricultural revolution, which took place prior to the industrial revolution in England (Timmer 1969).

According to our own observations based on the RePEAT data collected by the National Graduate Institute for Policy Studies 2004 to 2012 (see Table 4), hybrid maize and intercropping of maize with beans with the capacity to fix nitrogen were increasingly adopted, as were crops of commercial value in the highlands of Kenya. While the number of both traditional and improved cross-bred cows decreased, the former decreased more sharply. As a result, the application of organic manure increased, even though the application of mineral fertilizer decreased during a time of rising fertilizer prices. Interestingly, because of the intercropping, maize yield does not increase with the intensification of farming system, but total crop yield does increase significantly from 2004 to 2012. This is consistent with the finding of Headey and Jayne (forthcoming) that although population density positively affects many indicators of intensified farming systems including total value of production per unit of land, it does not affect cereal yield.

The adoption of cross-bred cows and the application of manure to banana fields are common in Western Uganda, where population density is relatively high. We would also like to point out that this intensified farming system is seldom practiced in maize growing areas of Uganda, where land is more abundant relative to labour than in Kenya. How generalizable this observation is remains a major empirical question to be explored. Apart from intensification of cereal production, there is also intensification through diversification into more profitable but costly crops such as fruits and vegetables. According to Tschirley (2011) this shift is taking place most rapidly in Kenya due to land pressure and is just emerging in other countries such as Zambia and Mozambique.

The inverse relationship between farm size and productivity is likely to appear only if farmland is cultivated intensively based primarily on family labour. Indeed, to our knowledge, the inverse relationship between farm size and crop yield per hectare was reported only recently in SSA. Holden et al. (2009) is one of the first studies to report this phenomenon in SSA. By now there are a large number of other studies that report the inverse relationship in SSA. It is difficult to explain such observations without considering the increased intensification of farming systems in recent years.

When land becomes scarce and farming system is intensified, the value of land increases. In order to use and allocate valuable land efficiently, incentives must be created to reallocate land from less productive to more productive producers. Land transaction, be it renting or selling, can occur only if rights to transfer land, including rights to rent out or sell, have been established. Both Holden et al. (2009) and Holden et al. (2013) report active transactions of land from land-abundant, large farms to labour-abundant, small farms, which is consistent with the widely observed inverse relationship between farm size and productivity in SSA. In particular, land rental markets contribute to both efficiency and equity by transferring land rights from large farmers to small farmers, e.g., in Kenya as reported by Jin and Jayne (2013). In his literature review, Place (2009) points out that formal or informal land sales have occurred in areas of increased land pressure, arising from both population growth and commercial opportunities.

5 Policy options

In many parts of SSA, population pressure has exhausted uncultivated land and reduced farm size. The increasing scarcity of farm land has increased pressure to intensify farming systems, which require investments in land improvement. For farmers to undertake long-term investments, their future land rights must be secure. Individualization of land rights is often accelerated by population pressure which has transformed land acquisition processes from clearing and allocation towards intra-familial inheritance. Commercialization of agriculture also induces behaviours to establish individual claims to land. In addition, according to our literature review, such investments in land tend to strengthen individual land rights spontaneously, which contribute to higher productivity of land not only directly but also indirectly through facilitating informal land transactions. In order to accelerate such changes, government should implement policies to strengthen land rights and to improve profitability of intensified farming systems by means of investing in agricultural research and extension systems and infrastructures. Conferring land titles or certificates will improve farmers' access to formal credit, which, in turn, will stimulate the use of purchased inputs, such as inorganic fertilizer, and further investments in land improvement.

In land-abundant regions where vast tracts of uncultivated land still exist, the appropriate policy options are different. In such regions, the customary land tenure system prevails and individualization of property rights is low. A problem is that the state often directly infringes on rights or sanctions outsiders to make claims on land in such areas under the guise of available land. Since land rights are insecure, farm land tends to be infrequently fallowed, which leads to soil degradation. Since farmland is owned collectively by a group of kin-related people, granting land title to a particularly member or a group of members would create tenure conflict, rather than tenure security. One possible solution is to grant collective entitlement of the family land. Or if the village community is tightly structured with trust among community members, conferring land title to the community as a whole is another possible option. To the extent that transaction cost of settling conflicts over land among family members and boundary disputes between neighbours is lower than the cost of litigation, the land policies that respect the traditional communal land rights are expected to improve land tenure security.

