Land Sovereignty and Tree-Planting in Uganda

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1. Introduction

Timber is used for a variety of purposes in Uganda and is important in Uganda's rural and urban economies. In rural areas, timber is the main fuel source for domestic tasks such as cooking, lighting, and heating, but it is also integral to income generating activities. Many livelihoods in Uganda are connected directly or indirectly to domestic timber production. Brick making, fish smoking, and tea curing depend on large amounts of firewood to fuel kilns and smokers necessary for these livelihoods. Ugandan furniture makers use wood almost exclusively for frames in the furniture they make. Intermediaries who collect and sell firewood are also dependent on a steady supply of timber for income. Rapid urbanization is increasing the amount of timber-intensive construction projects throughout the country. Timber-based economic activities diversify rural household income portfolios against unexpected systemic shocks. When drought or pests wipe out crops, timber-based livelihoods offer alternative sources of income.

Many households depend on timber for income generation, but almost all rural households are highly dependent on timber for subsistence tasks, such as cooking and heating. Very few rural residents have access to electricity or other modern energy sources, making fuel-wood the predominant energy source for most rural households. High efficiency stoves are not yet widespread throughout Uganda and most rural households use a three-stone stove akin to an indoor campfire. Such stoves are highly inefficient and require large amounts of firewood daily. At present, firewood consumption in Uganda is estimated to be growing at a rate of 2.5% per annum (Tabuti et al. 2003). Such growth in fuel-wood consumption is not environmentally or economically sustainable in light of current reforestation trends.

Several historical and emerging challenges threaten the sustainability and productivity of the Ugandan timber industry. Historically, much of Uganda's timber needs were supplied by vast forests that covered the country. Dramatic increases in population over the past fifty years have led to expansion of

farmland into forested areas. Slash and burn agriculture is a common practice in many parts of Uganda where demand for farmland has outstripped supply. Uganda's forest cover has decreased commensurately with population pressure and considerable concern now exists within the country that current deforestation rates are unsustainable. Between 2000 and 2005, Uganda lost an average of 2.1% (86,400 acres) of its forest cover, a 21% increase in the rate of deforestation since the late 1990s (FAO 2007). Faulkenberg and Sepp (2000) estimate the annual cost of deforestation in Uganda is between $3.8-5.7 million. The dramatic rates at which Uganda is losing its forest have resulted in recent action from the Ugandan government. In June of 2009, Uganda's National Forest Authority banned timber harvesting in 23 grossly deforested districts in an attempt to stem deforestation in the most fragile parts of the country (Bugembe 2009).

Growing trees on private land is a potential solution to increased timber demand. Rapidly growing tree varieties, such as Eucalyptus, can grow up to two meters per year, resulting in per hectare production rates of 40-60 cubic meters of wood per year. Such high rates of private tree production can significantly reduce the amount of indigenous forest cover harvested every year, while providing an income source for those growing trees. However, complex property rights laws and traditions have prevented Uganda from obtaining its agro-forestry potential.

In recent years, researchers have taken interest in the effect of various aspects of land rights on long term investments, such as tree planting (Deininger and Jin 2006). Much of this literature has examined three components of land rights from which landholders derive benefit: tenure security, using land as collateral, and gains from trade (Besley 1995). A lesser studied aspect of land rights is the landholder's sovereignty over the land. Sovereignty refers to the extent a landholder has freedom to use the land for the purpose which they desire. In this study we examine the role of land sovereignty on tree planting behavior in rural Africa, where many landholders do not have full sovereignty over their land.

We find having no right to plant trees on a parcel of land has a negative and significant impact on whether farmers have trees on their land, but does not impact the number of trees on the land. Farmers on customary land are impacted less than farmers on mailo land by a prohibition to plant trees on the land they occupy. We find more flexible restrictions, such as having to get permission from extended family, the mailo owner, or village elders, have little impact on the decision to plant trees or the number of trees planted on parcels of land in Uganda.

2. Past research

Over the past twenty years, increases in availability and diversity of agricultural household data have allowed researchers to investigate specific investment decisions by agricultural households, including tree-planting decisions. Two early studies examine how households use trees on private plots. Chambers and Leach (1989) investigate the extent to which households use trees as a form of savings and find trees are comparable to jewelry, livestock, and bank deposits, while noting advantages and disadvantages of using trees as a savings mechanism. Dewees (1995) considers the environment for private tree planting in Malawi and concludes investments in tree planting are most beneficial when they are low cost and low risk. Several authors have sought to quantify the profitability of growing trees on private land. Patel et al. (1995) find tree planting is competitive with other productive activities and farmers are responsive to economic incentives to plant trees. These incentives vary across households according to specific factor endowments and household market access. In a cost/benefit analysis of planting eucalyptus trees in Ethiopia, Jagger and Pender (2003) conclude households see returns well above 20% on eucalyptus trees.

In one of the first empirical studies to examine household agroforestry decisions, Scherr (1995) highlights the influence of external interventions on household tree planting decisions. She finds high levels of variability in circumstances farmers face when deciding to plant trees and calls for increased

extension strategies accommodating the diversity in household agroforestry conditions. Nibbering (1999) also highlights the effectiveness of government tree-planting campaigns to induce private tree-planting in Java, Indonesia.

