LAND MARKETS AND AGRICULTURAL LAND USE EFFICIENCY AND SUSTAINABILITY: EVIDENCE FROM EAST AFRICA[†]

Samuel Benin[a], Frank Place[b], Ephraim Nkonya[a], John Pender[a]

[a] International Food Policy Research Institute, Washington DC, USA
[b] World Agroforestry Center, Nairobi, Kenya

Abstract: Land markets, including land sales and short-term land rentals, have an important role to play for efficient and sustainable land management and agricultural development, especially where markets for other factors of production are imperfect or missing. This study utilises data from the highlands of Ethiopia, Kenya and Uganda to examine the impact of land markets on various types of land investment and management practices, crop yield, and land quality. The results highlight the relative long-term versus short-term return to different types of investment and practices, where those with longer-term benefits such as trees, manuring, and composting are preferred on more tenure-secure plots, while those with immediate or season-to-season benefits such as drainage structures or chemical fertilizers are preferred on rented plots. The impact on agricultural productivity is mixed and context specific. Regarding land quality outcomes, there is reason to believe that plots traded on short-term markets in Kenya and Uganda tend to be of inferior quality, supporting the hypothesis of movement of land from households to those with higher capital/land ratios.

Keywords: land markets, land investment and management, land use efficiency

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1. INTRODUCTION

Land is naturally an important resource in agrarian economies and, thus, efficient land markets (including sales and rentals) are important for sustainable land management and agricultural development. Particularly, land markets allow land to be used by farmers who are more capable to earn the highest return from it, through mobility of scarce factors of production such as labour, draft power, implements, purchased inputs, and management ability. There is an old and large literature on land tenure contracts and their implications for agricultural efficiency.[1] Adam Smith (1776), John Stuart Mill (1848), Alfred Marshall (1890) and numerous authors since have argued that share tenancy causes inefficient resource allocation. The rationale being that the share tenant receives as marginal revenue only a fraction of the value of his marginal product of labor, thus reducing the tenant's incentive to supply labor or other inputs at the optimal level, assuming that the tenant's work effort cannot be monitored and enforced and there is no production uncertainty.[2] More recently, others have argued that if the tenant's work effort can be costlessly monitored and enforced by the landlord, then resource allocation can be as efficient under sharecropping as under owner-cultivation or fixed-rent tenancy (Johnson, 1950; Cheung, 1969).[3]

Whether monitoring and enforcement of contracts are sufficiently costless to allow for efficient sharecropping is of course an empirical question. Not surprisingly, the available empirical evidence on the efficiency of alternative land tenure contracts is mixed. A review of a large number of case studies in South and Southeast Asia by Otsuka and Hayami (1988) and Otsuka et al. (1992) show that there is not much significant inefficiency associated with share tenancy. The few case studies in sub-Saharan Africa also show mixed evidence.[4] For example, while Pender and Fafchamps (2001) did not find significant inefficiency associated with rented plots, Gavian and Ehui (1998) found that total factor productivity was lower on rented than

[1] For excellent reviews, see Otsuka et al. (1992); Singh (1989); Otsuka and Hayami (1988); and Binswanger and Rosenzweig (1984).

[2] This is commonly referred to as the Marshallian inefficiency of sharecropping.

[3] Marshall himself noted this possibility even while arguing for the inefficiency of sharecropping.

[4] There is a substantial and growing literature investigating the impacts of land rights and land titles on agricultural productivity in Africa (Platteau, 1996), but little of it addresses the impacts of land tenure contracts.

owner-operated plots. Similarly, Ahmed et al. (2002) found that crop yield was lower on sharecropped plots than on owner-cultivated plots, although they also found that crop yield was the same on fixed-rent and owner-operated plots. Holden et al. (2001), on the other hand, found that barley yield was about 51% higher on rented plots compared to owner-operated plots.

Many of the studies, however, did not adequately distinguish sharecroppers from fixed-rent tenants or owner-operators and/or control for other factors that may affect the efficiency or sustainability of land use such as land quality or differences in farmers' endowments or abilities (Shaban, 1987). Several studies that did control for such characteristics have found evidence supporting the Marshallian perspective (Bell, 1977; Shaban, 1987; Sadoulet et al., 1994; Laffont and Matoussi, 1995; Chunrong Al et al., 1996; Ahmed et al., 2002), although inefficiency was not always found for all groups of farmers (Sadoulet et al., 1994), nor did it always mean lower input use or output per hectare on sharecropped land (Chunrong Al et al., 1996). Controlling for and examining the significance of the factors that capture the underlying arguments for the existence of different contractual arrangements, including risk and uncertainty (Cheung, 1969; Stiglitz, 1974; Reid, 1977), transaction and monitoring costs and incentive problems (Stiglitz, 1974; Eswaran and Kotwal, 1985; Pender and Fafchamps, 2001), and capital market constraints (Jaynes, 1982, 1984; Allen, 1985; Shetty, 1988; Laffont and Matoussi, 1995; Pender and Fafchamps, 2001), is particularly important from a policy perspective, i.e., to be able to prescribe policy recommendations for improving the efficiency of land markets or improving land management and agricultural productivity in a sustainable manner.

Using community, household and plot level data from the highland areas of Ethiopia, Kenya and Uganda, we examine the efficiency and sustainability impacts of land markets in East Africa. The conceptual framework, data, and empirical approach are discussed next. This is followed in section 3 by a descriptive analysis of land markets and land use, productivity and quality. Results of econometric analyses are discussed in section 4, and conclusions and implications in section 5.

2. CONCEPTUAL FRAMEWORK AND EMPIRICAL APPROACH

Conceptual framework

A conceptual model of the link between land markets, investment in land improvements, agricultural productivity, and land quality is given in Figure 1; appealing to the literature on property rights and investment incentives and the relative efficiency of alternative land tenure arrangements (including many of those cited in the introduction in addition to: Besley 1985; Feder, 1985; Feder and Feeny, 1993; Place and Hazell, 1983).

In some cases, the effects of markets are similar whether the markets are for more permanent purchases of land or shorter term rentals. In other cases, the effects of land purchase and rental markets are expected to differ. Four main pathways are identified. The first, *capitalization effect* (in the upper left quadrant), is that land market activity will lead to greater capitalization of the value of investment into land values and, thus, provide increased incentives for longer term investment, notably visible and lumpy investments. This induced incentive effect would apply to all land in a community, assuming that all land would potentially be traded. The second, *distribution effect* (in the upper right quadrant), is that land markets may facilitate the movement of land resources to households with higher labor/land or capital/land ratios and, thus, increase investment and efficiency (and reduce the variance of yields across farms). This efficiency-increasing effect would be most observed on plots that were acquired via the market. The third is the *tenure security effect* (in the lower left quadrant) and posits that farmers who purchase land will have more incentive to title their land and privatize it away from local customary tenure arrangements that may impinge on investment decision making. On the contrary, rented plots are typically of limited duration and carry with them significant limitations in terms of investments that can be made by the tenant. The fourth effect is the *asymmetric information effect*, which hypothesizes that where investments are not capitalized into land prices and where land quality is difficult to assess, the types of land traded may be of inferior quality. This is likely to be much more the case for land rentals than land purchases, because the spontaneous nature of rental markets, along with the low price reduces information gathering efforts. If this is the case, then one would expect lower investment and productivity on traded plots, especially rented and borrowed plots. Thus, it is obvious that the overall effects of land markets on investment and efficiency are complicated. The effects of improved markets for land purchases are mainly positive.[5] The case of land rental markets is much less clear, with some positive and some negative linkages.

