Land Access, Land Rental and Food Security: Evidence from Kenya

Rie Muraoka[1], Songqing Jin[1], and Thomas S. Jayne[1]
1 Department of Agricultural, Food, and Resource Economics, Michigan State University
Justin S. Morrill Hall of Agriculture,
446 West Circle Dr., Rm 202
East Lansing, MI 48824
Corresponding author e-mail address: muraokar@msu.edu

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Abstract: Constrained access to land is increasingly recognized as a problem impeding rural household welfare in densely populated areas of Africa. This study utilizes household and plot level data from rural Kenya to explore the linkage between land access and food security. We find that a 10% increase in operated land size would increase total cereal consumption and home produced food consumption by 0.8% and 2.0%, respectively. We also find that land rental is the dominant mechanism that poor rural farmers use to access additional land for cultivation. However, the levels of long-term land investment (measured by applications of organic manure) and land productivity are significantly lower for rented plots than for own plots even after household fixed-effect and plot level observed characteristics are controlled for. Furthermore, land rental markets do not allow farmers to fully adjust their operated land size to their optimal level. These findings point to the existence of problems with land rental markets that impede their ability to fully contribute to national food security and poverty reduction goals.

Key words: Land access, Land rental, Food security, Kenya

JEL Classification Code: O12, Q15

1. Introduction

The combination of rising global food prices, rapid population growth, urbanization and increasing demands on the agricultural land base has heightened the world's awareness of its major global food security challenges. Food security was elevated to the top priority of 2012's G8 and G20 Summits (Mowlds, Nicol, and Cleirigh. 2012). Food security has also been placed at the top of governments' policy agenda in many countries. For example, the right to access to sufficient food was embedded in the Section 26 and 27 of the South African Constitutional Law of 1996 (Chirwa 2009).

Despite the considerable efforts by national governments and the international community to reduce food insecurity and improve nutrition over the years, food insecurity and malnutrition still persist worldwide. In 2005, 1.4 billion people lived on less than $1.25 a day, the international poverty line (Chen and Ravallion 2008). And according to FAO (2010), 925 million people suffered from food insecurity in 2010.[1] While the largest number of under-nourished people is in Asia and Pacific (578 million), sub-Saharan Africa has the highest incidence of under-nourishment where 30% of its total population (roughly 239 million people) suffers from

[1] According to FAO, food security is defined as having physical and economic access to sufficient safe and nutritious food for people to meet their dietary needs and food preferences for a healthy and active life (Pinstrup-Anderson 2009).

chronic hunger, compared to 16% in Asia and Pacific. Furthermore, Sub-Saharan Africa is the only region where the number of malnourished children has increased in the past 10 years (Ezzati et al., 2002). The number of underweight children is very large and malnutrition is the major cause of child death in Sub-Saharan Africa (UN SCN, 2004; Black et al., 2003). The situation of African women and children is particularly serious, as well as the situation among female teenagers who receive less food than their male counterparts in the same households (Albert 2012).

These problems of food insecurity are likely to be exacerbated in densely populated and poverty-stricken areas of Africa where the arable land frontier has been exhausted, and where farm sizes are small and declining due to increased population pressures and sluggish structural transformation processes (Jayne, Headey and Chamberlin 2014). This situation characterizes many areas of rural Kenya (Muyanga and Jayne 2014). In such settings, many land constrained rural households rely on land markets as an important means for increasing their access to land (Holden, Otsuka, and Place, 2009; Yamano et al., 2009; Jin and Jayne 2013). However, the potential of land rental markets to support poor households' ability to improve their access to food is poorly understood. This study is motivated by the need to more accurately understand the potential of land rental markets to improve rural households' access to land and their food security status.

While there are many studies of land access with focus on the determinants of land rental market participation in numerous countries, the relationship between land access and food security has not been well explored in the literature. This study relies on the combination of plot level data and panel household data covering more than 700 rural Kenya households from 2003 and 2006 to explore the relationship between land access and food security. Specifically, our analysis aims to achieve the following three objectives: (1) to assess and quantify the relationship between operated land size, household income and food consumption (a proxy for food security); (2) to use the plot level data from owner-cum-tenant households to compare the productivity and investment differences between rented plots with own plots; and (3) to investigate the extent to which households are able to access the optimal amount of operated land size through land rental markets.

Our descriptive and econometric analyses yield several important findings. First, we find a strong positive relationship between land access and food security. A 10% increase in operational land size increases per capita total consumption and per capita home- produced food consumption by 0.8% and 2%, respectively. Second, we find that land rental is the single most important mechanism that land-poor households use to access additional land for cultivation. However, our analysis also highlights considerable concerns with the performance of rental markets in Kenya. We find that productivity of rented land is significantly lower than owned plots and farmers tend to apply less organic manure to rented land than to own land. Furthermore, land rental markets do not able to allow farmers to achieve the optimal amount of operated land size, as suggested by the fact that tenants rented in approximately 70% of the amount of land they would like to rent in and landlords rented out less than half the amount of land they desired to rent out.

The organization of this paper is as follows. Section 2 reviews the literature on the performance of land rental markets in developing areas and in Kenya. Section 3 presents our estimation strategy. The data used in this research is discussed in Section 4, followed by descriptive statistics. Section 5 discusses estimation results. Finally, Section 6 summarizes the major findings and draws policy implications.

2. Background

Land Rental Markets and Productivity

If all markets function perfectly and farming technology exhibits constant return to scale, the initial endowment of land would not matter in terms of production efficiency because land-labor ratio would be equalized across all households through market equilibration (Feder 1985; Bardhan and Udry 1999). Even if there is no land market, efficient outcomes could be achieved as long as other factor markets function perfectly. However, there is ample evidence pointing toward imperfection of rural factor markets in developing areas (De Janvry et al. 1991, Binswanger and Rosenzweig 1986). One of the reasons why factor markets do not function well in developing areas is the presence of high monitoring costs of hired labor, which makes farmers prefer to use family labor rather than hired labor on their farms. When labor market and other factor markets do not function well, households with surplus labor (or other excess assets relative to land) can benefit from acquiring additional land. Land sales and rental land markets are therefore potentially important means for enabling land-poor households to improve agricultural production efficiency when labor market fails to function perfectly (Deininger 2003).