In densely populated areas, government should support the spontaneously emerging intensification of farming systems for productive use of land and poverty reduction. As is predicted by Hayami and Ruttan (1985), induced innovations are taking place which lead to the intensification of agriculture in SSA. However, they are not significant enough to realize major productivity gains. We fully support the argument of Meybeck and Place (2014) that intensive integrated soil management practices will need to become standard practice, with complementary investment in soil conservation, crop rotations and intercropping, inorganic fertilizer, and organic nutrient management with animal manure, green manures and agroforestry, and crop residues. A major constraint on the dissemination of such intensive farming system is the lack of research on the development of highly productive 'integrated farming systems,' and the complementary dissemination activities that would support them. It must be clearly recognized that development of such improved farming system, which accompanies the effort to invest in soil improvement, will not only intensify the farming system but also strengthen the individual land rights. Improved access to markets brought about by investment in roads and telecommunication networks will have the similar effects, as it will increase the rates of return to investment in land improvement and the advantage of intensive farming systems.

Once land becomes scarce and, hence, valuable, land competition and conflict becomes prevalent between individuals. Thus, it makes sense to strengthen them by granting land titles or certificates to individual farmers. A major issue is to develop a system of formal private land rights documentation that is affordable and accessible in rural areas. Recent programmes by the Government of Ethiopia (certificates) and the Government of Rwanda (titles) have been very cost effective in allocation of initial documents of tenure to millions of smallholder farmers. Land whose transfer rights are officially recognized can be used as collateral for formal credit and, hence, its ownership stimulates investment and purchase of inorganic fertilizer and other inputs. In all likelihood, concerted efforts to strengthen land rights, stimulate investment in land, and promote intensified farming systems will lead to sustainable management of land, higher productivity of farming, and poverty reduction in SSA.

References

Bai, Z., Dent, D., Olsson, L., and Schaepman, M. (2008). *Global Assessment of Land Degradation and Improvement: 1. Identification by Remote Sensing*. Wageningen: World Soil Information.

Baland, J.-M., Gaspart, F., Place, F., and Platteau, J.P. (1999). *Poverty, Tenure Security and Access to Land in Central Uganda: The Role of Market and Non-market Processes*. CRED: University of Namur.

Bamwerinde, W., Bashaasha, B., Ssembajjwe, W., and Place, F. (2006). 'The Puzzle of Idle Land in the Densely Populated Kigezi Highlands of Southwestern Uganda'. *International Journal for Environment and Development*, 3(1): 1–13.

Besley, T. (1995). 'Property Rights and Investment Incentives: Theory and Evidence from Ghana'. *Journal of Political Economy*, 9(3): 903–37.

Binswanger, H.P. and McIntire, J. (1987). 'Behavioral and Material Determinants of Production Relations in Land-abundant Tropical Agriculture'. *Economic Development and Cultural Change*, 36(1): 73–99.

Boserup, E. (1965). *The Conditions of Agricultural Growth*. Chicago: Aldine.

Brasselle, A.-S., Gaspart, F., and Platteau, J.-P. (2002). 'Land Tenure Security and Investment Incentives'. *Journal of Development Economics*, 67(2): 373–418.

Bruce, J.W. and Migot-Adholla, S.E. (eds) (1994). *Searching for Land Tenure Security in Africa.* Washington, DC: World Bank.

Carletto, C., Savastono, S., and Zezza, A. (2013). 'Fact or Artefact: The Impact of Measurement Errors on the Farm Size-Productivity Relationship'. *Journal of Development Economics,* 103: 254-61.

Deininger, K. (2003). *Land Policies for Growth and Poverty Reduction.* Oxford: Oxford University Press and World Bank.

