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Determinants of Households' Land Allocation for Crop Production in Uganda

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Abstract

Using UNHS 2005/6 and 2009/10 data, we examined various cropping and land allocations patterns practiced by farming households in Uganda, and their implications on government plan of prioritizing some crops for expansion and zoning. On average, households were observed to cultivate 1.7 ha despite having ownership right to 1.58 ha. A decrease in total cultivated area across all the twelve sub-regions was observed between 2005 and 2009. Over time, only the proportions of land allocation to sweet potato and bean are increasing. Fractional multinomial logit model estimates showed that significant factors that influence share of land allocated to crops include household location within sub-regions, size of cultivated land, distance to output markets and education levels of household head. Efforts to commercialize agriculture through prioritized expansion and zoning of certain crops should also target breaking the current culture of diversified cropping patterns on small sizes of land.

Keywords: agricultural commercialization, smallholding, land-use policy, cropping patterns, land allocation, Uganda

1. Introduction

The Government of Uganda has developed a blue print of enhancing the role of agriculture in food and income security [Ministry of Agriculture Animal Industries and Fisheries (MAAIF), 2010].One of the recommendations to improve agriculture is the promotion of some selected agricultural crop enterprise. Crops prioritized for promotion include maize, coffee, beans, tea, cassava and banana. Queries have been raised on the factors that would influence the success of the government interventions in agriculture. This is especially, with the changing macro and micro- environment, which affects agricultural production [Africa Capacity Building Foundation (ACBF), 2012]. Moreover, researchers have shown that cultivation of small land sizes (common in Uganda) is not economically viable (Carswell, 2002; Jayne and Muyanga, 2012; Jayne, *et. al,* 2012; Benson, *et. al.*, 2008). It is important to have a thorough understanding of household land-size holdings, patterns of land allocation to different crops and trends in ownership and allocation, in order to reinforce government efforts of intervening in agricultural sector (MAAIF, 2010; Uganda Bureau of Statistic_UBoS, 2010) as well as transforming the economy [Government of Uganda (GoU), 2010].

Field survey reports on crop popularity amongst agricultural households across the country (UBoS, 2010) indicate that the same crops targeted for expansion by the government as stipulated in the Agricultural Sector Development Strategy and Investment Plan (DSIP)(MAAIF, 2010)are also propagated by a large proportion of farmers across time and regions (UBoS, 2010). It therefore implies that the successful implementation of the DSIP (MAAIF, 2010) will depend on first of all understanding the factors that influence allocation of land to crops and yields achieved, and later designing working strategies to increase production. One of the pertinent questions is whether there exists opportunity to increase production within zones through land expansions, and whether farmers are willing to drop the current cropping patterns (Ebanyat, et al., 2010) in favour of DSIP recommended patterns. Information on the prevailing socio-economic factors that will affect household expansion of land to various crops is also missing (MAAIF, 2010).

Due to the critical role land plays in influencing agricultural production in Uganda[Ministry of Land Housing and Urban Development (MLHUD), 2011], understanding household land allocations will provide vital lessons on factors that influence resources allocation for the sector. The information will also help in developing land policies and implementation of the relevant strategies to ensure sustainable land and agricultural development (MAAIF, 2010; MLHUD, 2007). Understanding land allocation patterns is important in agricultural development as it signals how households schedule to utilize other factors of production for various crop enterprises. This paper sets to establish determinants of land share allocation to crops in Uganda. Objectives of the study are to determine factors influencing the share of land allocation to major crops in Uganda and to elucidate changes in cropping patterns and land allocation over time. Understanding land allocation and changes will shed light on the reasons of the observed reduction in agricultural production and shifts in the crops produced, decreased contribution to the economy and increasing food insecurity (Benson, *et. al.,* 2008).

2. Literature Review

Based on the development stage of a country or settlement, two major theories have been adopted in explaining land allocation and changes observed. The chayanov's theory, which has been favoured for developed societies e.g. Europe, stipulates that household size, age structures and dependency levels which are factors of family labour force availability determine land allocation to agriculture (Perz, 2002). The Amazonian theory has largely been used to explain land allocation and dynamism in use in the newly settled areas especially in South America (McCracken, *et al*. 1999). It stipulates that land allocation is influenced by the stage of household life cycle, specific duration of residence and household age (Pichon, 1997). Both theories have one common assumption that land is not limiting (Perz, 2002; McCracken, *et al.,* 1999). While the two theories may provide insights on factors influencing land allocations in Uganda, they may not be appropriate because land availability has been shown as limiting agricultural production (Benson, *et. al.*, 2008). Furthermore, the two theories are based on rich historical information on settlements (Carmona, *et al.,* 2010) and have categorized household land use into broader patterns including perennial and annual crops, pastureland management and forestland allocations.