There are several reasons why land rental markets may achieve these gains for poor rural households more effectively than land sales market. First, land purchases require a much greater up-front payment than renting land. Hence, land rental markets are more accessible for farmers, especially poor farmers facing credits constraints (Hayami and Otsuka 1993). Second, rental payment sometime can be paid after harvest, which makes renting land by poor farmers possible. Third, rental markets are more flexible in terms of duration. Finally, rental markets are less risky than sales markets. These considerations partially explain why land sales markets are generally much less active than rental markets in Africa (Holden et al. 2009). For the same reasons, rental markets are widely promoted by the Government of Kenya (Government of Kenya, 2007, paras 162 and 163) and many other developing countries (Deininger 2003).

Empirical Evidence

For the past decade or so, land rental markets have been actively studied although there is considerably more evidence to draw upon from South and East Asia than from Africa (Holden et al. 2009). A few highly consistent and important findings have emerged from the large number of studies covering a large number of countries. First, with few exceptions, land rental markets have been found to be a major way -- if not the major way -- for enabling land-poor households to access land (Jin and Deininger 2009 and Kimura et al. 2011 on China, Deininger and Jin 2008 on Vietnam; Deininger, Jin and Nagarajan 2008 on India, Pender and Fafchamp 2001, Deininger, Ali, Alemu 2008, and Gebregziabher and Holden 2011 on Ethiopia, Migot-Adholla et al. 1994 on Ghana; Holden et al. 2006 on Malawi; Yamano et al. 2009, and Jin and Jayne 2013 on Kenya; Andre and Platteau 1998 on Rwanda; Deininger and Mpuga 2009 on Uganda). Second, land rental markets are generally found to enhance farm productivity (Jin and Deininger 2009; Deininger and Jin 2008, Deininger, Jin and Nagarajan 2007; Deininger and Mpuga 2009; Jin and Jayne 2013). Third, many studies identified the presence of significant transaction costs associated with participating in land rental markets, and therefore they typically do not allow farmers to fully adjust their operated land size to the optimal level (Skoufias 1995; Deininger, Ali and Alemu 2008; Yamano et al. 2009; Kimura et al. 2011).

Land Rental Markets in Kenya

Unlike many countries in Africa, Holden et al. (2009) point out that both land sales and rental markets are allowed in Kenya. Wangila (1999) showed that less than 10% households rented land in several districts in Kenya. However, Yamano et al. (2009) find that 17.9% households rented land in 15 districts in Kenya in 2004. Jin and Jayne (2013) show that the proportion of households renting in land increased from 18% to 20% from 1997 to 2007 in 24 districts in Kenya. The data used in this study (which is a panel of the 2004 data used by Yamano et al. (2009) in their analysis) showed that 22.9% of households rented in land in 2007, suggesting that the proportion of households renting in land increased by 5% in 3 years.

The Government of Kenya's National Land Policy (2007) states that "the potential to provide access to land to those who are productive but own little or no land" and also says that government should "encourage the development of land rental markets while protecting the rights of smallholders by providing better information about transactions to enhance their bargaining power" (Government of Kenya, 2007, paras 162 and 163). Given the fact that the Kenyan government takes a positive stance to promote land rental markets and that a significant proportion of Kenya farmers are participating in land rental markets, it is important to understand how well the current land rental markets are functioning in terms of allowing farmers to access additional land for agriculture and the ensuing effects on household income and food security.

3. Estimation Strategy

To estimate the effect of operated land size on crop production, income, and consumption based on household level panel data, we specify the following reduced form

$$Y_{it} = \alpha_i + \beta Land_{it} + \gamma X_{it} + \varepsilon_{it} \qquad (1)$$

where Y_{it} is one of eight output variables of interest (total food consumption, total cereal consumption, total non-cereal consumption, amounts of purchased food, amount of home produced food, gross value of crop production, net value of crop production, net household income) of household i in time t. $Land_{it}$ is the operated land size. X_{it} is a vector of households control variables including household size, total value of assets, household head's age, dummy for female head, and dummy for head with primary education. α_i is a household fixed effect that captures household farmer management ability, household risk preferences, unmeasured household wealth, and so on, that are correlated with the operated land size and production/food consumption. The existence of α_i would cause OLS estimates to be biased and inconsistent. To purge α_i, we take advantage of household panel data and estimate equation (1) using a panel fixed effect estimation approach (or first-differenced estimation approach).[2] This is equivalent to estimating the following equation:

$$Y_{it} - \overline{Y_i} = \beta(Land_{it} - \overline{Land_i}) + \gamma(X_{it} - \overline{X_i}) + (\varepsilon_{it} - \overline{\varepsilon_i}) \quad (2)$$

where $\overline{Y_i}$, $\overline{Land_i}$, and $\overline{X_i}$ are the mean values over the two time periods for the corresponding variable. In equation (2), household fixed effect (α_i) has been dropped. β is the key parameter of interest to be estimated. However, even after α_i is purged, reverse causality issues could still remain, in which a change in operated land size caused by time-specific shock to a household could bring a change in income over time. To obtain consistent estimates, we also estimate equation (1) by an instrumental variable (IV) approach. Operated land area is instrumented by inherited land area because land inheritance is likely to be highly correlated with the operated land size but unlikely to affect the outcome variables of interest directly except through its effect on operated land size.

To examine the yield and input use intensity differences between own and rented plots based on the plot level data in 2007,[3] we use the following reduced form:

$$Yield_{ij} \text{ or } Input_{ij} = c_i + \delta Rent_{ij} + \rho Z_{ij} + \mu_{ij} \quad (3)$$

where $Yield_{ij}$ is either the gross revenue per acre of land or the net revenue per acre of land of plot j belonging to household i, $Input_{ij}$ is the input use intensity variable (either the value of organic manure or the value of chemical fertilizer per acre of land), $Rent_{ij}$ is a dummy variable for land ownership (equal to 1 for rented plots, and 0 for owned plots), Z_{ij} is a vector of plot characteristics including steepness, irrigation condition, and distance to homestead, and c_i is a household level fixed effect capturing unobserved household level factors that simultaneously affecting farmers productivity/input use intensity and household's tendency to rent land (e.g., farming skills, access to technology, and wealth). We note that OLS estimation of δ will be biased because c_i is correlated with $Rent_{it}$ (or $E(c_i|Rent_{it}=1)\neq 0$). To deal with this, we take

[2] Given that the panel data covers two time periods, the fixed effect and first-differenced estimation approaches give the same estimation results.
[3] We only use 2007 data because (1) 2004 data does not have the plot characteristics variables, and (2) the 2004 and 2007 plot level data are not matched and hence cannot be considered as panel at the plot level.

advantage of the fact that all the households who rented in land also happen to own land, so we can use the owner-cum-tenants subsample to perform within-household estimation to eliminate c_i, an approach that is widely adopted in plot-level analysis (Shaban 1987; Jacoby and Mansuri 2009). The second source of bias is that $E(u_{ij}|Rent_{ij}=1) \neq 0$); in fact, it is argued in the literature that the rented plots are generally of lower quality than owned ones. While it is not easy to find an instrumental variable that is correlated with participation in renting but uncorrelated with the output variable, the best we can do is to include all the main plot-level variables collected in the survey (e.g., irrigation, distance, and steep) to mitigate the problem. Without being able to fully control for the unobserved factors, our productivity estimate can be regarded as an upper bound (i.e., if the bias could be eliminated the coefficient estimate would be lower). Finally, to account for the fact that a large number of households that do not apply organic or chemical fertilizer, we adopt the semi-parametric trimmed LAD approach (Honore 1992) to estimate a fixed-effect tobit model for the input use regressions.