Other studies have investigated various other factors influencing household tree-planting decisions. Amacher et al. (2004) investigates tree planting in areas near micro-dams to determine the impact of human disease on household tree planting. They find disease has a positive impact on the household's decision to plant trees, but not the number of trees planted. Nepal et al. (2007) find social networks specifically related to forest conservation are positively related to private tree planting, but social networks unrelated to forest conservation have no effect on private tree planting. Bluffstone et al. (2008) similarly find community property forest management has a positive effect on private tree planting.

Economists have long recognized the importance of property rights in investment decisions (Demsez 1967; Alchian and Demsetz 1973). More recently Besley (1995) has formalized these arguments and applied them to the context of rural African agriculture. Besley develops three theoretical arguments describing the mechanisms through which landholders benefit from property rights. First, greater tenure security provides farmers with greater incentive to invest in their land. Second, landholders who can use land as collateral benefit from increased capacity to borrow capital. Lastly, Besley shows the ability to transfer land results in optimal allocations of both land use and household labor.

Many studies have followed Besley's lead and empirically investigate one or several of these theories, some of which have specifically investigated the decision to plant trees. Ali et al. (2005) examine the impact of tenure security on tree planting in Ethiopia using panel data. They find perceived transfer rights, rather than a relatively short-term threat of expropriation, are quantitatively more

important in explaining relatively low investment in trees. Deininger and Jin (2006) differentiate tenure security from the ability to transfer land in their study. Analyzing a nationally-representative cross-section of Ethiopian households, they find tenure security has a large investment-enhancing effect on tree planting. Mekonnen (2009) considers the decision to plant separate from the number of trees planted and finds tenure security influences the household's decision to plant trees, but not the number of trees that it grows. Hansen et al. (2005) investigate the effect of marriage and inheritance patterns on tree planting and find tenure insecurity resulting from cultural marriage practices has a significant impact on number of trees planted.

We add to this literature by considering the effect of household sovereignty over land, an aspect of land rights yet to be thoroughly investigated, on both the decision to plant trees and the intensity of tree planting. To this point very few studies have used panel data in considering tree planting decisions, as we do in our study. Observing household tree planting behavior over time gives us the ability to control for unobservable parcel-level effects that may confound results.

3. Situation in Uganda

There are currently four primary land tenure systems in Uganda: freehold, mailo, leasehold, and customary. Such diversity may complicate property rights law, but it offers researchers an opportunity to analyze the impacts of differing sets of land rights. Below we outline the evolution of land rights in Uganda to give a better understanding of the differences among the types of land rights.

Several important events of the twentieth century have shaped Uganda's current land rights arrangements. Under British colonial rule, the Buganda Agreement of 1900 divided land from parts of the central and western regions of Uganda into large blocks and awarded them to the Bugandan king. These blocks of land became known as mailo land and were quickly allocated, occupants and all, amongst those whom the king chose. Many mailo owners assumed the role of absentee landlord,

allowing the occupants to stay on the land with little or no involvement. Currently, many mailo owners maintain the role of absentee landlord, often living far from the land they own. Over the years, disputes over mailo land have led the Ugandan government to enact legislation further defining the rights of mailo owners and occupants. An important piece of legislation regarding mailo ownership came in 1928 when the federal government put a limit on the rent mailo owners could collect and declared tenants must be compensated for any improvements made to the land. Currently, mailo occupants have very little formal or defacto rights. Despite the 1928 land act, mailo tenants are subject to eviction without compensation for improvements they have made to the land. Even homes built on mailo land are subject to confiscation at the behest of the mailo owner.

In 1975, under Idi Amin's dictatorship, nationalization of all land further complicated land rights. The decree was never taken seriously by land holders and nationalization was quickly rescinded. By the late 1980's, property rights had become an important issue in Uganda. The World Bank and USAID commissioned a study to examine options for tenure reform. The report suggested freehold tenure should be promoted throughout the country. Freehold tenure was established in Uganda around the same time as mailo tenure and gives full ownership rights to landholders. Authors of the report championed the importance of land markets and title collateral that would result from greater freehold tenure.

In 1995 Uganda adopted a new constitution, outlining specific reforms to the existing land tenure system. The 1998 Land Act operationalized these reforms. The act stipulated all land shall be owned by Ugandans and established the four tenure systems mentioned above. Customary tenure—where communities have the right to govern land according to traditional or tribal custom—was formally recognized under the new law and gave customary tenants the option to obtain a certificate of customary ownership, which could eventually be converted to a freehold title. Strengthening of

customary land rights was an important development in Uganda, as almost 70% of Ugandans live on customary land. Currently, customary tenants have considerable land rights and are typically much more tenure secure than mailo occupants.

Our review of land rights in Uganda would not be complete without mention of leasehold tenure. Under leasehold agreements, a lessee/occupant is given exclusive rights to land for a specific period of time, typically 49 or 99 years. Leasehold agreements are contractual in nature and usually will stipulate conditions for the lease. Leasehold tenure is the least common of all types of land tenure and less than one percent of our sample exists under this tenure distinction.