Empirical approach

Two types of empirical analyses are used to assess the impact of land markets on land use efficiency and sustainability. First, descriptive analysis of means and variances and statistical tests are used to examine differences in various indicators of land investment (e.g. stone terraces, trees, irrigation), land management practices (e.g. contour plowing, crop rotation, mulching, fertilization), crop yield, and land quality across different land acquisition methods. In the second approach, we use econometric techniques to examine the impact of the different types of plot on those same indicators. Here, we control for several other factors that may affect land investment, land management practices, crop yield, and land quality outcomes; including extension, type of crops planted, land operator's technical knowledge and capacity (which is enhanced through education, farm experience, and access to services and markets), characteristics of the land (e.g. size, slope, soil depth), and natural factors (e.g. rainfall, elevation). Typically, we estimate the following four regression equations:

1. Land investment = *f* (land markets; other factors)
2. Land management = *f* (land markets, stock of land investments; other factors)
3. Crop yield = *f* (land markets, stock of land investments, land management; other factors)
4. Land quality = *f* (land markets, stock of land investments, land management; other factors)

Depending on the nature of the dependent variable in equations 1 through 4, different econometric techniques are used for the estimation, including probit, tobit, and ordinary lease

[5] We have not discussed non-economic reasons for acquiring land, some of which may lead to over-accumulation and inefficient use of land.

squares (Maddala, 1983; Greene, 1993). All the analyses were carried out using STATA software (StataCorp, 2006). The specifics are discussed in the relevant sections.

Study sites and data

We use survey data from Ethiopia, Kenya and Uganda to test the hypotheses outlined in the conceptual framework. The Ethiopia data are from community, household and plot level surveys that were conducted in the highland areas (above 1500 meters above sea level (m.a.s.l.)) of the Amhara and Tigray regions between 1999 and 2001. A stratified random sample of 99 peasant associations (PAs, usually consisting of three to five villages),[6] two villages (198 in total) randomly selected from each PA and four or five households (934 in total) randomly selected from each village, were selected from the highland areas of the two regions.[7] In addition, all plots operated by the selected households were surveyed, and the stratification was based upon indicators of agricultural potential, market access, and population density (Benin, 2006; Pender and Gebremedhin, 2006). Information were collected through structured surveys and include household structure and endowments, household's access to infrastructure and services, plot characteristics (mode of acquisition, size, slope, quality, crops cultivated, etc.), land investments, land management practices, inputs, and agricultural production in 1999 and 2000 cropping seasons. Recall methods were also used to obtain information prior to 1999/2000, specifically 1991. Data on altitude were collected using a global positioning system (GPS). The primary data were supplemented by secondary information on rainfall and population.

The Kenya data are from a study of 943 households in 100 communities. The communities themselves are distributed across 15 districts in the Eastern, Central, Rift Valley, Nyanza, and Western provinces. All the sites fall within medium to high potential areas (i.e. rainfall above 800 mm per annum) and as such are potential maize growing areas, and indeed maize is grown in all of them. Here too a stratified random sample procedure, based on

[6] The peasant administration (called *Kebele* and *Tabia* in Amhara and Tigray region, respectively) is the lowest unit of government.

[7] PAs that are predominantly below 1500 m.a.s.l. in elevation or have more than 50% of their total area below 1500 m.a.s.l. were excluded from the sample frame.

indicators of agricultural potential, market access and population density, was used. Structured survey instruments were used to collect information on household agricultural activities such as cropping, livestock and tree growing, land acquisition and rights, and access to labor and capital. The study also measured soil quality through the sampling and analysis of soils from the major cereal fields, which was maize in all cases. Other information collected includes household assets, expenditures, income, demographics, education, and health. Community surveys were also used to assess the prevalence of livelihood and farming practices, land market activity, prices and wages.

The data on Uganda come from three sets of surveys collected between 1999 and 2004. A stratified random sample of 270 communities (LC1s, the lowest administrative unit, usually consisting of a single village) and four to ten households (1426 in total) randomly selected from each village Here too, all plots operated by the selected households were surveyed and the stratification was based on indicators of agricultural potential, market access population density and altitude (Nkonya et al., 2004; Nkonya et al., 2005). The total number of plots surveyed was 5391. At the household level, information collected includes household composition, endowments of assets, income and expenditures and adoption of agricultural and land management technologies. At the plot level, information collected includes land tenure, plot quality characteristics, land management practices, use of inputs and outputs from the plot in the year 2000. The survey information was supplemented by secondary information collected from the 1991 population census and available digitized map information incorporated into a geographic information system.

3. DESCRIPTIVE ANALYSIS

3.1. Land markets, land rights and land values

Ethiopia

Prior to 1975, land tenure in Ethiopia was based on a feudal system in which land was owned by the emperor, who granted tenure rights subject to feudal obligations. Land tenure forms known as *rist* and *gult* were then practiced (Rahmato, 1984). The *rist* was a communal form of land ownership where an individual was entitled to usufruct rights in a commune if he or she could prove some blood relation to the founding patriarch of the commune. Usufruct rights were lifelong and extended over many generations. The *gult* was linked with the legal and political institutions of the crown and those involved, *gultegnas*, were responsible for levying and collecting tax from *ristegnas*, who tilled the land. Upon overthrow of the monarch, lands were nationalized and declared as the collective property of the people in the land reform proclamation of March 1975, and households were given use rights only, with occasional redistribution of farmland to accommodate landless households. Since 1991, under the current government of the Ethiopian Peoples Revolutionary Democratic Front (EPRDF), households have been given the right to use the land indefinitely, lease it out temporarily to other farmers, and transfer it only to their children. However, they cannot sell or mortgage the land. Land redistribution has been phased out, except where major infrastructure investments such as irrigation necessitate redistribution.

Leading up to the time of the data collection, however, there were significant differences across regions with respect to the implementation of land redistribution. For example, in the Tigray region, land redistribution was stopped in 1991, and the policy of no future redistribution was made official by a land use and tenure policy in 1997. In the Oromiya region too, there had not been a land redistribution since 1992 (Tefera et al., 2000). In the Amhara region, on the other hand, land redistribution was common, with the most recent major land redistribution taken place in 1997/98. There had been at least one land redistribution since 1991 in about 73% of the villages surveyed, with the average number being three. One of the villages interviewed had experienced as many as fourteen land redistributions since 1975.

Compared to other countries, land is relatively equally distributed in the Ethiopian highlands because of the radical land reform program begun in 1975 (Rahmato, 1984; Bruce et al., 1994; Abate, 1995; Amare, 1995) and the continued prohibition of land sales and mortgages, a policy enshrined in the new Ethiopian constitution.[8] The data show that the average land holding per household is about 1.3 ha in the Amhara region and 1 ha in the Tigray region. However, the average farmland holding was significantly higher (about 75% more in the Amhara region) among male-headed households than their female counterparts. Up to 89% of the plots were cultivated by their owners, i.e., by those receiving the land directly from the government (peasant association) or through gift, inheritance, or permanent exchange (Table 1). The remaining 11% of the plots were obtained through temporary farmer-to-farmer exchanges in the form of rental, mostly sharecropping. Although both male and female headed households participate equally in the land rental market, the males tended to rent in more while females tended to rent out more. Contracts for rented plots were very short (one season or year on average) and *equl* sharecropping (one-half of crop output to landowner) was the common practice. For fixed leases, rents were about US$30–65 per hectare, depending on the quality of the land.[9]

Land rights associated with exchange, transfer, and making long-term investments were exclusive to owner-cultivated plots. There seem, however, to be a high level of restriction on rented plots even for simple activities such as crop choice and grazing animals. Tenants could not choose what type of crops to plant on 50% of the rented plots, while they could not graze their animals on 28% of the rented plots. Expectations to operate the plot in the next 5 or 10 years or to bequeath the plot were almost perfect on owner-cultivated plots, but were between 20 and 28% on rented plots.[10] The main reason for expecting not to operate the plot in the future was due to fear of land redistribution on owner-cultivated plots, especially in the Amhara region, and termination of rental contract or uncertainty of renewal of contract on rented plots.