Finally, we adopt a switching regression to estimate the extent to which farmers are able to adjust their operated land size to the optimal level through participating in land rental markets. Following Skoufias (1995) and Deininger, Ali and Alemu (2008), the switching regression with three rental participation regimes can be specified as the following:

$$y_i = \begin{cases} -\alpha_{out} + \beta_{out}L_i + \gamma_{out}Z_i + \varepsilon_i & if \quad \varepsilon_i < \alpha_{out} - \beta_{out}L_i - \gamma_{out}Z_i \\ 0 & \text{if } \alpha_{out} - \beta_{out}L_i - \gamma_{out}Z_i \leq \varepsilon_i \leq \alpha_{in} - \beta_{in}L_i - \gamma_{in}Z_i \\ -\alpha_{in} + \beta_{in}L_i + \gamma_{in}Z_i + \varepsilon_i & if \quad \varepsilon_i > \alpha_{in} - \beta_{in}L_i - \gamma_{in}Z_i \end{cases} \quad (4)$$

where y_i is the amount of net area leased-in; subscript *out* and *in* denote the rental market participation status of household *i* with negative net area leased-in and positive area leased-in, respectively; L_i is household's land endowment (the key variable of interest); Z_i is a vector of household characteristics excluding land endowment (e.g., ownership of bullocks, labor endowment, value of total assets, household head age, number of dependents); α_{in} and α_{out} are the constant terms and β_{in} and β_{out} are the coefficients on land endowment, γ_{in} and γ_{out} are the vectors of other coefficients to be estimated. The coefficients of land endowment (β_{in} and β_{out}) are the key coefficients of interest. The magnitude of these coefficients allows us to test whether and to what extent land rental allows households to optimally adjust operated land size. Specifically, a fully functioning rental market without transaction costs would imply β_{in} equals to -1 and β_{out} equals to 1. So to test whether $\beta_{in} = -1$ (or β_{out} =1) is to test whether the rental market allows tenants (landlords) to rent-in (rent-out) the amount of land they desire to rent. A detailed description on the derivation of the hypothesis can be found in Skoufia (1995). Equation (4) is estimated by maximum likelihood estimation.

4. Data Source and Descriptive Evidence

The Data

The household- and plot-level data used in our analysis are from a survey called RePEAT.[4] The data is jointly collected by GRIPS, the World Agroforestry Center, and Tegemeo Institute of Agricultural Policy and Development. The RePEAT survey is based on the survey conducted by the Smallholder Diary Project (SDP)[5] that collected data from more than 3,300 households randomly from communities in the Central, Rift Valley, Nyanza, and Western, and Eastern provinces in Kenya (Yamano et al. 2011). In 2004, the RePEAT survey randomly selected 99 sub-locations and 10 households from each of the selected sub-locations, which results in a sample of 934 households. The second round of the RePEAT survey was conducted in 2007. Due to budget constraints, 23 sub-locations in Eastern province were dropped in 2007. The survey targeted 777 households but interviewed 725 households in 76 sub-locations (the attrition rate is 6.7%). Therefore, the panel sample has 725 households. Our analysis uses 712 panel households because 13 households do not have data for one or more key variables needed for our analyses. The RePEAT survey includes detailed household information on agricultural activities (cropping, raising livestock and growing trees), land (land tenure, land acquisition, plot characteristics), demographics, education, assets, salary income, expenditure, consumption and so on. Household income is computed as the sum of net crop revenue, net livestock revenue, wage income, net revenue from self-owned business and non-labor income such as remittances and pensions. The food consumption in household including total food consumption, cereal consumption, non-cereal consumption (meat, vegetables, fruits, dairy products, fish, etc.). Home-produced and

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[4] R*e*PEAT is Research on Poverty, Environment, and Agricultural technology and survey project in Ethiopia, Kenya, and Uganda founded by GRIPS and Foundation for Advanced Studies on International Development (FASID).

[5] The SDP is a project jointly by the Ministry of Livestock Development and Fisheries, the Kenya Agricultural

purchased food consumption are used to measure food security in a household.

Mode of Land Transfer

Table 1 shows access to land by different channels in 2003 and 2006. While only 13 operated plots in 2003 and 6 operated plots in 2006 were purchased, the number of operated plots rented was 197 in 2003 and 222 in 2006, respectively. In addition, 8 operated plots in 2003 and 7 operated plots in 2006 were inherited or gained through other channels. This indicates that land rental markets were a much more important source of land acquisition than any other channels. The average size of purchased plots during the two periods was 1.14 acre, slightly bigger than the average of rented plots (0.89 acre). Overall, land rental is the most important way by which farmers access additional land for cultivation on a year-to-year basis.

Land Access and Household Characteristics

Table 2 describes household characteristics in 2007 for four groups according to their land access status: those who rented-in land, those who rented-out land, those who were autarkic and those who purchased land between 2004 and 2006. The simple tabulation reveals a number of interesting insights with regard to land access. Households who purchased land during 2004 and 2006 were socially and economically the strongest households. They have the largest number of working age household members and the highest value of livestock. The percentage of households with heads having completed primary education and who owned bullocks are also the highest. And most of all, the average total value of assets of this group is three times more than any other group. And as noted before, the number of households purchasing land is very small (only 15 out of 713 households). Hence, access to land through land purchase is only used by very few wealthy households.

On the other hand, household who access land through land rental markets have a total value of assets that is not significantly different from the overall sample average. Land rental markets also tend to transfer land from households with higher land-labor ratio (on average, 1.15 acre per capita) to those with smaller land-labor ratio (0.5 acre per capita). Land rental markets also tend to transfer land from female-headed households to male-headed households and also from households without a bullock to those with at least one bullock. The share of heads having

Research Institute, and the International Livestock Research Institute (ILRI).

completed primary educations is higher for those renting in land than those renting out land. This may suggest that, for individuals with at least a primary education, the marginal return to labor may exceed that in non-farm sectors where casual labor and low-skill jobs predominate. Farming may also be a source of income diversification for educated Kenyans. We also notice that households renting out land have relatively high land-labor ratios. Households renting out land also tend to be slightly wealthier in terms of their total value of assets.