Economists have also adopted the use of agricultural household model in determining resource allocation for production (Singh, *et al.,* 1986). The model considers agricultural households to be involved in maximization of both production and consumption. Decisions on what to produce and consume are simultaneously made with the aim of maximizing profit and utility, considering the constraints presented by resource availability. The use of profit and utility maximization approach yields better results in situations where households operate in a complete market. Where households operate in incomplete markets, the agricultural household model predicts production decisions to be a factor of preference and endowment of households.

Wortmann and Eledu (1999) provide an agricultural development strategy that would target promotion of crops based on prevailing biophysical and socio-economic characteristics of the community. This is through publication of the agro-ecological zones in Uganda. The entire country has been categorized into fourteen agro-ecosystem zones with a goal of guiding the cropping patterns that are likely to yield highly, and be easily adopted in specific locations. Delineation of the agro-ecosystem zones was based on the amount of rainfall, minimum temperature, dominant soil type and farming system that is widely adopted by farmers.

In an effort to enhance agricultural production and productivity, the government has prioritized some commodities (crops) for expansion and intensification in different locations as stipulated in the DSIP (MAAIF, 2010). The selection was based on crop's cumulative score for a number of indicators such as return to investment, priority within agro-ecological zones, number of households involved, contribution to export, poverty effect, size effect and potential future impact. Commodities that had the highest cumulative score include maize, coffee, fishery, dairy cattle, beans, beef cattle, and tea. Through the process of prioritization of the commodities, DSIP lists benefits and challenges of promoting the selected enterprises but fails to sufficiently incorporate prevailing socio-economic characteristics of households as a factor to influence success of the intervention.

Other reports provide insights on land allocation to various crops with limitations on trends and analysis that are crucial to guide the implementation of the DSIP. For example, in an effort to have a system of Food and Agricultural Statistics in place, UBoS (2010) presents a report of a survey on area, production, yields and disposition of major crops in the country. The report shows the total area and yield for 21 crops per district in the second season of 2008 and first season of 2009. It goes further to present how the produce was utilized including proportion sold, consumed, stored and used for other purposes. It shows maize, banana, beans and sweet potatoes as the most popular crops in households across seasons.

Using small-scale farm surveys, data of Ethiopia, Kenya, Mozambique, Rwanda and Zambia, Jayne et al., (2010) highlighted challenges to smallholding agriculture. Some of these challenges include: adoption of technology, inability to escape poverty, failure to achieve commercial production, poor access to produce market and negative impacts in case of higher agricultural produce prices. They conclude that small land holding has no economic future in Africa and recommended government interventions in policy and investment towards land issues. Understanding the size of land holding, crop allocations and trend in Uganda is important in view of the observation and recommendation being highlighted elsewhere and to guide policy and investment decisions.

Changes in agricultural cropping patterns have been reported in some areas of the country, with land allocation to some crops increasing and diminishing in other areas (Ekanyat, *et. al.,* 2010). Reported drivers of change include diversification of crops, changes in land fertility and socio-economic instability as a result of local and national conflicts. More national based studies are, however, required to quantify changes and establish factors influencing land allocation. In addition, studies should be able to provide a better explanation of cropping patterns. There is limited published information on determinants of land allocation in Uganda unlike those on labour allocation and diversification strategies by households (Bagamba, *et al.,* 2009; Smith *et al*., 2001).

Elsewhere in Africa, a number of studies on land allocations have been reported. Chibwana, *et al.,* (2012) used a Tobit model to regress factors that influenced share of land allocation to maize, tobacco and other crops in Malawi. The study showed positive correlations between participation in the farm input subsidy program and the share of land planted with maize and tobacco. Using a Tobit model to determine the factors that influence adoption and the extent of land allocation for *Jatropha curcas* in Malawi, Mponela and others, (2011) report household characteristics such as:age, education of household head, availability of labor, ownership of uncultivated land, ownership of livestock and non-farm income as the factors that influenced land allocation *to Jatropha curcas.* Random-effects Tobit model was used to estimate cropland allocation decisions for upland agricultural households in Philippines using panel data (Coxhead and Demeke, 2004). The study reported total farm area, expected revenue of various crops (own and cross), wage rate, slope, distance to the road, available farm labour force and the age of household head to have significantly affected land allocations to various crops.