Kenya

[8] As a result of the predominant *rist* land tenure system that existed in northern Ethiopia prior to the 1975 land reform (which also involved periodic land redistribution and prohibited land sales and mortgages), land ownership was not greatly unequal in most places even before 1975 (Bruce et al., 1994).
[9] At the time of the surveys, US$ 1≈Ethiopian Birr 8.50.
[10] On rented plots, bequeath refers to the expectation of transferring the rental contract to an heir in the event that the current contract holder is unable to continue farming.

Table 1 also shows the distribution of plots according to the method of acquisition in Kenya. The majority of plots, 59%, were acquired through inheritance primarily and other permanent means. Compared to the Ethiopian case, however, a significant percentage was acquired through market mechanisms, with 26% being purchased, 14% being acquired through fixed-rent arrangements, and less than 1% being acquired through sharecropping arrangements. Unlike in the Ethiopian case, where sharecropping was the more common rental form, fixed rentals was more common in Kenya. The prevalence of land markets varied across the 15 districts in the sample. Regarding purchases for example, fewer than 10% of the plots were purchased in two of the districts while more than 30% were purchased in four of the districts. The highest incidence occurred in the Nakuru District, where 52% of the plots were purchased. Regarding rentals, less than 10% of the plots had been rented in eight of the fifteen districts, but in three, the proportion of rented plots was greater than 20%.

As is typically found in other empirical studies in Africa, and similar to the Ethiopian case, rented plots have been more recently acquired than others. The average age of a rented plot was 4 years, as compared to 24 years for both purchased and inherited land. Another expected finding is that rented plots are smaller than owned plots. The average size of rented plots was just 0.34 ha as compared to 0.98 ha for inherited plots. Purchased plots averaged 1.25 ha in size, which was significantly greater than the average size of inherited plots. Interestingly, the percentage of purchased plots in households headed by females was the same as in those headed by males. This does not mean that women are active buyers of land however, since many of the purchased plots were acquired two decades ago when their husbands may still have been around. On the other hand, the percentage of rented plots was only 10% in female-headed households as compared to 15% for male headed households, suggesting that it is easier for males to participate in land rental markets.

Similar to the Ethiopian case too, there were significant differences in the rights associated with the different types of plot. For example, the right to sell and give land was much more limited with rented plots, as expected. However, there were some cases (about 20% of rented plots) with restricted rights (i.e. right to sell or give with approval), which likely refer to cases where the tenant was renting from another family member. Individualized rights of sale were stronger with respect to purchased plots than inherited plots. About 83% of purchased plots could be sold by the household head alone or after consultation with the nuclear family, as opposed to 64% of inherited plots. Regarding the rights to plant trees, a notable visible and long-term investment, they were completely absent for 72% of the rented plots. On the other hand, households had strong rights to plant trees on at least 90% of inherited and purchased plots.

Kenya has had a widespread land registration and titling program and so it is interesting to examine differences across systems. Focusing on purchased and inherited land, the differences between the two are striking. All purchased plots were claimed to be titled whereas about 14% of the inherited plots had no title. Furthermore, of the titled purchased plots, 84% were titled in the name of the household head or spouse. Of the inherited plots, on the other hand, only 47% were under title of the household head or spouse, and almost 35% was still titled in the name of a parent of the household head or spouse. This does suggest that there is a much stronger incentive to update the registration and title status of purchased plots. However, whether a current title confers stronger tenure security is an empirical issue; it may be that the lack of updating of land titles on inherited land is because the holders already feel sufficiently secure. One particular concern is the tenure security of women or female-headed households. Across all plots operated in female-headed households, a worrying 22% were titled in the name of a deceased husband. Although the problem is worse for inherited plots than purchased plots, it is not possible to confirm which of the many possible explanations are the most relevant, including that sons may have already laid claim to previously purchased plots.

Compared to the Ethiopian case, average rental values were much higher, ranging between $10 and $525 per ha, with a mean of $83.[11] The value of rented and purchased land was estimated to be the same, but both were greater (about 20% more) than the estimated rental value of inherited plots. The stated rental values on rented plots are obviously informed by and

[11] At the time of the surveys, US$ 1≈Kenyan Shillings 75.

strongly correlated with actual prices paid. It may be that respondents believe that market prices for land rentals are somewhat fixed in their locations, hence the somewhat small differences in the estimated values.

Uganda

In Uganda, there are four major land tenure types (customary, mailo, freehold and leasehold) and each type has its own associated land rights and obligations (Republic of Uganda, 1998) and sense of tenure security. *Customary land tenure*, as the name implies, is regulated by customary rules and is the most common land tenure system in Uganda and often involves limitations on the holder's right to sell or mortgage land, though usufruct and bequest rights are usually secure. Transfer of rights under this system is mainly through inheritance and landholders require approval of clan chiefs regarding any land transaction. However, under the 1998 Land Act (Republic of Uganda, 1998), a customary landholder may apply for a certificate of ownership from the District Land Board and, once such a certificate is issued, the landholder may lease, mortgage, sell, give away or bequeath the land by will. Under the *freehold land tenure* system, the landholder is allowed to own the land for an unlimited time and can use it for any lawful purposes, including sell, lease or use it as collateral to obtain a loan. This form of tenure provides holders with the most complete rights and the least bundle of obligations or restrictions on use. The *mailo land tenure* system is similar to the freehold system in the sense that the landholder is allowed to own the land for an unlimited time. However, in most cases, *mailo* land tends to been occupied by their holders over a period of time. The *leasehold land tenure* system, which is similar to the case of Ethiopia and Kenya, has the smallest bundle of land rights.

Similar to the Kenya case, land markets in Uganda have been allowed to develop without much intervention from the government. About 34% of the plots surveyed were purchased and 57% inherited (Table 1). Unlike in Kenya, however, rentals were not common, with only 2% of the plots being acquired through sharecropping arrangements. In general, land transactions are informal, as they involve little legal recourse (Rugadya, 2003). Hence, one of the objectives of the Land Act of 1998 is to formalize the land market, with a proposal to convert customary land to freehold status (Republic of Uganda, 1998).

Consistent with the case of Ethiopia and Kenya, the data show that male-headed households were more likely to buy or lease in land than their female counterparts. This is expected since female-headed households have lower per capita household income (Nkonya et al., 2005). Female-headed households were more likely to borrow land than male-headed households, which also is expected, since poor households tend to have strong social capital, which helps them to acquire capital and services. With average buying and rental price of land estimated at about $285 and $27 per ha,[12] respectively, land markets are likely to increase the inequality of land between male and female headed households. Surprisingly, the share of female and male headed households who acquired land through inheritance was not significantly different (58% and 56% for female and male headed households, respectively). Given that most customary institutions encourage household heads to bequeath their land to their sons (Bikaako and Ssenkumba, 2003), it was expected that a significantly lower share of female-headed households will acquire their land through inheritance.

3.2. Land markets and land investments

The presence of long-term land investments on the plots surveyed across the three countries was generally low (Table 2). In the Amhara region of Ethiopia, the most common types of investment, in terms of proportion of plots having them, were drainage ditches followed by stone terraces and constructed fences. While the incidence of stone terraces, live fences and trees was significantly higher on owner-cultivated plots compared to rented plots, the incidence of drainage ditches was lower. In fact, there were no trees on rented plots. In Kenya, the most significant types of investments were trees, with the density of trees being three to eight times greater on inherited and purchased plots than on rented plots (Table 2). In fact, the density of trees was similar on inherited and purchased plots except in the case of coffee, where the density

[12] The standard deviations of these estimates are quite large, and land in the high potential area in the central region is likely to be more expensive than the case in the northern and northwestern marginal areas.

was higher on inherited plots. In Uganda also, tree planting was the most common type of investment and, here too, the incidence was greater on purchased plots than the other types of plot (Table 2). Similar to the case of Ethiopia, differences in the other types of investment across plot types were mixed. For example, while the incidence of stone walls was significantly higher on inherited plots than purchased plots, the incidence of soil bunds was significantly higher on rented plots than purchased plots.