Land Access, Production, Income and Food Security

Table 3 and 4 presents descriptive findings on the relationship between land access measured as operational farm size and households' agriculture income, and food security by dividing households into 4 quartiles based on land size in 2007. Table 3 shows a clear and consistent positive relationship between operated land size and total production per capita, net crop revenue per capita and household income per capita. Total production and net crop revenue for the top quartile of households are more than double those of households in the bottom quartile. These differences in farm production are consistent with differences in total income by farm size, even though a significant share of household income is derived from non-farm activities. Household income per capita for households at the top land size quartile is almost 80% higher than that among households at the bottom quartile.

The data also show a robust and positive relationship between land access and food consumption. As Table 4 shows, households who belong to the highest operated land quartile consumed the highest value of total food, cereal, non-cereal and self-produced food. Among all the food categories, the largest source of the difference is food consumption from own production. For example, the food consumption from own production for the top quartile household is 84% higher than those at the bottom quantile. On the other hand, there is very little variation in the value of purchased food across quantiles. The results suggest that the main contribution of land access to rural households' food security status is through their own farm production.

Land Tenure Status, Revenue per Hectare, and Input Use Intensity

Table 5 compares the revenues and input use intensity between rented plots and owned plots using plot level data in 2007.[6] The data indicate marked differences in gross ad net revenue per hectare cultivated and the value of organic fertilizer use between the two types of plots. Revenue per acre on rented plots is significantly lower than owned plots by some 14% for gross and 42% for net revenue (Ksh 13,719 vs Ksh 15,883 and Ksh 7,388 vs. Ksh 12,658). Data on organic manure per acre also pointed toward remarkable correlation between tenure type and incentives to apply organic manure. We find that the organic manure use in the rented plots is only less than half the level of that in own plots (Ksh 774 vs. Ksh 281). This is not the case for the chemical fertilizer. In fact, the value of chemical fertilizer per acre is slightly higher in rented plots than owned plots (Ksh 1,258 vs. Ksh 1,214). As organic manure is widely considered as a long-term investment in the literature, it is not surprising that farmers are not incentivized to make the investment when they only use the plots temporarily and cannot fully recoup the investment.

While the simple tabulations presented in the descriptive analysis provide preliminary insights about the relationship between operated land size and household production and food security, and differences in input use intensity and net revenues per unit land between rented and owned plots, we will need to rely on rigorous multivariate econometrics analyses to draw inferences about the causal relationships between land access and food security, etc.

5. Econometric Results

This section presents the main econometric results based on equations (1), (3), and (4). We find the econometrics results are mostly consistent with the descriptive results presented in the previous section. For example, the econometric results confirm the positive and significant relationship between land access, the value of crop output per unit land, and food security. The results also confirm that land rental markets help land-poor households to access additional land from households with relatively high land-labor ratios. And the productivity and the value of organic manure per acre are significantly lower for the rented plots than for the owned plots after the household fixed effect and important plot level characteristics are controlled for. In addition, the switching regression allows us to gain additional insights about the extent to which households are able to adjust their operated land size relative to the optimal size.

[6] The results are similar to the 2004 sample. We only report the 2007 data to make it consistent with the econometrics analysis. Due to the fact several of the key plot level characteristics were not collected in the 2004 survey, we excluded 2004 from the regression analysis.

Land Access and Food Security

Table 6 reports the effect of land access on food consumption that was estimated by panel fixed-effect estimation using a panel household data set from 2004 and 2007. The model is in log-log specification, so the coefficients are elasticities. The results are highly consistent with the descriptive findings as the coefficient on operated land size is positive and significant at the 5% level in the case of household total food consumption, total cereal consumption, non-cereal consumption and self-produced food consumption. The magnitudes of the coefficients on operated land size suggest that a 10% increase in operated land size would increase household total food consumption per capita, cereal consumption per capita, non-cereal consumption and self-produced food consumption by 1.1%, 1.8%, 0.8% and 1.9%, respectively. As found earlier from the descriptive analysis, the coefficient on operated land size in the purchased food regression is not only the smallest among all categories of consumption; it is also not statistically significant. The negative coefficients on household size for all the consumption categories are consistent with the literature that food consumption is associated with considerable economies of scale. Total value of assets is important for total food consumption, non-cereal consumption and purchased consumption, but not for cereal consumption and own produced consumption, suggesting that wealthier households have more diversified and nutritious dietary patterns.

Table 7 reports the estimated effects of land access on food consumption using the IV method. While the coefficients on operated land size are in general less consistent than those based on the fixed-effect results, the coefficient on operated land size remains positive and statistically significant in the case of household cereal consumption and the household self-produced food consumption (the two types of consumption on which the operated land size is most likely to have influence). The magnitude of coefficients on operated land size suggests that a 10% increase in operated land size would increase household total food consumption per capita and home produced food consumption by 0.8% and 2.0%, respectively, again pointing toward the fact that land access helps improve food security through food availability.

Land Access, Production, and Income

Table 8 shows the impacts of land access on agricultural production and household income using household level panel data in 2004 and 2007. As in the case of food consumption, the econometrics results on the impact of operated land size on production and income are generally consistent with the descriptive evidence. Like in Table 7, we report results based on both the fixed effect estimation (columns 1,3 and 5) and on IV estimation (columns 2, 4, 6). Results from Fixed-Effect model estimation indicate that doubling the operated land size would increase gross and net crop revenue per capita by more than 50% and total household income per capita by 17%. Except for the case of total household income where the coefficient has the right sign but insignificant, the IV results also suggest significant and large effect of land access on agricultural production and agricultural income; doubling the operated land size would lead to 31% and 24% increase in total harvest per ha and net agricultural income per ha by 31% and 24%, respectively. Results on other variables are also interesting and mostly as expected. For example, both female headed households and households with older heads have significantly lower production and income. Total value of assets, which may include farm assets, has positive and significant impact on production and income in all IV estimations. Value of livestock is positively related to household production and income. This is not surprising as high value of livestock may help household buy more inputs and also provide more organic manure for crop production.

Land Rental and Productivity, and Input use Intensity

Table 9 reports the estimation results on the impact of land rental on gross and net agriculture revenue using plot level data in 2007. The base models include only the land area and dummy for rented plot (columns 1 and 3). The base model is expanded by including irrigation dummy, steepness dummy, and distance from home to the plot (columns 2 and 4).