Despite the reforms of the 1998 Land Act, factors outside of the household still play a significant role in the extent to which occupants hold rights to their land, especially on customary and mailo lands. Households with customary tenure may have to ask extended family or village members for permission to plant certain crops or undertake significant investments on the land. These interactions can be complicated by cultural or family dynamics beyond mere production decisions. Mailo tenants often require permission from the landowner before they make large-scale changes to the land, such as planting trees. These restrictions on land rights have significant impact on the household's productive activities and economic decisions. It is these interactions between landowners and customary/mailo tenants we investigate.

4. Conceptual framework

When farmers decide to plant trees, they forego other productive opportunities of the land, typically growing agricultural food crops. Clay et al. (2002) break farmer decisions concerning land use alternatives into two main questions: (1) Will adoption of the new land use be profitable? (2) Can they afford the implementation costs? Our analysis focuses mainly on the first question, whether the new use will be profitable. Profitability will depend on many factors, such as costs of implementation, output

prices at the time of harvest, and the success of the new land use. For tree planting, farmers must consider whether the land they are converting to agroforestry is well suited to grow trees. A number of factors determine the growth and quality of the trees and thus, affect the profitability. Another consideration relating to profitability is the probability the farmer will be able to reap the rewards of the harvest at a future date. Farmers must consider threats to the trees posed by pests, natural disaster, and weak land rights, which can reduce or eliminate the benefits of adoption. In particular, farmers with weak land rights must consider eviction threats when adopting agroforestry. As probability of eviction increases, households view tree planting less as profitable.

Agricultural production decisions in developing countries are complicated by extensive interconnection between household consumption and production decisions. Adoption decisions are not based solely on market signals, especially in situations where markets are weak or non-existent. Swinton and Quiroz (2003) formally model the household's decision to adopt and intensity of adoption of a particular agricultural practice or technology. They model the household's decision as:

$$\left.\begin{array}{ll} \underset{x}{Max} & U(c, y^c) \\ Subject\ to & y = y(L_a, x|k, z) \\ & p_c c \leq p_y(y - y^c) - p_x x - p_{ah} L_{ah} + p_{Ln} L_n \\ & L = L_{af} + L_n \end{array}\right\} \quad (1)$$

Equation (1) states households maximize utility subject to a production constraint, a budget constraint, and a labor constraint. The household chooses agricultural practices x to maximize its utility, which is a function of household consumption of good c and home-produced good y^c. Maximization is subject to the production constraint of good y, where production of y is a function of agricultural labor L_a, agricultural practices x, conditional on capital levels k available to the household, and household and external characteristics z. The budget constraint states the household cannot consume more of good c, purchased at price p^c, than can be afforded with income from off-farm work $p_{Ln}L_n$ and the sale

of home-produced good y, less the amount of household consumption of y^c at price p_y, the cost of production $p_x x$, and the cost of hired labor $p_{ah} L_{ah}$. The household is constrained by a total labor endowment L, which can be allocated to either on farm work L_{af} or off-farm work L_n.

The solution to this optimization problem yields equation (2), an input demand equation for agricultural practice x_j, associated with a level of natural resources i. Agricultural practice x_j is a function of the price p_y of output y; other inputs x; labor L_a and L_n; farm capital k; and household characteristics z.

$$x_{ij}^* = x_j^*(p, x_{(j)}, k, z) \qquad (2)$$

Variable z captures household characteristics, such as the household's rights to land and sovereignty over the land. Sovereignty can be seen as specific value on a continuum of rights, where the strength with which rights are owned can be defined by the extent to which an owner's decision about how a resource will be used actually determines the use (Alchian and Demsetz 1973). On one end of the spectrum, the occupant does not have any right over production decisions, in this case tree-planting decisions. At the other end of the spectrum, the occupant has full sovereignty over the decision to plant and alone decides whether to plant trees. In between, any number of restrictions imposed by family, community members, mailo owners, or others, impact the household's tree-planting decision.

Restrictions on land sovereignty enter into the adoption equation as an additional cost. The magnitude of restriction will vary across households and the source from which the restriction comes. For instance, one household may have to ask extended family before making any long-term adoption decisions. For some households, this may be prohibitively restrictive, but for others it may only be a formality, depending on family dynamics. In some cases, getting permission to plant from a mailo owner may be less restrictive than getting permission from family members. In other cases, getting permission from a mailo owner may be much more difficult than getting permission from family. The difficulty by

which permission is granted is the additional cost. In cases where permission is needed, the occupant has to decide whether to obey or disobey the source through whom they get permission. Occupants may disobey, incurring an additional cost. The cost of disobedience will again vary across households.

5. Empirical strategy

For several reasons, we restrict our study to occupants of customary and mailo land. First, leasehold occupants make up such a small percentage of the total farmers (0.4%) that the data is insufficient to perform meaningful empirical analysis. Occupants of freehold land have full sovereignty over their land, with no restrictions which we can consider. Second, customary and mailo occupants account for a large percentage of Ugandan landholders and consideration of these farmers yields insight of a significant portion of the overall population. Last, the mailo tenure system is currently a controversial and politically important issue in Uganda and empirical investigation into the impact of mailo tenancy on adoption decisions is needed.