Together, however, these results reflect the relative long-term versus short-term return to different types of investment, where those with longer-term benefits such as trees are preferred on more tenure-secure plots, while those with immediate or shorter-term benefits such as drainage structures are preferred on rented plots. The mixed results also indicate that there are other factors that influence the decision to invest in land improvement.

3.3. Land markets and land management practices

Compared to the types of land investment discussed in the previous section, household tended to engage more in various short-term land management practices across the three countries, although the incidence of occurrence was generally higher in Ethiopia compared to Uganda. In Ethiopia, the most common practices included contour plowing, plowing in crop residues, and crop rotation (Table 3). Notable differences across different types of plot was for contour plowing, where the incidence was higher on gifted and inherited plots than on PA-allocated and rented plots. Chemical fertilizers, household refuse, manure and improved seeds were used on 9–35%. Application of household refuse and manure was higher on owner-cultivated than rented plots, while use of chemical fertilizers and improved seeds was higher on rented plots. It is likely that renters have more resources including access to credit to finance the purchase and use of chemical fertilizers and improved seeds, which is consistent with our distribution effect hypothesis. Also, since sharing the cost of purchased inputs is a common feature associated with sharecropping arrangements, the cost (and risk) of applying chemical fertilizers and improved seeds is reduced for each party, which increases the likelihood of using chemical fertilizers and improved seeds on rented (sharecropped in this case) plots.

In Kenya, the incidence of manuring and mulching, as well as the average amount of manure applied, was greater on purchased and inherited plots than rented plots (Table 3). However, fertilizer use and amounts applied were similar across all types of plots. In Uganda too, the incidence of application of mulch, animal manure, compost and household refuse was higher on purchased plots (and in several instances inherited plots as well) than on rented plots, while application of chemical fertilizers and herbicides was higher on rented plots than the others (Table 3). Regarding other practices, slash and burn tended to be used more on borrowed and rented plots, while fallowing was used more on inherited and purchased plots.

Again, these results reflect the relative long-term versus short-term return to different types of management practices, where those with longer-term benefits such as manuring, mulching and composting are preferred on more tenure-secure plots while those with immediate or season-to-season benefits such as chemical fertilizers are preferred on rented plots.

An interesting observation with the Kenya data is that differences in some of the land investment and management practices seem to have a bearing on land rental values. For example, although estimated land rental values were not significantly related to investments in timber or coffee, they were positively correlated to the number of tea bushes on the plot. Rental values also were higher by about 20% and 40% for plots receiving manure and mineral fertilizer application, respectively. Land sales value also was significantly correlated with all types of investments,[13] and land sales prices were also 40% and 66% higher on plots that were manured and fertilized, respectively.

3.4. Land markets and agricultural productivity and land quality

[13] We treat these results with some caution because the mean reported sales values were about 200 times the rental values. Although it is known that land sales costs are very high in rural Kenya, the lack of high sales activity in some areas may have lead to some inflation of values.

With very little irrigation (see Table 2), crop production was restricted to the main rainy season, and cereals seem to dominate the crops cultivated. In Ethiopia for example, teff and maize were dominant on rented plots. As Table 4 shows, in Ethiopia, there was no statistically significant difference in productivity across the different types of plot. In Kenya, however, average maize yield was significantly higher on purchased plots than on inherited and rented plots. In Uganda also, the value of crop production per ha was larger on purchased and inherited plots compared to borrowed and rented plots. In fact, the value of output per ha was nearly twice as much on purchased plots than on rented plots.

In terms of land quality, we examine farmers' perception of erosion problems in Ethiopia and actual soil fertility and nutrient measures in Kenya and Uganda.[14] Farmers in Ethiopia in general perceived a majority of their plots as having little or no erosion problems, but these perceptions were not significantly different across plot types (Table 4). Regarding the more rigorous land quality measures associated with the Kenya and Uganda data, however, we find some significant differences. In Kenya, inherited plots were the most fertile, followed by purchased plots. Rented plots were the least fertile. In Uganda, the analyses show that purchased plots had the greatest nutrient stocks (N, P and K in kg/ha) than all other types of plot, with borrowed plots faring the worst. These results from Kenya and Uganda support the hypothesis that plots traded on short-term markets tend to be of inferior quality, due to market imperfections. However in Uganda also, the N and P balances (in kg/ha/yr) for the purchased plots were lower than those measured for plots acquired through other methods, suggesting that purchased plots experience more severe nitrogen and potassium depletion than plots acquired by other methods, despite the seemingly better land management practices associated with purchased plots that was discussed previously. But recall that purchased plots also were associated with significantly greater extractive activities in terms of output per ha.

[14] For the Kenya data soil samples taken from farmers' plots were analyzed using new spectroscopy methods developed at the World Agroforestry Center. The results, in addition to others fromanalysis of many thousands of other soil samples, was then used to develop a soil fertility index, centered around zero with negative values being less fertile than positive ones, and applied to the data. In Uganda, soil nutrient (nitrogen (N), phosphorus (P) and potassium (K)) stocks and balances were estimated of soil samples taken from farmers' plots.

4. ECONOMETRIC RESULTS

Impact of land markets on land investments

Regression analyses to examine the impact of land markets in long-term land investments were undertaken for the Tigray region and Kenya datasets only. Interestingly in Ethiopia, investment in stone terrace is predicted to be less likely on PA-allocated plots than on the other types of plot, though the coefficient is only statistically significant at the 10% level (Table 5). Given that sharecropping and other lease arrangements are restricted to be no more than two years in Tigray (Gebremedhin et al., 2002), this result may appear surprising. However, a substantial share of the investments made in stone terraces were made by the community as a whole under mass-mobilization campaigns requiring people to contribute labor to soil and water conservation measures in the community.[15] Such investments are apparently not affected by the tenure category of the land. Furthermore, private land investments are almost always made by the landowner, even if the land is leased to a tenant. Thus, the short duration of tenancy contracts may not significantly inhibit soil and water conservation investments. With regards to Kenya, Table 5 also shows that while purchased plots, compared to inherited plots, were associated with greater investment in timber trees, they were also associated with lower investment in coffee bunches. In general, rented plots were associated with much lower investment in trees of all types, which supports our hypotheses on capitalization and tenure security effects.

Impact of land markets on land management practices

Table 6 shows regression results of the impact of land markets on use of various land management practices across the three countries. Controlling for several other factors that may affect invest in land improvement, the results are mixed, sometimes surprising but, in many cases, consistent with our expectations. In the Amhara region of Ethiopia for example, compared to rented plots, inherited plots were associated with lower likelihood of using reduced tillage, while PA-allocated and gifted plots were associated with greater likelihood of using crop rotation

[15] In Tigray, adults are required to contribute 20 days per year to labor mass-mobilization campaigns, which focus mainly on soil and water conservation investment (Hagos et al., 1999).

and plowing in crop residues, respectively. However, rented plots were associated with greater likelihood of applying manure and using improved seeds than on other types of plot. These results are consistent with our hypotheses on tenure security and distribution effects.

In the Tigray region of Ethiopia, we find that, compared to rented plots, PA-allocated plots were associated with lower likelihood being contour plowed, gifted plots were associated with more slash and burn, while inherited plots were associated with more use manure and fertilizers. Perhaps recipients of gift plots, and renters to some extent, are expected to use such conservation measures in deference to the landowner who provided the land.

In Kenya, we find that rented plots were less likely to receive manure or mulching and, for plots that received fertilizer, they were associated with lower amounts. Because mulching and manure are expected to have effects over multiple seasons, the latter finding is sensible and expected. However, it is not clear why rented plots received less fertilizer amounts given that they were equally likely to have received fertilizer, but this may have to do with the wealth effect of those renting in lands (e.g. they may be labor rich but capital poor).