The base model indicates that the productivity is 49% (in the case of gross revenue per acre) or 44% (in the case of net revenue per acre) for the rented plots than for the owned plots. As expected, adding the plot characteristics (irrigation, distance to home and steep) reduces the coefficient quite substantially.

After adding the plot characteristics, the productivity is lower for the rented plots than for the owned plots by 21% for the gross revenue.

Two key explanations for the lower productivity of rented plots compared to owned plots. One explanation is related to tenure security. Because rental is informal and more temporary, tenants do not have the incentive to invest on the rented land as compared to own land. The other explanation is that the plot quality including soil fertility may be lower for rented plot than for owned plots. The lower productivity on rented plots in our case is likely to be the outcome of the two combined effects.

Table 10 reports the fixed-effect tobit results on input use intensity (i.e., the value of organic manure and chemical fertilizer use per acre). Consistent with the descriptive evidence, the coefficient on rented plots is negative and statistically significant for organic manure but insignificant for chemical fertilizer. The lower level of organic manure on the rented plots is consistent with the argument that farmers have less incentive to make investment including organic manure on plots that are less secure. Unlikely in the case of productivity, the unobserved lower quality of rented plots relative to owned plots cannot explain the lower level of organic manure used on the rented plots than on owned plots. If the unobserved land quality is taken into account in the investment decision, then our results on rented plots are the lower bound estimate of disincentive effect of tenure insecurity.

The negative and significant coefficient on the dummy variable for rented plots in the organic manure regression (columns 1 and 2, Table 10) increase our confidence that the tenure insecurity is likely to have contributed to the lower productivity of rented plots as compared to the owned plots.

Determinants of Net Land Leasing In and Out

Table 11 reports the results for the switching regression of land rental (equation 4) using data from 2007. The base model (column 1) only includes all the relevant household characteristics and the augmented model (column 2) includes both the household characteristics and the community dummies.

First, we look at the lease-in side. If the rental land market functions perfectly, the coefficients of land endowment will be -1 (i.e., $\beta_{in} = -1$ in equation (5)) in columns (1) and (2). However, the coefficients of area owned in renting-in equation are -0.734 for the base model and -0.665 for the augmented model and both coefficients are significantly different from -1 at the 5% significant level. This indicates that land rental markets don't perform perfectly. Tenants who rented in land only rented in 67% to 73% of the amount of land they would like to rent in.

Next, we turn to the lease-out side. If the land rental market functions perfectly, the coefficient of land endowment would be 1 (i.e., $\beta_{out} = 1$ in equation (5)) in columns (2) and (3). However, the coefficients of area owned in lease-out equation are 0.437 for the base model and 0.483 for the augmented model and both coefficients are statistically different from 1 at 1% level of significance. In other words, households who rented out land were only able to rent out 44% to 48% of the amount of land they would want to rent out.

The coefficients on other variables provide further insights on the performance of land rental markets in Kenya. First of all, land rental does allow land-poor households to rent in land from land-rich households as indicated by the negative coefficient of land endowment in the rent-in and positive coefficient of land endowment in the rent-out equations. Similarly, rental markets tend to transfer land from households with less labor to households with more labor as the coefficient of numbers 14-65 is significant and negative in the rent-out equation and positive and significant (though only in the expanded model) in the rent-in equation. Consistent with the literature, having a bullocks or not is very significant in household's renting decisions as land rental tend to transfer land from households without a bullock to households with at least one bullock.

6. Conclusions and Policy Implication

While African governments have devoted enormous efforts to promoting food security, the prevalence of malnutrition and food insecurity is still quite high. Raising farm production and productivity is a top food security strategy for rural household who remain largely dependent on agriculture for their livelihoods. Considerable evidence shows a strong correlation between operated farm size and food production in rural Africa. However, there is no rigorous empirical evidence to shed light on the linkage between land access and food security. It is quite possible that households with relatively small landholding sizes have diversified to a greater extent into non-farm activities and are able to fully offset their lower own farm production with food purchased through their non-farm incomes. We attempt to fill in these knowledge gaps by exploring the relationship between land access and food security using data from rural Kenya in this study.

Our analyses yield three salient findings. First of all, we establish a strong linkage between land access and food security. In general, households with small farms are not able to procure sufficient food through non-farm jobs to achieve comparable levels of food consumption per capita as their relatively land-abundant neighbors. Second, we find that land rental markets are the most important means available to land-constrained rural households to access additional land for cultivation. Third, regression results show that rental markets perform below their potential. The gross and net values of production are significantly lower on rented plots than on owned plots even after plot characteristics and household fixed effects are controlled for. Consistently, farmers also apply less organic manure on rented plots than on owned plots. In addition, farmers are not able to attain the operated land size at the optimal level. Tenants were only able to rent in from 67 to 73 percent of the optimal amount of land, and landlords were only able to rent out from 44 to 48 percent of the optimal amount of rent-out land.

Therefore, while land rental markets currently play a positive role in promoting household food security in rural Kenya, there appears to be untapped potential for them to play a more important role than they currently do. Policy efforts to improve the functioning of land rental markets may be an underecognized yet important component of food security and nutrition strategies in rural Kenya, and most likely in other parts of the region. More detailed research on the organization and behavior of land rental markets is needed to identify the specific causes of the apparently considerable underperformance of Kenya's rural land rental markets.

References

Albert, S. (2012). Food Security for Africa: an urgent global challenge, *Agriculture & Food Security*, 1(1), 1-2.

André, C., & Platteau, J. (1998). Land Relations Under Unbearable Stress: Rwanda Caught in the Malthusian Trap. *Journal of Economic Behavior & Organization* 34 (1) , 1–47.

Bardhan, P., & Udry, C. 1999. *Development Microeconomics*. Oxford University Press, USA.

Binswanger H. & Rosenzweig, M. (1986). Behavioral and Material Determinants of Production Relations in Agriculture. *Journal of Development Studies* 22(3), 503-539.

Black, R. E., Morris, S. S. & Bryce, J. (2003). Where and Why Are 10 Million Children Dying Every Year? *The Lancet* 361 (9376), 2226–2234.

Boon, E. K., (2002). Food Security in Africa: Challenges and Prospects. *Regional Sustanable Development Review: Africa*, *1*.

Chen, S., & Ravallion, M. (2008). The developing world is poorer than we thought, but no less successful in the fight against poverty. World Bank Policy Research Working Paper Series, Vol.4703.Washington, DC.