Deininger, K. and Ali, D. (2007). 'Do Overlapping Land Rights Reduce Agricultural Investment?: Evidence from Uganda'. World Bank Policy Research Paper 4310. Washington, DC: World Bank.

Deininger, K. and Jin, S. (2006). 'Tenure Security and Land Related Investment: Evidence from Ethiopia'. *European Economic Review*, 50(5): 1245–77.

Dregne, H., Kassas, M., and Rozanof, B. (1991). 'A New Assessment of the World Status of Desertification'. *Desertification Control Bulletin*, 20(1): 7–18.

Dreschel, P.L., Gyuele, D., Kunze, O., and Cofie, O. (2001). 'Population Density, Soil Nutrient Depletion and Economic Growth in sub-Saharan Africa'. *Ecological Economics*, 38(2): 251–58.

FAO (2010). 'Global Forest Resources Assessment 2010'. FAO Forestry Paper 163. Rome: FAO.

FAO (2011). *The State of World's Land and Water Resources for Food and Agriculture* (SOLAW)—Managing Systems at Risk. Rome: FAO and London: Earthscan.

FAO (2012). *Agriculture Towards 2030/2050: The 2012 Revision.* Rome: FAO.

FAO (2013). FAOSTAT.

Fenske, J. (2011). 'Land Tenure and Investment Incentives: Evidence from West Africa'. *Journal of Development Economics*, 95(2): 137–56.

Garrity, D., Akinnfesi, F., Ajayi, O., Weldesemayat, S., Mowo, J., Kalinganire, A., Larwanou, M., and Bayala, J. (2010). 'Evergreen Agriculture: A Robust Approach to Sustainable Food Security in Africa'. *Food Security*, 2(3): 197–214.

Hayami, Y. and Otsuka, K. (1993). *The Economics of Contract Choice: An Agrarian Perspective*. Oxford: Clarendon Press.

Hayami, Y., and Ruttan, V.W. (1985). *Agricultural Development: An International Perspective*. Baltimore: Johns Hopkins University Press.

Headey, D. and Jayne, T.S. (forhcoming). 'Adaptation to Land Constraints: Is Africa Different?' *Food Policy*.

Henao, J. and Banaante, C. (2006). *Agricultural Production and Soil Nutrient Mining in Africa: Implications for Resource Conservation and Policy Development: Summary*. Muscle Shoals: International Fertilizer Development Centre.

Hertel, T. (2011). 'The Global Supply and Demand for Agricultural Land in 2050: A Perfect Storm in the Making?'. *American Journal of Agricultural Economics*, 93(2): 259–75.

Holden, S.T. and Fisher, M. (2013). 'Can Area Measurement Error Explain the Inverse Farm Size Productivity Relationship?'. CLTS Working Paper 12. Ås: Norwegian University of Life.

Holden, S.T. and Otsuka, K. (forthcoming). 'The Role of Land Tenure Reforms and Land Markets in the Context of Population Growth and Land Use Intensification in Africa'. *Food Policy*.

Holden, S.T., Deininger, K., and Ghebru, H. (2009a). 'Impact of Low-Cost Land Certification on Investment and Productivity'. *American Journal of Agricultural Economics*, 91(2): 359–73.

Holden, S.T., Otsuka, K., and Deininger, K. (eds) (2013). *Land Tenure Reforms in Asia and Africa: Assessing Impacts on Poverty and Natural Resource Management*. Hampshire: Palgrave Macmillan.

Holden, S.T., Otsuka, K., and Place, F. (eds) (2009b). *The Emergence of Land Markets in Africa: Assessing the Impacts on Poverty, Equity, and Efficiency*. Baltimore: Resources for the Future.

Edenhofer, O. et al. (eds) (2011). *IPCC Special Report on Renewable Energy Sources and Climate Change*. Cambridge: Cambridge University Press.

Jayne, T.S., Chamberlin, J., and Muyanga, M. (2012). 'Emerging Land Issues in African Agriculture: Implication for Food Security and Poverty Reduction Strategies'. Stanford: Stanford University.