In the case of Uganda, purchased plots were generally more likely to have better land management practices than plots acquired through other methods, and many of the significant differences relate to purchased versus borrowed plots. The results in Table 6 show that slash and burn was more likely to be practiced on borrowed plots than on purchased plots, probably because farmers temporarily give away undeveloped plots in order to get help to clear the land. Borrowed plots also were less likely than purchased plots to be fallowed, receive fertilizer, animal manure, household residues and pesticides, and for crop rotation to be practiced. This is expected and is likely due to the short-term perspective that land borrowers tend to have, hence lower incentive to invest in long-term land improvement. To the extent that lessees seek to rent in more developed plots, the finding that slash and burn was less likely to be practiced on leased in plots than on purchased plots (Table 6) is also not surprising. Consistent with the above findings regarding borrowed plots, other regression results show that labor input on borrowed plots was significantly lower that the amount used on purchased plots.

Impact of land markets on land productivity

Results of the impact of land markets on land productivity are given in Table 7. In the Amhara region of Ethiopia, we find that owner-cultivated (PA-allocated, gift and inherited) plots, compared to rented plots, were associated with lower value of crop yield by about 33–66%. This result is puzzling as it contradicts the tendency of yields being lower on rented plots (Otsuka and Hayami, 1988). It also contradicts the results from the Tigray region of Ethiopia and Kenya, where land markets had no observed significant impact on land productivity, controlling for other factors (see also Table 7). The results from the Amhara region also contradicts findings from other parts of Ethiopia in the Oromiya region (Pender and Fafchamps, 2001; Ahmed et al., 2002). Pender and Fafchamps (2001) found no difference in yields between owner-cultivated and sharecropped plots, while Ahmed et al. (2002) found that crop yields were lower on sharecropped plots than on owner-cultivated plots. The result is puzzling also because the econometric results do not show much consistent and statistical significant difference in land management practices and inputs between owner-cultivated and rented plots. Although, the result is consistent with some of the findings of Holden et al. (2001), who found that barley yield was about 51% higher on rented plots, the puzzle was addressed by re-estimating the value of crop yield regression using a household fixed-effects model and also by restricting the sample to households operating both owner-cultivated and rented plots only.[16] The results of these estimations show that the negative impact associated with the different types of owner-cultivated plots is robust only for gifted plots. Note, however, that there is substantial loss of information (i.e. dropping several variables in the fixed-effects model and observations in the restricted sample) associated with these models, and so they should be interpreted with caution.

In the case of Uganda, we find that, compared with purchased plots, rented plots were significantly associated with a lower value of crop yield (Table 7), which is consistent with our expectations. Surprisingly, borrowed plots, compared with purchased plots, were associated with

[16] In the household fixed-effects model, all variables that do not vary across plots (on within the household) are dropped. Thanks to Kei Otsuka for suggesting these methods for addressing the puzzle.

a higher value of crop yield, although the coefficient is only statistically significant at the 10% level. The later contradicts the finding of Nkonya et al. (2004) that purchased plots had higher value of crop yield than inherited plots and borrowed plots.

Impact of land markets on land quality

Here, the analysis is based on the Kenya and Uganda datasets, since the land quality measures are based on actual soils sample analysis, as opposed to perception of farmers in the case of Ethiopia datasets. Regarding Kenya, we find that much of the variation in soil fertility is explained by meso level factors, as district dummies in our regression picked up nearly 60% of the variation. However, the micro factors do explain a significant portion, as we find that rented plots are less fertile than inherited and purchased plots (Table 7). This also supports the hypothesis that due to market imperfections, plots that are transacted on short-term markets tend to be of inferior quality than others.

Results associated with the Uganda data are mixed. The nitrogen balance on rented plots was significantly higher than the balance on purchased plots, while the phosphorus and potassium balances were lower on inherited plots than on purchased plots. The former supports the distribution effect hypothesis of movement of land to households with higher capital/land ratios. But it may also be an outcome effect due to the higher crop productivity on purchased plots.

5. CONCLUSIONS AND IMPLICATIONS

Using community, household and plot level survey data from the highland areas of Ethiopia, Kenya and Uganda, this paper examined the efficiency and sustainability impacts of land markets. Land rental markets (including sales and short-term rentals) were more developed in Kenya and Uganda than in Ethiopia. With the existing ban on land sales in Ethiopia, short-term rentals, mainly through sharecropping arrangements, were used. Land sales were common in both Kenya and Uganda, but short-term rentals were more common in Ethiopia and Kenya than in Uganda.

Regarding the impact of the different types of plot on land investments and management practices, both descriptive and econometric analysis generally highlight the relative long-term versus short-term return to different types of investment and practices, where those with longer-term benefits such as trees, manuring, mulching and composting are preferred on more tenure-secure plots (especially purchased, distributed by the community, or inherited), while those with immediate or season-to-season benefits such as drainage structures or chemical fertilizers are preferred on rented plots. In cases where the latter did not hold, it may have to do with the wealth effect of those renting in lands (e.g. they may be labor rich but capital poor).

The impact of land markets on agricultural productivity was mixed: surprising in the Amhara region of Ethiopia (owner-cultivated plots were associated with lower value of crop yield), no impact in the Tigray region of Ethiopia and Kenya, and partially expected in Uganda (purchased plots were associated with greater value of crop yield than rented plots, while borrowed plots were associated with a greater value of crop yield than purchased plots). These suggest that the impact of land markets on agricultural productivity is context specific.

Regarding land quality outcomes, we found that inherited and purchased plots were relatively more fertile than rented plots in Kenya, suggesting that plots traded on short-term markets in Kenya tend to be of inferior quality, due to market imperfections. In Uganda, the results were mixed. The nitrogen balance on rented plots was significantly higher than the balance on purchased plots, while the phosphorus and potassium balances were lower on inherited plots than on purchased plots. The former supports the distribution effect hypothesis of movement of land to households with higher capital/land ratios. But it may also be an outcome effect due to the higher extractive activities (output per ha) on purchased plots.

REFERENCES

Ahmed, M., Gebremedhin, B., Benin, S., and Ehui, S. 2002. Measurement and sources of technical efficiency of land tenure contracts in Ethiopia. *Environment and development economics* 7:507-527.

Allen, F. 1985. On the fixed nature of sharecropping contracts. *Economic Journal* 95: 30–48.

Bell, C. 1977. Alternative theories of sharecropping: Some tests using evidence from northeast India. *Journal of Development Studies* 13(4): 317-346.

Benin, S. 2006. Policies and programs affecting land management practices, input use and productivity in the highlands of Amhara region, Ethiopia. In Pender, J., Place, F. and Ehui, S. (Eds.). *Policies for Sustainable Land Management in the East African Highlands*. IFPRI, Washington, DC. (*forthcoming*).

Besley, T. 1995. Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy* 103(5):913–937.

Bikaako and Ssenkumba. 2003. Gender, land and rights: Contemporary contestation in law and policy and practice in Uganda. In: Wanyeki, L.M. 2003. Women and land in Africa – culture, religion and realizing women's rights. Zed books: 232-277.

Binswanger, H.P., Rosenzweig, M. 1984. Contractual arrangements, employment, and wages in rural labor markets: A critical review. In *Contractual arrangements, employment, and wages in rural labor markets in Asia*, eds., Binswanger, H.P., Rosenzweig, M. New Haven, CT: Yale University Press.

Cheung, S.N.S. 1969. *The theory of share tenancy*. Chicago, USA: University of Chicago Press.

Chunrong Al, Arcand, J-L., Ethier, F. 1996. *Moral hazard and Marshallian inefficiency: Evidence from Tunisia*. Cahier 0896. University of Montreal, Center for Economic Development Research.