Chirwa, D.M., (2009). *Child poverty and children's rights of access to food and basic Nutrition in South Africa: A contextual, jurisprudential, and policy analysis.* Published by the Community Law Centre, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa.

De Janvry, A., Fafchamps, M. & Sadoulet, E. (1991). Peasant household behaviour with missing markets: some paradoxes explained. *The Economic Journal*, 1400–1417.

Deininger, K. (2003). *Land policies for growth and poverty reduction*. *World Bank Policy Research Report*, Oxford University Press, USA.

Deininger, K., Ali, D. A. & Alemu, T. (2008). Impacts of Land Certification on Tenure Security, Investment, and Land Markets: Evidence from Ethiopia. World Bank Policy Research Working Paper Series, No. 4764. Washington, DC.

Deininger, K., & Jin, S. (2008). Land Sales and Rental Markets in Transition: Evidence from Rural Vietnam. *Oxford Bulletin of Economics and Statistics* 70 (1), 67–101.

Deininger, K., & Jin, S. and Nagarajan ,H.(2008). Efficiency and equity impacts of rural land rental restriction: Evidence from India. *European Economic Review* 52(2), 892-918

Deininger, K., & Mpuga, D. (2009). Land market in Uganda: What is their impact and who benefit?. In *The Emergence of Land Markets in Africa*, ed. S.T. Holden, K. Otsuka and F. M. Place, 131-155 . RFF Press. Washington, DC.

European Union. (2012). The EU's Long-term Action to Tackle Global Hunger and Under-nutrition. http://ec.europa.eu/europeaid/what/food-security/documents/food-security_fact_sheet_2012_en.pdf.

Ezzati, M., Lopez, A. D., Rodgers, A., Vander Hoorn, S., & Murray, C. J. (2002). Selected major risk factors and global and regional burden of disease. *Lancet*, 360(9343), 1347.

FAO. (2010). *The State of Food Insecurity in the World*. Roma. http://www.fao.org/docrep/013/i1683e/i1683e.pdf.

Feder, G., Just , R. E., & Zilberman, D. (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change* 33(2), 255–298.

Gebregziabher, G, & Holden, S. T. (2011). Distress Rentals and the Land Rental Market as a Safety Net: Contract Choice Evidence from Tigray, Ethiopia. *Agricultural Economics* 42, 45–60.

Government of Kenya. (2007). *National Land Policy*. National Land Policy Secretariat, Nairobi.

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

Holden, S., Kaarhus, R., & Lunduka, R. (2006). *Land Policy Reform: The Role of Land Markets and Women's Land Rights in Malawi*. As, Norway: Norweigian University of Life Science

Holden, S. T, Otsuka, K. & Place, F. M. (2009). *The Emergence of Land Markets in Africa:" Impacts on Poverty, Equity, and Efficiency"*. RFF Press. Washington, DC.

Honore, B. E. (1992). Trimmed Lad and Least-Squares Estimation of Truncated and Censored Regression-Models with Fixed Effects." *Econometrica 60* (3): 533-65.

Jacoby, H. G., & Mansuri, G .(2009). Incentives, Supervision, and Sharecropper Productivity." *Journal of Development Economics* 88 (2), 232–241.

Jayne, T.S., D. Headey, and J. Chamberlin (2014). Boserup and Beyond: Land, Labor and Development Pathways in Africa. *Food Policy,* in press.

Jin, S, & Deininger, K. (2009). Land Rental Markets in the Process of Rural Structural Transformation: Productivity and Equity Impacts from China. *Journal of Comparative Economics* 37 (4), 629–646.

Jin, S, & Jayne, T. S. (2013) Land Rental Markets in Kenya: Implications for Efficiency, Equity, Household Income, and Poverty. *Land Economics.* 89 (2), 246-271.

Kimura, S., K., Sonobe, T. and Rozelle, S. (2011). Efficiency of Land Allocation through Tenancy Markets: Evidence from China, *Economic Development and Cultural Change*, University of Chicago Press, vol. 59(3), 485 - 510.

Migot-Adholla, S. E., Benneh, G., Place, F., Atsu, S. & Bruce, J. W. 1994. "Land, Security of Tenure, and Productivity in Ghana." *Searching for Land Tenure Security in Africa.* 97–118.

MSU Food Security Group (FSG). (2009). Lessons Learned from 25 Years of Food Security Research, Capacity-Building, and Outreach. MSU International Development Working Paper No.101. East Lansing, MI.

Mowlds, S. W., Nicol, E. & Cleirigh, O. (2012). Aid for Food and Nutrition Security. OECD Report. http://www.oecd.org/dac/povertyreduction/Brochure%20on%20Food%20Security%20FINAL%2013%20July%202012.pdf.

Muyanga, M. and T. Jayne (2014). Effects of Rising Rural Population Density on Smallholder Agriculture in Kenya. *Food Policy*, in press.

Owusu, V., Abdulai, A. , & Abdul-Rahman, S. (2011). Non-farm Work and Food Security Among Farm Households in Northern Ghana. *Food Policy* 36 (2), 108–118.

Pender, J., and Fafchamps, M. (2001). *Land Lease Markets and Agricultural Efficiency: Theory and Evidence from Ethiopia*. Environment and Production Technology Division, International Food Policy Research Institute. EPTD DISCUSSION PAPER NO. 81 Washington, DC.

Pinstrup-Andersen, P. (2009). "Food Security: Definition and Measurement." *Food Security* 1 (1): 5–7.

Shaban, R. A. (1987). Testing Between Competing Models of Sharecropping. *Journal of Political Economy* 95 (5), 893–920.

Skoufias, E. (1995). Household Resources, Transaction Costs, and Adjustment Through Land Tenancy. *Land Economics*, 42–56.

UNDP, (2012). Africa Human Development Report 2012: Toward a Food Security Future. United Nations Publication. New York, USA.

UN Millennium Project (2005). *Halving Hunger: It Can Be Done.* New York, USA: The Earth Institute at Columbia University. http://www.unmillenniumproject.org/documents/HTF-SumVers_FINAL.pdf.

UN System Standing Committee on Nutrition (SCN). (2004). *5th Report on the World Nutrition Situation*. Geneva. http://www.unsystem.org/scn/Publications/AnnualMeeting/SCN31/SCN5Report.pdf.

USAID (2007). *Mozambique Food Security Programming Framework 2008-2012*. Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED). Washington D.C.

USDA, (2009). Food Security Analysis: Kenya. Report by USDA, http://www.fas.usda.gov/itp/Kenya/KenyaFoodSecurity09.pdf.

Wangila, J. (1999). Socio-Economic Characteristics of Households in the Soil Fertility Replenishment Pilot Project Area in Vihiga and Siaya Districts. Nairobi: ICRAE.