Jayne, T.S., Govereh, J., Wanzala, M., and Demeke, M. (2003). 'Fertilizer Market Development: A Comparative Study of Ethiopia, Kenya and Zambia'. *Food Policy*, 28: 293–316.

Jin, S. and Jayne, T.S. (2013). 'Land Rental Markets in Kenya: Implications for Efficiency, Equity, Household Income, and Poverty'. *Land Economics*, 89(2): 246–71.

Jumbe, C.B.L. and Angelson, A. (2006). 'Do the Poor Benefit from Devolution Policies: Evidence from Malawi's Forest Co-Management Program'. *Land Economics*, 82(4): 562–81.

Larson, D., Otsuka, K., Matsumoto, T., and Kilic, T. (forthcoming). 'Should African Rural Development Strategies Depend on Smallholder Farms? An Exploration of the Inverse Productivity Hypothesis'. *Agricultural Economics*.

Manyong, V. and Houndekon, V. (2000). 'Land Tenurial Systems and the Adoption of Mucuna Planted Fallows in the Derived Savannas of West Africa'. CAPRi Working Paper 4. Washington, DC: IFPRI.

Marenya, P. (2008). *Three Essays on The Effect of* Ex-ante *Soil Fertility on Smallholder Fertilizer Use Behavior*. Ph.D. Dissertation, Department of Natural Resources. Ithaca: Cornell University.

Meybeck, A. and F. Place (2014). 'Food Security and Sustainable Resource Use—What are the Resource Challenges to Food Security'. Paper presented at the conference on Food Security Futures: Research Priorities for the 21st Century'. Dublin, Ireland, 11–12 April 2013.

Namubiru-Mwaura, E. and Place, F. (2013). 'Securing Land for Agricultural Production'. In *Africa Agriculture Status Report: Focus on Staple Crops*. Nairobi: Alliance for a Green Revolution in Africa.

Oldeman, L.R. (1998). 'Soil Degradation: A Threat to Food Security?'. Report 98/01. Wageningen: ISRIC.

Oldeman, L.R., Hakkeling, R.T., and Sombroak, W.A. (1991). *World Map of The Status of Human-Induced Soil Degradation: An Explanatory Note*. Second revised edition. Wageningen: ISRIC and Nairobi: UNEP.

Otsuka, K. (2007). 'Efficiency and Equity Effects of Land Markets'. In Evenson, R.E. and P. Pingali (eds), *Handbook of Agricultural Economics, Volume III*. Amsterdam: Elsevier.

Otsuka, K. and Larson, D. (eds) (2013). *An African Green Revolution: Finding Ways to Boost Productivity on Small Farms*. Dordrecht: Springer.

Otsuka, K. and Place, F. (eds) (2001). *Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Asia and Africa*. Baltimore: Johns Hopkins University Press.

Pingali, P., Bigot, Y., and Binswanger, H.P. (1987). *Agricultural Mechanization and the Evolution of Farming Systems in Sub-Saharan Africa*. Baltimore: Johns Hopkins University Press.

Place, F. (2009). 'Land Tenure and Agricultural Productivity in Africa: A comparative Analysis of the Economics Literature and Recent Policy Strategies and Reforms'. *World Development*, 37(8): 1326–36.

Place, F. and Binam, J. (2013). 'Economic Impacts of Farmer-Managed Natural Regeneration in the Sahel: End-of-Project'. Technical Report for Free University Amsterdam and IFAD, World Agroforestry Center, Nairobi, Kenya. Mimeo.

Place, F. and Hazell, P. (1993). 'Productivity Effects of Indigenous Land Tenure Systems in sub-Saharan Africa'. *American Journal of Agricultural Economics*, 75(1): 10–19.

Place, F. and Migot-Adholla, S. (1988). 'Land Registration and Smallholder Farms in Kenya'. *Land Economic*, 74(3): 360–73.

Place, F. and Otsuka, K. (2000). 'Population Pressure, Land Tenure, and Tree Resource Management in Uganda'. *Land Economics*, 76(2): 233–51.

Place, F. and Otsuka, K. (2001). 'Tenure, Agricultural Investment, and Productivity in the Customary Tenure Sector of Malawi'. *Economic Development and Cultural Change*, 50(1): 77–99.