Eswaran, M., Kotwal, A. 1985. A theory of contractual structure in agriculture. *American Economic Review* 75(3): 352-367.

Feder, G. 1988. Land Policies and Farm Productivity in Thailand. Baltimore, Maryland: Johns Hopkins University Press.

Feder, G. and Feeny, D. 1993. The theory of land tenure and property rights. In: Hoff, K., A. Braverman and J.E. Stiglitz (eds.). *The economics of rural organization: Theory, practice and policy*. Washington D.C., USA: The World Bank. Pp. 241–258.

Gavian, S. and Fafchamps, M. 1996. Land tenure and allocative efficiency in Niger. *American Journal of Agricultural Economics* 78(2):460–471.

Greene, W.H. 1993. *Econometric analysis*. New York, USA: Macmillan Publishing Company.

Hagos, F., J. Pender, and N. Gebreselassie. 1999. Land degradation in the highlands of Tigray and strategies for sustainable land management. Socioeconomic and Policy Research Working Paper No. 25, International Livestock Research Institute, Ethiopia.

Holden, S., Shiferaw, B. and Pender, J. 2001. Market imperfection and land productivity in the Ethiopian highlands. *Journal of Agricultural Economics* 52(3):53-79.

Jaynes, G.D. 1982. Production and distribution in agrarian economies. *Oxford Economic Papers* 34:346-367.

Jaynes, G.D. 1984. Economic theory and land tenure. In: H.P. Binswanger and M. Rosenzweig (eds.) *Contractual arrangements, employment and wages in rural labour markets in Asia*. Yale University PressJohnson, D.G. 1950. Resource allocation under share contracts. *Journal of Political Economy* 58:111-23.

Laffont, J.-J., Matoussi, M.S. 1995. Moral hazard, financial constraints and sharecropping in El Oulja. *Review of Economic Studies* 62: 381-399.

Maddala, G.S. 1983. *Limited-dependent and qualitative variables in econometrics*. Cambridge, UK: Cambridge University Press.

Marshal, A. 1890. *Principles of Economics*. 8th edition (1st edition 1956), London: Macmillan.

Mill, J.S. 1848. *Principles of Political Economy.* Ashley edition (1926), London: Longmans.

Nkonya, E., Pender, J., Kaizzi, C., Edward, K. and Mugarura, S. 2005. Policy options for increasing crop productivity and reducing soil nutrient depletion and poverty in Uganda. EPT Discussion Paper 134. International Food Policy Research Institute, Washington, D.C.

Nkonya, E., J. Pender, P. Jagger, D. Sserunkuuma, C. Kaizzi and H. Ssali. 2004. Strategies for Sustainable Land Management and Poverty Reduction in Uganda. Research Report No. 133, International Food Policy Research Institute, Washington, D.C.

Otsuka, K. and F. Place. 2001. Land tenure and natural resource management: a comparative study of agrarian communities in Asia and Africa. Baltimore, USA: John Hopkins University Press.

Otsuka, K. and Hayami, Y. 1988. Theories of share tenancy: A critical survey. *Economic Development and Cultural Change* 37(1):31-68.

Otsuka, K., Chuma, H., and Hayami, Y. 1992. Land and labor contracts in agrarian economies: theories and facts. *Journal of Economic Literature* 30:1965-2018.

Pender, J. and Gebremedhin, B. 2006. Land Management, Crop Production and Household Income in the Highlands of Tigray, Northern Ethiopia: An Econometric Analysis. In Pender, J., Place, F. and Ehui, S. (Eds.). *Policies for Sustainable Land Management in the East African Highlands*. IFPRI, Washington, DC. (*forthcoming*).

Pender, J. and Fafchamps, M. 2001. *Land lease markets and agricultural efficiency: theory and evidence from Ethiopia*. Environment and Production Technology Department Discussion Paper No. 81. Washington D.C., USA: International Food Policy Research Institute.

Place, F. and Hazell, P. 1993. Productivity effects of indigenous land tenure systems in sub-Saharan Africa. *American Journal of Agricultural Economics* 74(3):360-373.

Platteau, J.-P. 1996. The evolutionary theory of land rights as applied to sub-Saharan Africa: A critical assessment. *Development and Change* 27: 29-96.

Rahmato, D. 1984. *Agrarian Reform in Ethiopia*. Uppsala, Sweden: Scandinavian Institute of African Studies.

Republic of Uganda. 1998. *Land Act, 1998*. Government Printer, Kampala, Uganda.

Sadoulet, E., Fukui, S., de Janvry, A. 1994. Efficient share tenancy contracts under risk: The case of two rice-growing villages in Thailand. *Journal of Development Economics* 45:225-243.

Shaban, R.A. 1987. Testing between competing models of sharecropping. *Journal of Political Economy* 95(5): 893-920.

Shetty, S. 1988. Limited liability, wealth differences and tenancy contracts in agrarian economies. *Journal of Development Economics* 29:1-22.Smith, A. 1776. *The wealth of nations*. New York, NY. Modern Library Edition 1937.

StataCorp. 2006. *Stata statistical software: version 9.0*. Texas, USA: Stata Corporation.

Stiglitz, J.E. 1974. Incentives and risk sharing in sharecropping. *Review of Economic Studies* 41: 219–255.

Tefera, B., G. Ayele, Y. Atnafe, P. Dubale, and M. Jabbar. 2000. Nature and causes of land degradation in the Oromiya Region: a review of literature. Paper prepared for the National Seminar on Policies for Sustainable Land Management in the Highlands of Ethiopia, International Livestock Research Institute, Addis Ababa, Ethiopia. May 22–23.

Table 1. Land acquisition methods in East Africa (percentage of plots)

Tenure/Plot acquisition method	Ethiopia		Kenya	Uganda
	Amhara Region	Tigray Region		
Owned				
Purchased	--	--	26.1	34.4
Allocated by community (Peasant Association)	72.4	84.0	--	--
Inherited, other permanent acquisition (e.g. exchange)	6.8	1.4	58.8	56.9
Gift	10.6	0.9	--	--
Rented				
Sharecrop	9.9	13.0	0.3	2.0
Fixed rent	0.5	0.7	14.1	--
Other temporary acquisition (e.g. borrowed, squatting)	0.4	--	0.7	6.7

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 2. Land investments by method of plot acquisition in East Africa

Type of investment	All plots	Method of plot acquisition						t-test
		Owner-cultivated				Borrowed	Rented	
		Purchased	PA-allocated	Gift	Inherited			
Ethiopia (Amhara region) (% of plots)								
Stone terrace	21.9	--	23.6	16.0	36.8	--	9.0	a,c,f
Soil bund	3.2	--	3.4	2.9	1.2	--	2.7	
Check dam	1.4	--	1.4	3.5	0.0	--	0.0	a,e
Drainage ditch	39.2	--	39.0	33.6	35.5	--	58.5	a,b,c
Grass strip	4.9	--	5.2	7.7	0.6	--	2.6	e,f
Trees	2.8	--	2.3	7.3	6.2	--	0.0	a,b
Constructed fence	16.2	--	13.6	28.8	24.7	--	23.0	a,d
Live fence	12.5	--	11.4	27.3	26.0	--	2.7	a,b,c,d,e
Irrigation	4.0	--	3.1	6.5	11.8	--	3.1	
Kenya (number/ha)								
Timber trees	158.0	193.0	--	--	172.0	--	49.3	a,c
Fruit trees	15.8	18.8	--	--	23.5	--	5.8	a,c
Coffee bushes	114.0	90.3	--	--	147.0	--	38.5	a,c
Tea bushes	438.5	306.0	--	--	581.8	--	171.8	a,c
Uganda (% of plots)								
Bench terrace	6.1	6.1	--	--	6.3	6.0	1.8	
Fanya juu terrace	0.1	0.2	--	--	0.0	0.0	0.0	
Fanya chini terrace	0.3	0.3	--	--	0.3	0	0	
Soil bunds	1.0	1.1	--	--	0.9	0.6	1.9	a
Stone wall	0.7	0.3	--	--	1.0	0	0	e
Trenches	9.5	8.8	--	--	10.5	5.7	6.5	f
Grass strips	2.5	2.7	--	--	2.5	0	3.7	d,f
Planted trees	14.3	16.9	--	--	13.3	8.6	4.6	a,c,d,e
Irrigation well	0.1	0.0	--	--	0	0	1.9	a,b,c

Paired tests for significant difference at the 10% level: [a] is rented vs. purchased/PA-allocated; [b] is for rented vs. gift/borrowed; [c] is for rented vs. inherited; [d] is purchased/PA-allocated vs. gift/borrowed; [e] is for purchased/PA-allocated vs. inherited; and [f] is for gift/borrowed vs. inherited.