Because many households in Uganda do not have any timber trees on their land, the starting point of our analysis is to analyze the decision to plant trees. To determine important factors influencing the household's decision to plant trees, we use a parcel-level random effects probit model, with the number of trees on the parcel as the dependent variable. The random effects probit model specifies an underlying continuous unobservable variable

$$y_{it}^{*} = x_{it}^{'}\beta + \alpha_i + u_{it} \qquad (3)$$

and an observable variable

$$y_{it} = \begin{cases} 1 \; if \; y_{it}^{*} > 0 \\ 0 \; if \; y_{it}^{*} \leq 0 \end{cases}. \qquad (4)$$

In the model, y_{it} is a binary outcome taking the value of y_{it}*=1* if parcel i has trees on it at time t and *0* if at time t, parcel i does not have any trees on it. The random effects probit model specifies that

$$\begin{aligned}\Pr(y_{it}=1|x_{it},\beta,\alpha_i) &= \Pr\left(x_{it}^{'}\beta+\alpha_i+u_{it}>0\right)\\ &= \Pr(x_{it}^{'}\beta+\alpha_i>-u_{it})\\ &= \Lambda(x_{it}^{'}\beta+\alpha_i) \qquad (5)\end{aligned}$$

where Λ is the standard normal distribution, x_{it} is a vector of exogenous variables influencing y_{it}, $\alpha_i$is a time-invariant unobserved parcel effect independent of x_{it}, and u_{it} is an idiosyncratic error term independent of y_{it}.The model assumes $\alpha_i \sim N(0,\sigma_\alpha^2)$.

We are also interested in estimating the effect of planting restrictions on households that plant trees. To determine the effect of planting restrictions on the number of trees on the parcel, we estimate a random effects model correcting for sample selection. Past studies have often relied on tobit models to deal with the censored nature of the data. The validity of the tobit model is highly dependent on the assumption of normally distributed and homoskedastic errors. Diagnostic tests reveal our data violates the normality assumption, even when subjected to a lognormal transformation. This implies the tobit model is a poor fit for our data. Selection models present a solution to this problem by specifying a joint distribution for the censored and positive outcomes, finding the implied distribution conditional on the observed outcome (Cameron and Trivedi, 2003).

The random effects model accounting for sample selection is specified by:

$$y_{it} = x_{it}^{'}\beta+\alpha_i+\sigma_i\lambda_i+u_{it} \qquad (6)$$

where y_{it} is the number of trees planted on parcel i at time t. Again, x_{it} is a vector of exogenous variables influencing y_{it}, α_i is a time-invariant unobserved parcel effect independent of x_{it}, and u_{it} is an idiosyncratic error term independent of y_{it}. The inverse Mills ratio derived from the first stage equation is represented by λ_i. The model assumes $\alpha_i \sim N(0,\sigma_\alpha^2)$.

In order to determine the effect of planting restrictions on the number of trees planted, we only consider parcels with trees on them. In doing so, we open the possibility for selection bias to affect our

results. The inclusion of the inverse Mills ratio in the random effects model helps account for the possibility of sample selection bias (Wooldridge 2002).

A difficulty in identifying the impact of land rights on adoption is that some aspects of land rights are likely endogenous, particularly with respect to tenure security. It has been pointed out that some adoption decisions may be undertaken to increase productivity and tenure security simultaneously (Besley 1995; Deininger and Jin 2006). Tenure insecure farmers making costly improvements to the land may be doing so to strengthen their tenure position. Because we are examining land sovereignty rather than tenure security, endogeneity is unlikely. It is doubtful farmers give much weight to how planting trees in the current time period will affect the restrictions on their ability to plant trees in the future. The decision to plant trees is predominantly motivated by potential income trees produce and it is not likely farmers plant trees to strengthen their ability to plant trees in the future.

6. Data and Summary Statistics

Our data was collected by the Graduate Research Institute for Policy Studies (GRIPS) in Japan in collaboration with Makerere University in Uganda. This data includes information on 940 households in 29 districts of the East, West, and Central regions of Uganda. The survey was administered in 2003 and 2005, giving us an opportunity to explore factors affecting tree planting over time. The surveys are part of the Research on Poverty, Environment, and Agricultural Technologies (RePEAT) initiative. In total, 2208 parcels are available for investigation on mailo and customary plots.

The head of each household was asked questions about household composition, including questions concerning education, health, and labor activities for each household member. An agricultural section contained questions regarding household land use, input use, harvest characteristics, and agricultural assets. Questions about the household's formal tenure status and less formal indicators of

tenure security, such as the length of time on the land and acquisition channels, were included in the land survey.

The information of principle interest to this study comes from two questions about household tree planting activities. The first asks whether the occupant has the right to plant timber trees on a particular parcel. Respondents are given several options from which to choose in response to this question. Occupants may respond they have no right to plant timber trees on a particular parcel. This means, depending on the tenure status of the occupant, one of several parties deny the occupant the right to plant timber trees on that particular parcel. Most often these parties are mailo owners, extended family, or clan members, though in some rare cases they may be local authorities. The second option is households must ask permission from the mailo owner or family members before they plant trees. In this case, households are allowed to plant trees in certain situations, but must ask for permission before they plant. The last option is the household has the right to plant trees with no restrictions. In this case the household may plant trees on their land, without first seeking permission to do so.