Wu and Segerson (1995) used crop choices by farmers to determine policies and land characteristics that will affect groundwater quality in Wisconsin, USA. They adopted a logistic transformation model, described by Plantinga (2006) to estimate the share of land allocated to various crops. Wu and Brorsen (1995) analyzed the impacts of policy options' simulation that were aimed at discouraging corn production on cropping patterns of nine crops in Wisconsin using the logistic transformation model. Mu and McCarl (2011) used the fractional multinomial logit model to show how farmers were changing shares of land allocated to various crops in response to climate change.

3. Material and Methods

3.1 Data Sources

The Uganda National Household Survey (UNHS III) data collected in 2005-06 and Uganda National Panel Survey (UNPS) of 2009/10 were used. The two databases are nationally representative and collected by the Uganda Bureau of Statistic (UBoS). In 2005/06, UBoS collected information from 7,421 households. UBoS successfully re-surveyed 2,566 households of those surveyed under UNHS III during the UNPS (2009/10).

Information was collected at individual, household and community levels using the household, agriculture, and community questionnaires. The household module captured general demographic characteristics of the household. The agriculture module provided information on household crop farming enterprise particulars, with emphasis on land ownership and crop area among others.

The two databases were longitudinally merged to provide a rich database that would permit observation over the two periods and cross-sectional information. The longitudinally merged data had advantages of improving the efficiency of econometric estimates (Hsio, 2007) and allowed focusing agricultural activities at the sub-regional level. Sub-regions in Uganda are important as they present agro-ecological differentiation, which is critical for any agricultural analysis (Wortmann and Eledu, 1999). Figure 1 shows the locations of various sub-region of Uganda. The study interest was in determining land allocation at any time considering existing socio-economic environment of households, hence the panel was unbalanced and also considered households that were interviewed at each wave (Sigelman and Zeng, 1999; Chirembe and Williams, 2003). A total of 3645 agricultural households were used in this study from both panels with analysis at the household level. This was after dropping household data from Kampala and Karamoja sub-regions and cleaning of the remaining data. Kampala sub-region, which basically covers the city settlement, was not utilized due to its urban nature while Karamoja was dropped, as its economic activity is largely pastoral.

3.2 Conceptual Framework

Farming households have been involved in growing some specific crops (UBoS, 2011), which need to be dropped or expanded if the government plan for zoning production (MAAIF, 2010) areas is implemented. It is anticipated that whichever crop is adopted for an area, some trading off between crops (Wu and Brorsen, 1995) will take place, as farmers are already involved in multiple cropping patterns (UBoS, 2010). The success of the zoning process will depend on a number of factors including the crop prioritized for a given region and whether that crop enterprise meets the aspiration of households' engagement in production (Ebanyat, *et al*, 2010).

Figure 1. Location of sub-regions in Uganda

Source: UBoS and Measure DHS, 2013

Aspirations for households to engage in agriculture production are either income generation, food security, or both (Jayne*, et. al.,* 2010; Ebanyat, *et al*, 2010). The constraints influencing choice of a crop enterprise and share of resources allocated to it include: labor availability (Bagamba, *et. al.,* 2009); land availability and quality; knowledge based on an enterprise; and risks associated with weather factors, market forces and pestilences (Wortman and Eledu, 1999). Although our concept borrows from the agricultural household models (Singh, *et. al.,* 1986), we refrain from adopting the profit and utility maximization due to insufficiency of data on among others market (price) information on inputs and outputs.

Even as the government attempts to implement the zonation production, households will be faced with the same aspirations, opportunities and constraints they face today. However, socio-economic factors related to head of household, households and community characteristics exist and are known to influence agricultural production aspirations, opportunities and constraints (Chibwana, *et al.* 2012; Bagamba, *et al*. 2009; Mponela *et al.* 2011; Coxhead and Demeke, 2004). We estimate the share of land allocated to crops as influenced by the characteristics of household head. The patterns of land allocation to crops are hypothesized to change with variations in the characteristics observed in a household.

In this case:

$$(p_{i1},\ p_{i2},\ldots\ldots\ldots\ldots\ p_{ik-1,}p_{ik}) = f\ (\ X_1,\ X_2\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots X_n) \quad (1)$$

Where pi is the proportion of land allocated to a specified crop out of the total land cultivated while X represents explanatory variables related to household head, households and community characteristics. The explanatory variables used in this paper are assumed to be the farmers' socio-economic factors that will influence the implementation of the zoning production plans.

The use of share of land allocated to a crop takes cognizant that: (a) the sizes of land owned by farmers varies widely and a household can only allocate to use the land it has rights over; (b) households involved in multiple cropping with specific crops allocated to the land; and (c) some unobserved factors influence farmer's decisions to allocate a specific share of land to a given crop, considering their production utility maximization function against constraints presented by limitation of resources (land, labor, capital and management) and risk averseness.