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 3. Land management practices by method of plot acquisition in East Africa

Type of practice	All plots	Method of plot acquisition	t-test

		Owner-cultivated				Borrowed	Rented	
		Purchased	PA-allocated	Gift	Inherited			
Ethiopia (Amhara region) (% of plots)								
Reduced tillage	25.2	--	26.8	22.4	4.7	--	19.6	c,e,f
Contour plowing	69.3	--	67.1	87.5	91.0	--	69.4	b,c,d,e
Crop rotation	62.4	--	67.1	41.1	53.6	--	46.9	a,d
Crop residues	64.0	--	66.8	61.0	46.5	--	57.4	e
Household refuse	17.4	--	17.5	29.4	26.7	--	3.6	a,b,c,d
Manure	9.0	--	7.1	24.7	19.5	--	2.6	a,b,c,d,e
Fertilizers	34.5	--	35.1	19.0	17.6	--	59.2	a,b,c,d,e
Improved seeds	13.0	--	12.3	4.4	11.7	--	25.0	a,b,d
Kenya (% of plots)								
Mulching	16.1	16.7	--	--	18.7	--	4.8	a,c,e
Manure	66.7	70.9	--	--	72.4	--	36.7	a,c,e
Fertilizers	74.3	76.7	--	--	73.3	--	79.4	
Kenya (kg/ha)								
Manure	1377.5	1425.0	--	--	1437.5	--	962.5	a,c
Fertilizers	56.0	55.8	--	--	55.0	--	61.3	
Uganda (% of plots)								
Slash and burn	16.7	14.7	--	--	17.4	20.8	20.6	d,e
Fallow	20.9	17.9	--	--	24.1	11.7	13.1	c,d,e,f
Crop rotation	28.6	30.3	--	--	27.3	25.9	35.5	
Crop residues	17.1	18.6	--	--	16.0	15.1	24.3	e
Mulch	3.3	4.3	--	--	2.9	2.4	0.9	e
Compost	1.3	1.9	--	--	1.2	0.3	0.0	d
Household refuse	4.6	6.3	--	--	3.9	0.8	1.8	d,e,f
Manure	8.1	10.8	--	--	7.5	0.5	8.1	a,d,e,f
Inorganic fertilizer	2.1	1.9	--	--	2.3	0.5	3.6	
Pesticides	2.4	2.4	--	--	2.2	4.1	0.0	b
Herbicides	2.9	3.9	--	--	2.4	1.4	7.2	b,c,e

Paired tests for significant difference at the 10% level: [a] is rented vs. purchased/PA-allocated; [b] is for rented vs. gift/borrowed; [c] is for rented vs. inherited; [d] is purchased/PA-allocated vs. gift/borrowed; [e] is for purchased/PA-allocated vs. inherited; and [f] is for gift/borrowed vs. inherited.

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 4. Land productivity and quality by method of plot acquisition in East Africa

Type of practice	All plots	Method of plot acquisition						t-test
		Owner-cultivated				Borrowed	Rented	
		Purchased	PA-allocated	Gift	Inherited			
Ethiopia (Amhara region)								
Value of crop yield (US$/ha)[1]	332.8	--	294.0	508.2	673.2	--	282.0	
Perceived erosion problem (% of plots)								
None	53.9	--	52.7	60.3	64.8	--	52.6	
Moderate	37.9	--	38.3	32.3	26.0	--	44.0	
Severe	8.2	--	9.0	7.4	9.2	--	3.4	
Kenya								
Maize yield (kg/ha)	694	801	--	--	640	--	698	a,e
Soil fertility index	0.004	0.002	--	--	0.005	--	-0.003	a,c,e
Uganda								

Value of crop yield (US$/ha)[1]	141.9	155.2	--	--	140.4	108.8	77.7	d
Nitrogen (kg/ha)		4353.0	--	--	3697.0	3663.0	4038.0	d,e
Phosphorus (kg/ha)		2762.0	--	--	2437.0	1904.0	2389.0	d,e, f
Potassium (kg/ha)		8223.0	--	--	6788.0	6591.0	6528.0	d,e
Nitrogen (kg/ha/yr)		-84.9	--	--	–77.3	–65.5	–49.8	d
Phosphorus (kg/ha/yr)		-14.0	--	--	–16.7	–10.7	–10.7	f
Potassium (kg/ha/yr)		-90.8	--	--	–85.4	–53.5	–55.1	d, f

Notes:

Sample means are adjusted for stratification, weighting and clustering of sample.

[1] At the time of the surveys, US$ 1≈8.50 Ethiopian Birr, 1800 Ugandan Shillings, 75 Kenyan Shillings.

Paired tests for significant difference at the 10% level: [a] is rented vs. purchased/PA-allocated; [b] is for rented vs. gift/borrowed; [c] is for rented vs. inherited; [d] is purchased/PA-allocated vs. gift/borrowed; [e] is for purchased/PA-allocated vs. inherited; and [f] is for gift/borrowed vs. inherited.

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 5. Regression results: Impact of land markets on land investments in East Africa

Dependent/Explanatory variable (estimation method)	Ethiopia (Tigray Region)[1]	Kenya[2]
Stone terraces (probit)		
Purchased		
PA-allocated	–0.056 *	
Gift	–0.073	
Inherited	0.032	
Borrowed		
Rented		
Timber trees per acre (tobit)		
Purchased		20.04 *
PA-allocated		
Gift		
Inherited		
Borrowed		
Rented		-32.08 **
Fruit trees per acre (tobit)		
Purchased		.789
PA-allocated		
Gift		
Inherited		
Borrowed		
Rented		-4.52 ***
Coffee bushes per acre (tobit)		
Purchased		-10.98 *
PA-allocated		
Gift		
Inherited		
Borrowed		
Rented		-29.96 ***
Tea bushes per acre (tobit)		
Purchased		4.64
PA-allocated		
Gift		
Inherited		
Borrowed		
Rented		-125.72 ***

[1] Omitted category for the explanatory variable is rented; [2] Omitted category for the explanatory variable is purchased; [3] Omitted category for the explanatory variable is inherited. *, ** and *** mean coefficient is significant at 10%, 5% and 1%, respectively.
Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 6. Regression results: Impact of land markets on land management practices in East Africa

Dependent/Explanatory variable (estimation method)	Ethiopia[1]		Kenya[2]	Uganda[3]
	Amhara Region	Tigray Region		
Fallow (probit)				
Purchased				
PA-allocated				
Gift				
Inherited				-0.045
Borrowed				-1.57 ***
Rented				-0.346
Slash and burn (probit)				
Purchased				
PA-allocated		0.004		
Gift		0.178 *		
Inherited		0.081		0.416
Borrowed				1.388 ***
Rented				-2.153 ***
Reduced tillage (probit)				
Purchased				
PA-allocated	–0.257	–0.026		
Gift	–0.565	–0.028		
Inherited	–1.788 ***	–0.043		
Borrowed				
Rented				
Contour plowing (probit)				
Purchased				
PA-allocated	–0.159	–0.060 ***		
Gift	0.435	+ c		
Inherited	0.109	0.041		
Borrowed				
Rented				
Crop rotation (probit)				
Purchased				
PA-allocated	0.604 **			
Gift	0.128			
Inherited	0.200			0.012
Borrowed				-1.153 ***
Rented				0.356
Crop residues (probit)				
Purchased				
PA-allocated	0.100			
Gift	0.582 *			
Inherited	–0.520			-0.012
Borrowed				-0.365
Rented				0.533
Mulch (probit)				
Purchased			0.144	
PA-allocated				
Gift				