Table 1 compares mean differences for parcels with and without trees on customary and mailo land. A large number of variables differ significantly between parcels with and without trees, suggesting sample selection is a concern in our data. On average, customary occupants grow only one-sixth the amount of trees as mailo occupants. Parcels which have trees on them are more likely to be titled and their occupants have occupied them longer on average. There is no significant difference in the proportion of female headed households or education levels of household heads between parcels with and without trees. Parcels with trees are more likely to have no restrictions on tree planting and the occupant is less likely to be prohibited from planting trees.

Table 2 shows means and standard deviations for variables in our models by the level of restriction on tree planting. We use parcels which have no restrictions on tree planting as a reference for difference in means tests. No differences exist in gender or education of the household head, when the data are disaggregated by restriction. Many differences exist between parcels where occupants have no right to plant and parcels with no restrictions. On average parcels without the right to plant trees have a title less often, been occupied less time, and are further from the homestead. They have fewer boys per household, but more off-farm income. Parcels with no right to plant are more likely to be under mailo tenure and less likely to be under customary tenure.

7. Results and Discussion

7.1 The decision to own trees

Table 3 contains results of the first stage probit regression for the decision to plant trees. Marginal effects are reported with standard deviations in parenthesis. Many of the signs of the coefficients are expected, though some variation exists between mailo and customary parcels. Both length of time occupying the land and parcel size have positive and significant effects on the decision to plant trees. Households occupying their land for longer periods of time have greater confidence they will collect benefits of long-term agricultural practices, such as tree planting. Larger parcels afford households greater flexibility in land use. Households with smaller parcels may not have enough area for tree planting to be worthwhile or the cost of devoting land to something other than subsistence food production may be prohibitively high. Walking time to the parcel and the distance to town both have a negative effect on the households' decision to plant trees. The household's ability to monitor and protect land decreases with increasing distance from the homestead. Households likely plant trees on land closer to their home to protect their investment. Distance from town is an indicator of market

access. The further a household is from a central market location, the greater the transactions costs for purchasing inputs and selling outputs, decreasing incentive for tree planting.

For some coefficients, differences exist in significance between mailo and customary models. First, years on land is not significant for customary owners, but is significant for mailo owners. This may suggest customary occupants view indicators other than length of time on a parcel as more informative of actual tenure security. Customary occupants may have greater trust in their families and communities than mailo occupants have in mailo owners. If so, greater trust would allow customary occupants to partake in tree planting sooner in their tenure on a parcel. Walking time to the parcel is negative and significant for customary occupants, but not for mailo occupants. The magnitude indicates for customary occupants each minute of walking time decreases the probability of having trees on the parcel by 0.2%. A parcel thirty minutes away from the homestead is 6% less likely to have trees on it, compared to a parcel at the homestead. This result suggests customary occupants are less comfortable than mailo occupants with planting trees on remote parcels. This is likely the effect of mailo occupants weaker land rights. Customary occupants have greater tenure security and protect their investment by planting trees closer to home. Mailo occupants have little security, regardless of the distance of a parcel from the homestead, and this effect overwhelms any consideration of distance.

Number of boys in the household has a positive and significant effect on number of trees on mailo parcels, but has no significant effect on customary parcels. Number of boys in a household affects tree planting in a couple different ways. First, boys can be an indication of household labor and the effect of additional household labor is expected to be positively correlated with number of trees. Number of boys in the household could alternatively be expected to have a negative effect, if the household plans to divide its land amongst the male members of the household. In this situation, the household head typically keeps the most valuable land for himself/herself and planting trees

significantly increases the land's value. Once trees have been planted on the land, it is unlikely that it will be divided among the children. Increasing the houshold's land with trees, reduces the size of the land remaining to be split among the male members of the household. Our results are consistent with these two hypotheses. Mailo occupants are less able to pass land down to their children, so the positive effect of household labor from additional boys is prominent. On customary plots, the family is more likely to divide their land among the male members of the household, so the interests of the boys have a negative effect on the decision to plant trees.

The dummy variable representing the year 2005 was positive for both mailo and customary occupants, though only significant for customary occupants. The government of Uganda, concerned with deforestation rates, has begun encouraging farmers to plant trees on private land. It is not surprising as education and incentive programs develop, more Ugandans are planting trees on private land. These programs are likely more influential for customary occupants because of their stronger rights than mailo occupants, as is reflected by the significant coefficient for customary households.

For the restrictions variables, the comparison group is parcels with no planting restrictions. Having no right to plant trees has a large negative and significant effect on the number of trees per parcel. This result suggests those imposing restrictions-mailo owners, family members, and clan members have significant sway over tree-planting decisions in Uganda. Mailo occupants are 18% less likely to have trees on a parcel where tree planting is prohibited, than on a parcel that has no tree planting restrictions. Customary occupants are also significantly impacted by tree planting prohibitions. Parcels under customary tenure are 17% less likely to contain trees, if the occupants are prohibited from planting trees. One implication of these results is most mailo and customary occupants view the threat of sanctions for violations of the tree planting restriction as credible. These results are again consistent with the premise that customary occupants have greater rights than mailo occupants. Mailo occupants,

on average, believe the price of disobeying is higher than customary occupants. Another implication of the findings is not all occupants view the threat of sanctions as credible. The fact the number of trees on the parcel is not reduced by 100% suggests some farmers maintain trees on prohibited plots despite the prohibition.