Yamano, T., Place, F. M., Nyangena, W., Wanjiku, J. & Otsuka, K. (2009). Efficiency and Equity Impacts of Land Markets in Kenya. *In The Emergence of Land Markets in Africa*, ed. S.T.Holden, Otsuka, K. and Place, F. M. 93-111. RFF Press. Washington, DC.

Yamano, T., Otsuka, K., & Place, F. (2011). *Emerging Development of Agriculture in East Africa*. Springer Dordrecht Heidelberg London New York

Table 1. Access to land by mode of transfer in 2003 and 2006

Mode of transfer	Average	2003	2011
Purchased			
Number of parcels	9.5	13	6
Average area (acre)	1.14	0.84	1.43
Rented-in			
Number of parcels	210	197	222
Average area (acre)	0.89	0.95	0.84
Inherited or other			
Number of parcels	7.5	8	7
Average area (acre)	2.90	0.95	4.84

Table 2. Household characteristics by land rental market status

Rental status	All	Rent-in	Rent-out	Autarkic	Purchased land during 2004-06
Land owned (acres)	4.59	4.46	9.24	4.08	6.16
Household size (# of people)	8.35	8.96	8.06	8.11	10.40
Number of working age members (15-64)	5.25	5.72	4.96	5.07	6.80
Number of dependents*	3.10	3.24	3.10	3.04	3.60
Household head's age	58.62	56.29	56.69	59.89	49.53
% of Fem. headed HHs	23	16	31	25	7
% of heads completing primary education	31	42	13	28	53
% of HHs w/ a bullock	14	20	10	12	33
Total value of asset (KSh)	71,114	77,141	91,228	60,673	272,108
Total value of livestock (KSh)	48,405	59,051	43,703	44,940	59,907
Number of Observations	713	163	52	483	15

Table 3. Household crop income by operated farm size category

Farm size quartile*	Gross crop income per capita	Net crop income per capita	Household income per capita
1st (smallest)	4,697	3,885	20,696
2nd	6,397	5,204	28,437
3rd	8,870	7,144	26,146
4th (largest)	14,941	11,747	37,321
Average	**8,721**	**6,991**	**28,139**

Notes: * includes rented land

Table 4. Household food security status by operated land size category

Operated farm size quartile*	Total food consumption per capita	Total cereal consumption per capita	Total non-cereal consumption per capita	Total food consumption from own production	Value of food purchased
1st (smallest)	7,565	2,831	4,734	4,822	2,743
2nd	8,008	2,922	5,086	5,383	2,625
3rd	8,607	3,007	5,600	6,240	2,366
4th (largest)	11,358	3,955	7,404	8,894	2,465
Average	**8,883**	**3,178**	**5,705**	**6,333**	**2,550**

* includes rented land

Table 5. Tenure status, productivity, and input use intensity by plot type

Tenure Status	Total	Own Plots	Rented Plots
Value of Gross Revenue per Acre (Ksh)	15,448	15,883	13,719
Value of Net Revenue per Acre (Ksh)	11,656	12,658	7,388
Value of Organic Manure per Acre (Ksh)	680	774	281
Value of Chemical Fertilizer per Acre (Ksh)	1,210	1,214	1,258
Land size in acre (acre)	1.87	2.05	1.13
Number of Observations	1229	985	222

Table 6. Impact of and access on per capita food consumption (household fixed-effect model)

VARIABLES	Total food consumption per capita (log)	Total cereal consumption per capita (log)	Total non-cereal consumption per capita (log)	Food consumption, home production per capita (log)	Food consumption, purchased per capita (log)
Operated land size	0.109**	0.182***	0.0825*	0.189***	0.0200
	(0.0451)	(0.0408)	(0.0491)	(0.0574)	(0.0464)
Household size (log)	-0.105***	-0.0833***	-0.115***	-0.115***	-0.0700***
	(0.0171)	(0.0213)	(0.0184)	(0.0218)	(0.0223)
Total value of assets	0.108***	0.0394	0.106***	0.0557	0.150***
	(0.0348)	(0.0357)	(0.0400)	(0.0463)	(0.0533)
Female Headed	-0.104	0.133	-0.211	-0.350**	0.256
	(0.136)	(0.146)	(0.139)	(0.149)	(0.155)
Head’s age	-0.00379	-0.00182	-0.00241	-0.00851	0.00273
	(0.00521)	(0.00516)	(0.00589)	(0.00681)	(0.00581)
Head completed	0.0220	0.0758	0.00761	-0.0277	0.0431
	(0.0888)	(0.111)	(0.103)	(0.133)	(0.118)
Value of livestock (log)	0.0735***	0.0468**	0.0913***	0.166***	0.0243
	(0.0271)	(0.0217)	(0.0313)	(0.0390)	(0.0303)
Constant	-1.092***	-0.245***	-1.353***	-0.703***	-1.629***
	(0.0424)	(0.0475)	(0.0484)	(0.0585)	(0.0499)
Observations	1288	1288	1288	1288	1288
R-squared	0.095	0.073	0.083	0.108	0.138
Number of HHs	644	644	644	644	644

Robust standard errors in parentheses
* Significant at 10%, ** significant at 5%, *** significant at 1%

Table 7. Impact of and access on per capita food consumption (household IV model)

VARIABLES	Total food consumption per capita (log)	Total cereal consumption per capita (log)	Total non-cereal consumption per capita (log)	Food consumption, home production per capita (log)	Food consumption, purchased per capita (log)
Operated land size (log)	0.0898	0.0823*	0.0734	0.197**	-0.0398
	(0.0701)	(0.0487)	(0.0852)	(0.0769)	(0.0828)
Household size (log)	-0.999***	-0.759***	-1.075***	-1.039***	-0.947***
	(0.0437)	(0.0353)	(0.0529)	(0.0487)	(0.0583)
Total value of assets (log)	0.146***	0.0963***	0.163***	0.0999***	0.204***
	(0.0240)	(0.0179)	(0.0287)	(0.0254)	(0.0337)
Female Headed	-0.137***	0.0199	-0.179***	-0.139**	-0.143*
	(0.0510)	(0.0428)	(0.0615)	(0.0555)	(0.0767)
Head’s age	-0.00627***	-0.00332**	-0.00664***	-0.00265	-0.0132***
	(0.00168)	(0.00129)	(0.00205)	(0.00186)	(0.00227)
Head completed primary education	-0.0255	0.0395	-0.0368	-0.0751	0.0645
	(0.0497)	(0.0396)	(0.0605)	(0.0537)	(0.0694)
Value of livestock (log)	0.118***	0.0405***	0.165***	0.261***	-0.00382
	(0.0203)	(0.0125)	(0.0246)	(0.0231)	(0.0228)
Constant	9.020***	8.191***	8.151***	7.203***	8.945***
	(0.260)	(0.188)	(0.321)	(0.284)	(0.347)
Observations	1,338	1,338	1,338	1,338	1,338
R-squared	0.365	0.332	0.333	0.432	0.205