Conceptually, the sum of shares allocated to all the crops equal unity or 1, which is the total land cultivated. If shares of land allocated to crops are represented in a pie chart, it is expected that the explanatory variables that change the "slices of the pie chart" will change accordingly, based on interactions between the dependent and explanatory variables. More so, what the government aims to achieve through the zonation process is to have some "slices of the pie chart" expand while others contract. Using available data on the characteristics of the farmers and their farming systems, we attempt to predict the households based factors that will influence the zonation production proposal.

3.3 Model specification and estimation

We estimate household share of land allocated to different crop enterprises based on choices made and some explanatory variables. The household is faced with the choice of allocating land to: a) maize, b) beans, c) banana, d) coffee, e) sweet potato, f) cassava, g) leaving the land under fallow and/or h) propagation of any other crops. The choice of the above crops was influenced by their popularity with farmers (UBoS, 2010) and their prioritization for expansion (MAAIF, 2010).

The observed household land allocation to each of the crop enterprise is designated as j1, j2, and j8 respectively.

We adopt an aggregate land allocation model described by Miller and Platinga (1999) and Platinga (2006), which has been used by a number of economists in dealing with estimations of factors influencing share of land allocated to various use (Wu and Segerson, 1995; Mu and McCarl, 2011; Wu and Brorsen, 1995). The expected share of any crop is estimated by specifying its probabilities as influenced by a vector of explanatory variables and then constraining the linear form to the unit interval by a convenient transformation (Miller and Plantinga, 1999).

The logistic specification model for the share functions is as follows:

$$\mathrm{P_{ij}} = \frac{e^{Xik\beta k}}{\sum_{k=1}^{8} e^{Xik\beta k}}\,\forall j = 1,2,\ldots\ldots,8 \quad (2)$$

Xik are explanatory variables and βk measure the effect of explanatory variables on the expected land allocation shares (P_{ij}). The model is a system of K-1 equations where in this case we have seven equations since we are dealing with eight crop enterprises.

Based on this equation, a log-likelihood function and parameters can be estimated. A fractional multinomial logit (FMNL) model as described by Sivakumar and Bhat (2002) and utilized by Papke and Woodridge (2008) and Koch (2010) was used. FMNL fits by quasi-maximum likelihood (Mullahy, 2011). Unlike multinomial logit (MNL), where outcome values take either 1 or 0, FMNL outcome values are proportions. FMNL estimation could also be considered as a maximization of the MNL log likelihood function. FMNL model assumes the Independence of Irrelevant Alternatives (IIA) hypothesis (Hausman and McFadden, 1984) hold and require that the sum of the probability of allocating land to the crop(s) should be unity (one).

$$\sum_{j=1}^{8} P_{ij} = 1 \quad (3)$$

We estimate random effect multivariate outcomes measured as shares of land allocated to various crops to the total land cultivated using the fractional multinomial logit model on panel data (Mu and McCarl, 2011; Papke and Woodridge, 2008).

FMNL requires a rich data due to complexity of model specification. Estimated elasticities are quite similar across the model (Koch, 2010). The logistic function adopted has been criticized as being ad hoc, but the practical advantage has outweighed the conceptual shortcoming (Miller and Plantinga, 1999). The logarithm of the relative expected shares is linear in the model parameters, and the model identified if setting the coefficient equals to zero normalizes the parameters. By modeling using aggregate data and the appropriately defined categories, we avoid the challenge of zero shares in case of specific individual dependent variable.

3.5 Description of the Variables

The variables used in estimation include those based on agro-ecological factors, household characteristics and access to agricultural facilitative services. These variables are described in Appendix A.

4. Results and Discussion

4.1 Descriptive Statistics

4.1.1 Land Ownership, Size and Cultivation

Table 1 shows land ownership and allocation to crop cultivation in 2005 and 2009

It was observed that households were cultivating larger land sizes than the size they had ownership rights[1] to, in all sub-regions in 2005. On average, households utilized at least 29 percent of land they did not own in 2005 at national level, although there was variation across sub regions. The practice was mostly common in South Western and least common in West Nile.

[1] Ownership rights refer to owning land under any of the tenure system in Uganda including freehold, leasehold, mailo, and customary (MLHUD, 2007).