The results suggest needing permission to plant trees from either family members or mailo owners has no effect on the number of trees per parcel. For mailo parcels, the coefficients on permission from the mailo owner and permission from other family members are statistically indistinguishable from zero. We recognize it is uncommon an occupant is required to get permission from family or mailo owners. We had very few observations for permission needed from mailo owners (14) and permission needed from family (30). Thus, these results are heavily dependent on a small number of farmers who must ask permission before planting and should be interpreted with caution.

7.2 The intensity of tree planting

Table 4 presents results of the second stage of the selection models. In both models, the dependent variable is the log number of trees per parcel on mailo and customary plots. The models had fewer variables with significant coefficients than the binary model. Only mobile phone use, location in the western part of the country for customary occupants, and family restrictions for mailo occupants had significant impacts on the number of trees planted per parcel. The inverse Mills ratio was significant for customary land, suggesting exclusion of non-growers results in significant selection bias if the IMR is not included in the regression. The coefficient on the IMR for mailo land was not significant suggesting that sample selection was not a significant problem for the model of mailo occupants.

Prohibition of planting trees on a parcel reduces the number of trees on mailo land, though it is significant at the 10% level. Prohibition has no discernable effect on the number of trees planted by customary occupants. For the mean mailo occupant, a transition from having no rights to no restrictions

on tree planting would increase the number of trees on that parcel by 98%, a substantial change. This result may again be a reflection of differing relational dynamics with the landowner for customary occupants, relative to mailo occupants. Mailo occupants feel the price of disobeying the mailo owner is prohibitively high, where customary occupants seem little affected by a prohibition to plant trees, once they have made the decision to plant.

It is interesting to note the behavior differences between customary and mailo occupants. Once customary farmers decide to plant, having no right to plant does not impact the number of trees they plant. This may suggest customary farmers expect to be compensated for their trees once they have planted them. This result likely emerges from customary farmers' confidence that any sanctions resulting from their disobedience will not affect trees already planted. Disobedient mailo occupants are more conservative in the number of trees they plant, likely because they have an expectation the sanctions they face may affect trees they have planted. For instance, disobedience for mailo occupants may easily result in eviction from the land on which they have planted trees, leaving them with no compensation for the trees already planted. Customary occupants would expect eviction only under the most extreme circumstances, so once they have decided to disobey, they plant the same amount of trees as a farmer who is not restricted.

Having to ask a mailo owner for permission to plant trees has no effect on the number of trees planted by mailo occupants. Having to get permission from family members has a significant negative impact on the number of trees planted for mailo occupants, though not for customary occupants. At the mean, a mailo farmer who must first seek family permission plants 100% less trees than one who does not have to ask permission. It is interesting family restrictions do not have a significant effect on the decision to plant trees for a mailo owner, but do have an effect on the number of trees planted. This suggests the cost of seeking permission from family changes, once trees are established on a parcel. This

may suggest family members are supportive of small plots of trees, but do not support large scale agroforestry. Again, so few mailo occupants are required to get permission from family members before they plant that these results should be taken with caution.

8. Conclusion

Facing high deforestation rates and rapidly increasing population pressure, private tree planting has become an important economic activity in Uganda, for both individuals and the country as a whole. The strength of tenant land rights is a significant determining factor in the extent to which farmers privately invest in timber on their own land. This study investigates the impact of tree planting restrictions on the decision to plant trees and the number of trees planted, for occupants of customary and mailo land in Uganda. We distinguish between having no right to plant trees, from having to ask permission before planting and find the decision to plant trees and decision about how many trees to plant are governed by different processes. We find farmers who have no right to plant trees have less trees on their land than those that have no restrictions, for both customary and mailo occupants. We also find when landowners require permission before trees are planted, it has little effect on either whether occupants have trees on their parcel or the number of trees they have.

This study seeks to explain the wider phenomenon of tenant behavior in situations of limited sovereignty, in a rural developing country context. The results of this study have public policy implications in Uganda. The fragile land rights of mailo tenants have long been questioned as detrimental to both social and economic outcomes. This study uses empirical techniques to quantify the adverse economic effects of the limited land rights held by mailo and customary tenants. Strengthening land rights of mailo occupants would likely impact their decision to adopt long term agricultural practices, such as planting trees. Improvements in the land rights of customary occupants would likewise yield greater investment in private agroforestry. Considering much of Uganda is not currently

involved in timber production, the results imply landowners can provide significant disincentives for tree planting. We conclude when production decisions are taken away from occupants, who are best suited to make such decisions, a less than optimal economic outcome is likely.