Inherited				-0.333
Borrowed				0.734
Rented			-1.280 ***	0.238
Household refuse (probit)				
Purchased				
PA-allocated	0.050			
Gift	–0.744			
Inherited	–0.169			-0.489
Borrowed				-6.789 ***
Rented				-1.368
Manure (probit)				
Purchased			0.156	
PA-allocated	–0.910 **	0.018		
Gift	–0.490	0.365 **		
Inherited	–0.901 *	0.132 *		0.430
Borrowed				-6.446 ***
Rented			-1.414 ***	-5.488 ***
Use of fertilizers (probit)				
Purchased				
PA-allocated	0.515	0.020	-0.001	
Gift	–0.036	–0.162		
Inherited	–0.145	0.289 *		0.078
Borrowed				-5.638 **
Rented			-0.152	-1.707 *
Fertilizers (kg/acre) (tobit)				
Purchased			3.275	
PA-allocated				
Gift				
Inherited				
Borrowed				
Rented			-12.894 ***	
Use of improved seeds (probit)				
Purchased				
PA-allocated	–0.871 **	0.001		
Gift	–1.533 ***	– [c]		
Inherited	–1.064 *	0.013		
Borrowed				
Rented				
Use of pesticides (probit)				
Purchased				
PA-allocated				
Gift				
Inherited				-0.123
Borrowed				-1.550 ***
Rented				-0.488

[1] Omitted category for the explanatory variable is rented; [2] Omitted category for the explanatory variable is purchased; [3] Omitted category for the explanatory variable is inherited. *, ** and *** mean coefficient is significant at 10%, 5% and 1%, respectively.

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

Table 7. Regression results: Impact of land markets on land productivity and land quality in East Africa

Dependent/Explanatory variable (estimation method)	Ethiopia[1]		Kenya[2]	Uganda[3]
	Amhara Region	Tigray Region		
Crop yield[4] (OLS)				

Purchased			21.570	
PA-allocated	–0.288 **	0.016		
Gift	–0.505 ***	–0.046		
Inherited	–0.360 **	0.368		1.660 *
Borrowed				3.610
Rented			-71.120	-6.45 **
Soil fertility level (OLS)				
Purchased			0.001	
PA-allocated				
Gift				
Inherited				
Borrowed				
Rented			-0.003 ***	
Soil nutrient balances (OLS)				
Nitrogen (kg/ha)				
Purchased				
PA-allocated				
Gift				
Inherited				-5.020
Borrowed				12.820
Rented				20.410 **
Phosphorus (kg/ha)				
Purchased				
PA-allocated				
Gift				
Inherited				-2.330 **
Borrowed				0.020
Rented				-1.790
Potassium (kg/ha)				
Purchased				
PA-allocated				
Gift				
Inherited				-14.290 *
Borrowed				12.920
Rented				-1.980

[1] Omitted category for the explanatory variable is rented; [2] Omitted category for the explanatory variable is purchased; [3] Omitted category for the explanatory variable is inherited. *, ** and *** mean coefficient is significant at 10%, 5% and 1%, respectively.

[4] This is natural logarithm of the value of total crop output per ha in Ethiopia and Uganda; and cereal yield (kg/ha) in Kenya.

Sources of data: Community and household surveys in Ethiopia, Kenya and Uganda (see text for details).

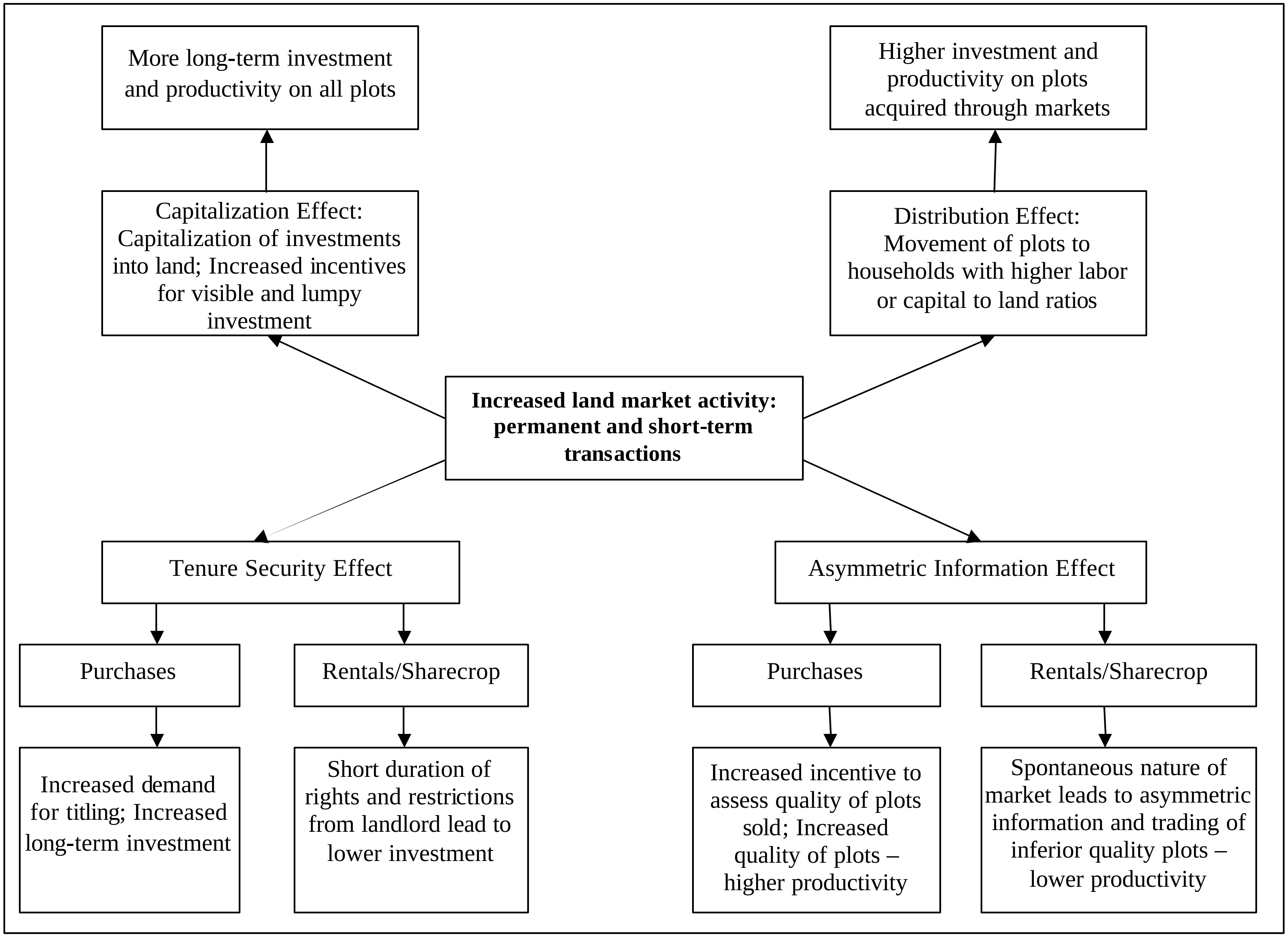

Figure 1. Conceptual model of land markets, investment and efficiency and inventory of possible effects.