Place, F. and Otsuka, K. (2002). 'Land Tenure Systems and Their Impacts on Agricultural Investments and Productivity in Uganda'. *Journal of Development Studies*, 38(6): 105–28.Place, F., Barrett, C., Freeman, H., Ramisch, J., and Vanlauwe, B. (2003). 'Prospects for Integrated Soil Fertility Management Using Organic and Inorganic Inputs: Evidence from Smallholder African Agricultural Systems'. *Food Policy*, 28: 365–78.

Place, F., Njuki, J., Murithi, F., and Mugo, F. (2006). 'Agricultural Enterprise and Land Management in the Highlands of Kenya'. In Pender, J., F. Place, and S. Ehui (eds), *Strategies for Sustainable Land Management in the East African Highlands*. Washington, DC: World Bank and IFPRI.

Quisumbing, A.R., Payongayong, E., Aidoo, J.B., and Otsuka, K. (2001). 'Women's Land Rights in the Transition to Individualized Ownership: Implications for Tree-Resource Management in Western Ghana'. *Economic Development and Cultural Change*, 50(1): 157–82.

Reij, C., Tappan, G., and Smale, M. (2009). 'Agroenvironmental transformation in the Sahel: another kind of 'green revolution'. IFPRI Discussion Paper 00914. Washington, DC: IFPRI.

Ruthenberg, H. (1980). *Farming Systems in the Tropics*. Oxford: Clarendon Press.

Salami, A., Kamara, A.B., and Brixiova, Z. (2010). 'Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities'. Working Papers 105. Tunis: AfDB.

Sheldrick, W.F., Syers, J.K., and Lingard, J. (2002). 'A Conceptual Model for Conducting Nutrient Audits at National, Regional, and Global Scales'. *Nutrient Cycling in Agroecosystems*, 62(1): 61–72.

Sjaastad, E. and Bromley, D. (1997). 'Indigenous Land Rights in Sub-Saharan Africa: Appropriation, Security, and Investment Demand'. *World Development*, 25(4): 549–62.

Tan, Z., Lal, R., and Wiebe, K. (2005). 'Global Soil Nutrient Depletion and Yield Reduction'. *Journal of Sustainable Agriculture*, 26(1): 123–46.

Timmer, C.P. (1969). 'The Turnip, the New Husbandry, the English Agricultural Revolution'. *Quarterly Journal of Economics*, 3(3): 375–95.

Tschirley, D. (2011). 'What is the Scope for Horticulture to Drive Smallholder Poverty Reduction in Africa?' Policy Synthesis 88, Department of Agricultural, Food and Resource Economics. East Landing: Michigan State University.

Yamano, T., Otsuka, K., and Place, F. (eds) (2011). *Emerging Development of Agriculture in East Africa: Markets, Soil, and Innovations*. Amsterdam: Springer.

Table 1: Rural population, its growth rate, and arable land per person in rural areas in selected countries in SSA

	Proportion of rural population (%)		Annual growth rate, rural population (%)	Arable land per person, rural areas (ha)[a]	
	2000	2011	2000-11	2000	2011
Burkina Faso	82	73	1.7	0.32	0.36
Ethiopia	85	83	2.3	0.15	0.16
Ghana	56	48	0.9	0.21	0.19
Kenya	80	76	2.2	0.16	0.13
Liberia	56	52	2.3	0.13	0.11
Malawi	85	84	2.7	0.24	0.23
Mali	72	65	2.0	0.45	0.48
Mozambique	71	69	2.2	0.21	0.21
Niger	84	82	3.5	1.27	0.90
Nigeria	58	50	1.6	0.24	0.22
Rwanda	86	81	2.4	0.11	0.11
Sierra Leone	64	61	1.3	0.12	0.19
South Sudan	83	82	4.1	n.a.[b]	n.a.[b]
Tanzania	78	73	2.4	0.25	0.25
Uganda	88	84	2.9	0.22	0.19
Zambia	65	61	2.4	0.28	0.25

Source: FAOSTAT (2013).