Robust standard errors in parentheses
No land inheritance dummys are included in all IV estimatations.
* Significant at 10%, ** significant at 5%, *** significant at 1%

Table 8. Impact of land access on production and agriculture income (household fixed-effect and IV model)

VARIABLES	Value of harvest per capita (log)		Net agricultural income per capita (log)		Household income per capita (log)	
	FE	IV	FE	IV	FE	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Operated land size	0.516***	0.309***	0.529***	0.240**	0.173***	0.0278
(log)	(0.0668)	(0.0901)	(0.0745)	(0.102)	(0.0340)	(0.0762)
Household size (log)	-1.166***	-1.046***	-1.464***	-1.014***	-0.911***	-0.884***
	(0.165)	(0.0576)	(0.207)	(0.0660)	(0.0517)	(0.0504)
Total value of assets	0.0359	0.129***	0.0602	0.111***	0.243***	0.272***
(log)	(0.0557)	(0.0277)	(0.0663)	(0.0315)	(0.0283)	(0.0271)
Female Headed	-0.504**	-0.224***	-0.561**	-0.205***	-0.178***	-0.169***
	(0.205)	(0.0691)	(0.258)	(0.0778)	(0.0610)	(0.0600)
Head's age	-0.0156**	2.72e-05	-0.0209**	2.78e-05	-0.00830***	-0.00675***
	(0.00728)	(0.00216)	(0.00934)	(0.00243)	(0.00198)	(0.00186)
Head completed	0.0639	-0.0129	0.113	-0.0614	0.105*	0.0958*
primary education	(0.147)	(0.0624)	(0.182)	(0.0759)	(0.0565)	(0.0515)
Value of livestock (log)	0.130***	0.142***	0.114**	0.137***	0.186***	0.205***
	(0.0451)	(0.0245)	(0.0519)	(0.0268)	(0.0230)	(0.0226)
Constant	9.737***	7.763***	10.24***	7.764***	7.655***	7.200***
	(0.743)	(0.327)	(0.885)	(0.364)	(0.282)	(0.286)
Observations	1,337	1,337	1,293	1,293	1,329	1,329
R-squared	0.253	0.342	0.236	0.257	0.199	0.408
Number of HHs	694		692		694	

Robust standard errors in parentheses
No land inheritance dummys are included in all IV estimatation.
* Significant at 10%, ** significant at 5%, *** significant at 1%

Table 9. Impact of land tenure on productivity (household fixed effect model, plot level data)

VARIABLES	Gross revenue per acre (log)		Net revenue per acre (log)	
	(1)	(2)	(3)	(4)
Land area (log)	-0.248***	-0.276***	0.0571	0.0326
	(0.0471)	(0.0469)	(0.0654)	(0.0695)
Rented in plot	-0.486***	-0.213**	-0.442***	-0.240
	(0.0859)	(0.0997)	(0.164)	(0.180)
Irrigated		0.355		0.207
		(0.320)		(0.549)
Steep		-0.0387		0.0630
		(0.111)		(0.147)
Distance		-0.0856***		-0.0644***
		(0.0154)		(0.0220)
Value of total input	0.0769***	0.0696***		
use per acre (log)	(0.0150)	(0.0154)		
Constant	9.035***	8.806***	9.059***	8.828***
	(0.110)	(0.111)	(0.0298)	(0.0803)
Observations	1,227	1,223	1,225	1,222
R-squared	0.118	0.176	0.740	0.743
Number of hhid	713	712	712	711

For net revenue per acre, negative net revenue dummy is included.
Robust standard errors in parentheses
*** p<0.01, ** p<0.05,

Table 10. Impact of land tenure on fertilizer use (household fixed-effect Tobit model, plot level)

VARIABLES	Organic manure per acre		Chemical fertilizer per acre	
	(1)	(2)	(3)	(4)
Land size	66.16	-192.9	-129.1	-156.3*
	(163.1)	(330.3)	(83.50)	(88.41)
Rented in Plot	-3,416***	-3,007**	-378.9	-369.3
	(1,276)	(1,425)	(291.2)	(240.1)
irrigated		2,837		5,523
		(3,090)		(9,160)
steep		49.78		446.0
		(749.3)		(271.2)
distance		-647.8		-5.360
		(497.7)		(33.34)
Observations	1,229	1,225	1,229	1,225

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table11. Determinants of net land leased in, maximum likelihood estimates (2007 data)

	(1)	(2)
Leasing-in equation		
Area owned	-0.734***	-0.665***
	(0.120)	(0.137)
Female head	-0.477	-0.645
	(1.341)	(1.343)
Own Bull	6.214**	7.691*
	(3.084)	(4.011)
Value of total assets (log)	0.0542	0.289
	(0.610)	(0.671)
Number of dependents (<14 & >65)	-0.198	-0.0938
	(0.252)	(0.250)
Members 14-65	0.360	0.491**
	(0.254)	(0.250)
Head with primary education	6.921**	7.122**
	(2.835)	(2.824)
Head’s age	0.107**	0.0988**
	(0.0477)	(0.0450)
Constant	21.99***	109.5***
	(7.191)	(12.80)
Leasing-out equation		
Area owned	0.437***	0.483***
	(0.0782)	(0.102)
Female head	1.184	1.291*
	(0.803)	(0.775)
Own Bull	−2.718***	-3.318***
	(0.918)	(0.971)
Value of total assets (log)	-0.686**	-0.426
	(0.295)	(0.313)
Number of dependents (<14 & >65)	-0.184	0-.227
	(0.141)	(0.147)
Members 14-65	-0.302**	-0.302**
	(0.142)	(0.144)
Head with primary education	-1.387*	-1.747**
	(0.725)	(0.761)
Head’s age	0.0324	0.0266
	(0.0232)	(0.0250)
Constant	-101.4***	12.48***
	(12.46)	(5.623)
Community dummies included	No	Yes
σ	7.133***	6.861***
	(1.252)	(1.181)
Log Likelihood	-1003.56	-978.8
Observations	712	712

Standard errors adjusted for clustering effect at the village level
* significant at 10%, ** significant at 5%, *** significant at 1%