9. Tables

Table 1. Means of parcels with trees and without trees

	Mailo			Customary		
	Trees	No trees	P-value	Trees	No trees	P-value
Number of trees on parcel	93.95	0.00	0.01	14.44	0.00	0.00
Title	0.16	0.10	0.04	0.06	0.03	0.01
Years on parcel	20.85	15.59	0.00	19.47	16.65	0.00
Walking time to parcel (minutes)	10.99	12.22	0.53	10.91	17.67	0.00
Parcel size (hectares)	4.74	2.73	0.00	4.56	1.55	0.00
Female head dummy	0.15	0.10	0.10	0.09	0.10	0.35
Head's age	45.43	43.88	0.23	45.93	44.29	0.02
Head's years of school	7.69	7.26	0.26	7.02	6.87	0.47
Number of boys in household	2.66	2.19	0.02	3.10	3.06	0.74
Mobile phone dummy	0.18	0.17	0.74	0.04	0.06	0.05
Off-farm income (US$)	33.75	29.95	0.58	26.96	39.46	0.02
West	0.03	0.02	0.52	0.00	0.08	0.00
East	0.00	0.00	.	0.97	0.86	0.00
Central	0.97	0.98	0.52	0.02	0.06	0.00
Distance to nearest town	18.40	22.82	0.00	15.70	16.31	0.29
No restriction on planting	0.87	0.74	0.00	0.90	0.81	0.00
Family permission required	0.01	0.01	0.68	0.02	0.01	0.42
Mailo permission required	0.01	0.02	0.24	0.01	0.00	0.12
No right to plant	0.09	0.20	0.00	0.06	0.15	0.00
N	177	381		585	1041	

Table 2. Summary of data by restriction level

	No restrictions		Restricted by family			Restricted by mailo owner			No right to plant		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	P-value	Mean	Std. Dev.	P-value	Mean	Std. Dev.	P-value
Number of trees on parcel	13.06	240.05	10.73	45.48	0.96	1.00	1.36	0.86	2.42	29.18	0.45
Title	0.07	0.25	0.00	0.00	0.14	0.05	0.07	0.94	0.02	0.13	0.00
Years on parcel	18.73	13.54	21.37	15.61	0.29	13.26	13.00	0.11	10.04	11.68	0.00
Walking time to parcel (minutes)	13.53	31.13	20.41	53.28	0.24	15.00	17.14	0.67	20.32	27.58	0.00
Parcel size (hectares)	3.05	16.99	2.65	3.41	0.90	1.81	1.83	0.79	1.69	2.86	0.17
Female head dummy	0.10	0.30	0.10	0.31	0.99	0.05	0.00	0.21	0.12	0.32	0.38
Head's age	45.12	13.54	46.60	18.24	0.56	36.32	36.29	0.01	43.32	13.77	0.03
Head's years of school	7.14	4.09	6.00	5.00	0.14	6.68	5.93	0.27	6.70	4.05	0.10
Number of boys in household	2.95	2.37	2.30	1.80	0.13	1.95	2.00	0.13	2.52	2.12	0.00
Mobile phone dummy	0.07	0.26	0.13	0.35	0.23	0.11	0.07	0.97	0.13	0.34	0.00
Off-farm income (US$)	31.89	95.28	26.55	68.21	0.76	24.41	17.99	0.59	45.44	131.19	0.03
West	0.05	0.21	0.03	0.18	0.71	0.00	0.00	0.40	0.02	0.14	0.04
East	0.68	0.47	0.77	0.43	0.32	0.47	0.43	0.04	0.59	0.49	0.00
Central	0.27	0.44	0.20	0.41	0.39	0.53	0.57	0.01	0.39	0.49	0.00
Distance to nearest town	17.37	12.79	21.46	16.65	0.09	11.37	11.50	0.09	18.43	14.04	0.20
Mailo	0.24	0.43	0.17	0.38	0.33	0.53	0.51	0.00	0.33	0.47	0.00
Customary	0.76	0.43	0.83	0.38	0.16	0.47	0.51	0.00	0.67	0.47	0.00
N	1840		30			14			290		

Table 3. Random effects probit results for selection model

Dependent variable: (=1 if trees are on parcel, 0=otherwise)	Mailo	Customary
No right to plant trees	-0.18***	-0.17***
	(0.048)	(0.036)
Permission from mailo owner required	-0.27	
	(0.227)	
Permission from family required	0.15	0.07
	(0.272)	(0.103)
Title	0.02	0.12
	(0.073)	(0.070)
Years on land	0.01**	0.00
	(0.002)	(0.001)
Walking time to parcel (min)	0.00	-0.002**
	(0.001)	(0.001)
Parcel size (acres)	0.01**	0.03***
	(0.005)	(0.005)
Female household head dummy	0.11	-0.07
	(0.086)	(0.044)
Household head's age	-0.00	0.00
	(0.002)	(0.001)
Household head's school	0.01	-0.00
	(0.006)	(0.003)
Number of boys in the household	0.03*	-0.01
	(0.012)	(0.006)
Mobile phone dummy	-0.03	-0.10
	(0.065)	(0.055)
Off-farm income	0.00	-0.00
	(0.000)	(0.000)
Distance to town (km)	-0.00*	-0.00
	(0.002)	(0.001)
2005	0.04	0.12***
	(0.050)	(0.026)
West		-0.25***
		(0.065)
East		0.21***
		(0.048)
N	558	1626
Groups	370	1111
Rho	0.51	0.26