Notes: [a]Arable land includes all land for annual and perennial cultivation and pastures; [b]not available.

Table 2: Arable and cultivated land areas in selected countries in SSA

Country	Arable land in 2011 (million ha)[a]	Proportion of cultivated land (annual and perennial) in 2011	Percentage change in cultivated area in 1990–2011
Burkina Faso	11.8	49.0	61.2
Ethiopia	35.7	44.0	48.8
Ghana	15.9	47.8	58.3
Kenya	27.5	22.4	12.4
Liberia	2.6	24.0	26.0
Malawi	5.6	66.8	56.9
Mali	41.6	16.8	228.8
Mozambique	49.4	10.9	46.7
Niger	43.8	34.3	53.3
Nigeria	76.2	51.4	22.2
Rwanda	1.9	76.6	24.1
Sierra Leone	3.4	36.0	98.9
South Sudan	28.5	9.7	n.a.[b]
Tanzania	37.3	35.7	33.0
Uganda	14.1	63.6	30.7
Zambia	23.4	14.7	18.0

Source: FAOSTAT (2013).

Notes: [a]Includes all land for annual and perennial cultivation and pastures; [b]not available.

Table 3: Forest area in 2010 and its changes by sub-region in SSA

	Forest in 2010		Annual rate of change (%)	
	Area (1000 ha)	% of land area	1990-2000	2000-2010
Eastern and Southern Africa	267,517	27	-.62	-.66
Western and Central Africa	328,088	32	-.46	-.46
Total	595,605	30	-.53	-.55

Source: FAO (2010).

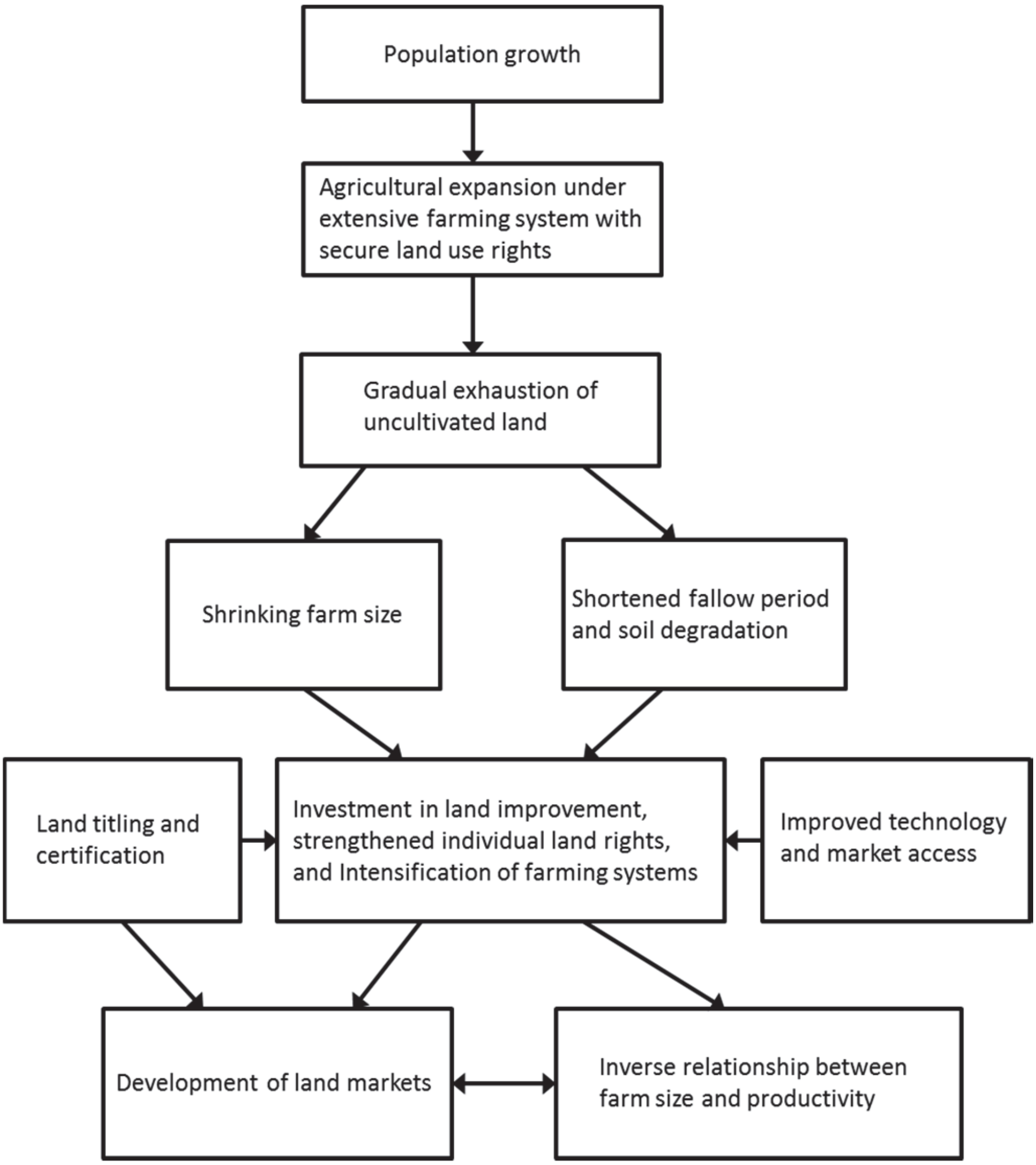
Table 4: The emerging new farming system in highlands of Kenya

	2004	2012
No. of sample farms	699	692
Application of inorganic fertilize (sum of N, P, and K, kg/ha)	57.10	47.11
Application of organic fertilizer (kg/ha)	2,285	2,786
Adoption of hybrid maize (%)	58.13	82.25
Intercropping with beans (%)	86.09	79.30
Proportion of nepiah grass area (%)	13.29	11.91
No. of traditional cows（no. per household）	1.85	1.17
No. of cross-bred cows (no. per household）	2.95	1.93
Maize yield（kg/ha）	1,907	2,125
Real value of maize production per ha (ksh/ha)	30,975	37,156
Real total value of crop production per ha (ksh/ha)	52,645	67,063

Source: Authors.

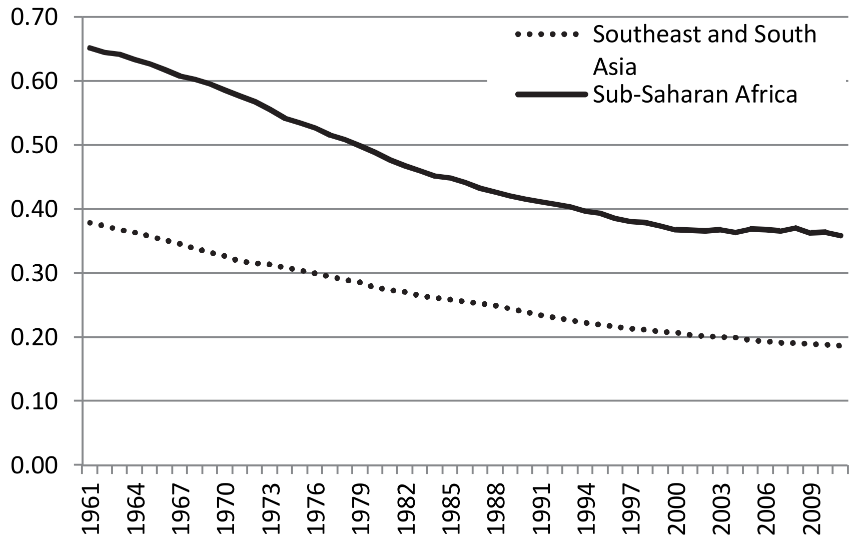
Notes: Ksh for Kenyan shieling (2009 real prices); N for nitrogen; P for phosphorus; K for potassium.

Figure 1: Conceptual framework of the evolution of land tenure, land management, and land markets



Source: Authors.

Figure 2: Changes in arable land per person in rural areas in Southeast and South Asia and SSA



Source: Authors.