Standard errors in parentheses p<.05 ** p<.01 *** p<.001

Table 4. Random effects regression results for intensity of tree planting

Dependent variable: Number of trees planted	Mailo	Customary
No right to plant trees	-0.98	0.22
	(0.542)	(0.162)
Permission from mailo owner required	0.42	
	(0.517)	
Permission from family required	-1.01*	0.27
	(0.394)	(0.452)
Title	-0.44	-0.42*
	(0.299)	(0.192)
Years on land	0.01	0.00
	(0.014)	(0.004)
Walking time to parcel (min)	0.01	-0.00
	(0.009)	(0.002)
Parcel size (acres)	0.05	0.00
	(0.041)	(0.005)
Female household head dummy	-0.42	0.14
	(0.248)	(0.190)
Household head's age	0.02	0.00
	(0.013)	(0.004)
Household head's school	0.03	0.00
	(0.027)	(0.010)
Mobile phone dummy	-0.32	1.33***
	(0.432)	(0.362)
Off-farm income	0.00	0.00
	(0.002)	(0.001)
Distance to town (km)	-0.02	0.00
	(0.012)	(0.005)
2005	0.07	-0.19
	(0.289)	(0.113)
East		2.39***
		(0.551)
West		-0.45
		(0.395)
IMR	-0.07	-1.14***
	(0.592)	(0.290)
Constant	1.03	2.80***
	(0.983)	(0.664)
N	177	585
Groups	144	464
Rho	0.21	0.47
Sigma	1.42	1.15

Standard errors in parentheses p<.05 ** p<.01 *** p<.001

References

Ali, D. A., Dercon, S., & Madhur, G. (2005). Property rights in a very poor country: Tenure insecurity and investment in Ethiopia. *World Bank Policy Research Working Paper,* 4363.

Alchian, A. A., & Demsetz, H. (1973). The property rights paradigm. *Journal of Economic History, 33*(1), 16-27.

Amacher, G. S., Ersado, L., Grebner, D. L., & Hyde, W. F. (2004). Disease, microdams and natural resources in Tigray, Ethiopia: Impacts on productivity and labour supplies. *Journal of Development Studies, 40*(6), 122-145.

Besley, T. (1995). Property rights and investment incentives: Theory and evidence from Ghana. *Journal of Political Economy, 103*(5), 903-937.

Bluffstone, R., Boscolo, M., & Molina, R. (2008). Does better common property forest management promote behavioral change? On-farm tree planting in the Bolivian Andes. *Environment and Development Economics, 13*(2), 137-170.

Bugembe, A. (2009, June 22). Timber trade banned in 23 districts. *The New Vision Online.* Retrieved June 20, 2010, from http://allafrica.com/stories/200906230066.html

Cameron, A. C., & Trivedi, P. K. (2009). *Microeconometrics using Stata* (Revised 2010 ed.). College Station, Texas: StataCorp LP.

Demsetz, H. (1967). Toward a theory of property rights. *The American Economic Review*, 57(2), 347-359.

Falkenberg, C. & Sepp, S. (2000). *Economic Evaluation of the Forestry Sector in Uganda.* Uganda Forest Department.

FAO (2007) *State of the world's forests.* Food and Agricultural Organization of the United Nations, Rome.

Gebreegziabher, Z., Mekonnen, A., Kassie, M., & Kohlin, G. (2010). *Household tree planting in Tigrai, northern Ethiopia: Tree species, purposes, and determinants.* Unpublished manuscript.

Hansen, J. D., Luckert, M. K., Minae, S., & Place, F. (2005). Tree planting under customary tenure systems in Malawi: Impacts of marriage and inheritance patterns. *Agricultural Systems, 84*(1), 99-118.

Jagger, P., & Pender, J. (2006). Influences of programs and organizations on the adoption of sustainable land management technologies in Uganda. In J. Pender, F. Place & S. Ehui (Eds.), *Strategies for sustainable land management in the East African highlands* (pp. 277-307) In collaboration with International Livestock Research Institute, World Agroforestry Centre, and World Bank; Washington, D.C.:; International Food Policy Research Institute.

Mekonnen, A. (2009). Tenure security, resource endowments, and tree growing: Evidence from the Amhara region of Ethiopia. *Land Economics, 85*(2), 292-307.

Nepal, M., Bohara, A. K., & Berrens, R. P. (2007). The impacts of social networks and household forest conservation efforts in rural Nepal. *Land Economics, 83*(2), 174-191.

Nibbering, J. W. (1999). Tree planting on deforested farmlands, Sewu Hills, Java, Indonesia: Impact of economic and institutional changes. *Agroforestry Systems, 46*(1), 65-82.

Patel, S. H., Pinckney, T. C., & Jaeger, W. K. (1995). Smallholder wood production and population pressure in East Africa: Evidence of an environmental Kuznets curve? *Land Economics, 71*(4), 516-530.

Salam, M. A., Noguchi, T., & Koike, M. (2000). Understanding why farmers plant trees in the homestead agroforestry in Bangladesh. *Agroforestry Systems, 50*(1), 77-93.

Scherr, S. J. (1995). Economic factors in farmer adoption of agroforestry: Patterns observed in western Kenya. *World Development, 23*(5), 787-804.

Swinton, M. S., & Quiroz, R. (2003). Is poverty to blame for soil, pasture and forest degradation in Peru's Altiplano? *World Development, 31*(11), 1903-1919.

Tabuti, J.R.S., Dhillion, S.S. & Lye, K.A. (2003). Fuelwood use in Bulamogi County, Uganda: Species harvested and consumption patterns. *Biomass & Bioenergy,* 25(6), 581-596.

Wooldridge, J.M. (2002). *Econometric analysis of cross section and panel data.* Cambridge, MA: MIT Press.