Table 1. A comparison of total land owned to total cultivated across regions in 2005 and 2009

	Average cultivated land area (acres)	Land ownership right (acres)	Proportion[2] land used without rights (%)	Average Cultivated land area (acres)	Land ownership rights (acres)	Proportion land used without rights (%)
	-----------------2005----------------			----------------------2009---------------		
National	2.065	1.458	29	1.701	1.58	7
Central 1	1.903	1.256	34	1.823	1.296	29
Central 2	2.268	1.418	38	2.187	1.944	11
East Central	1.985	1.377	31	1.58	1.498	5
Eastern	2.268	1.58	30	1.823	1.377	24
North	1.863	1.58	15	1.701	1.782	-5*[a]
West Nile	2.147	2.066	4	1.701	2.309	-36*[b]
Western	2.187	1.539	30	1.458	1.134	22
South West	2.066	1.337	45	1.742	1.499	14

*NB: * Households only utilizing land with ownership rights. Of such land [a]5% is not utilized and [b]36% is not utilized.*

By 2009 use of land without ownership rights nationally reduced significantly to 7 percent, implying that there could have been increased land acquisition and ownership. Nonetheless, large segments of households (about 40 percent) were still using land without ownership rights in 2009 (see appendix B). Lack of ownership rights has been observed to limit farmers' options in production to annuals and adoption of high yielding technologies (Ebanyat, *et. al.,* 2010). Generally, households in the North and West Nile had sufficient land and were therefore relying on land they had ownership rights over, for cultivation.

Figure 2 shows proportion of the households cultivating various sizes of land in Uganda in 2005 and 2009. Households cultivating less than 0.4ha, accounted for 15 and 10 percent in 2009 and 2005respectively. Those cultivating above 2.43 ha accounted for 21 and 25 percent in 2009 and 2005 respectively. The proportion cultivating smaller land size was observed to be higher in 2009 than 2005. Therefore, cultivated land sizes seem to decrease with time and this has implications on agricultural production.

[2] Rights refer to ownership rights

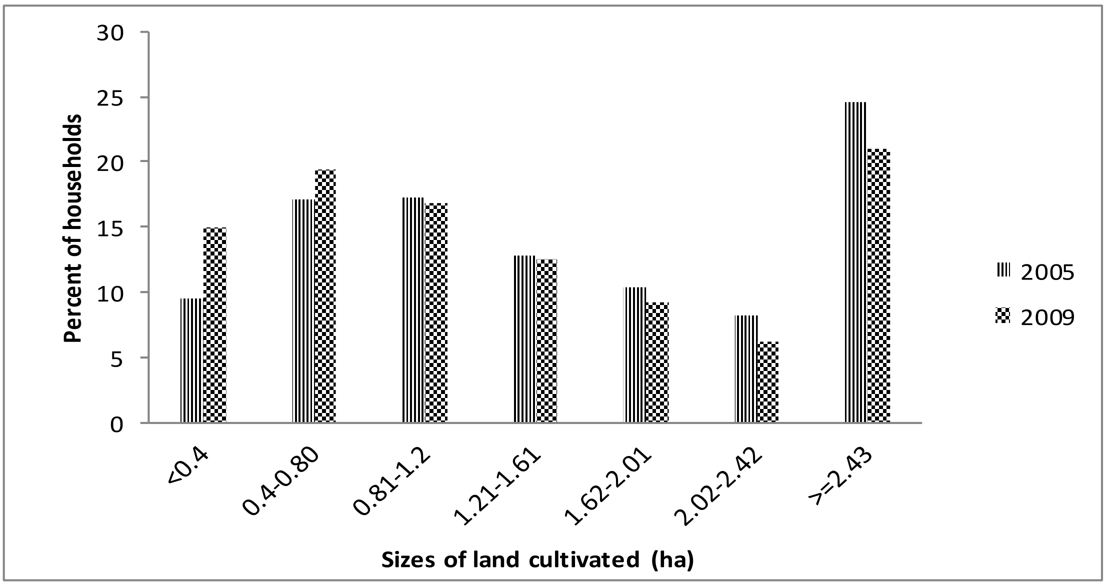

Figure 2. Proportion of households cultivating various sizes of land in 2005 and 2009

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10)

Household with different land sizes may require different cropping mix for efficiency in land resource utilization. Farmers with small land sizes need to adopt cultivation of high value crops e.g. horticulture (Jaetzold, *et. al.,* 2005). High value crops are resource (land, labour, capital and management) intensive, while those cultivating bigger land sizes could augment returns by adopting cropping patterns that requires large scale for optimization.

Figure 3 shows the share of cultivated land allocated to various crops by farmers. Coffee and fallow occupied most land (more than 25%) for farms of above 2.43ha while sweet potatoes and beans occupy most of the land for households cultivating less than 0.51 ha of land.

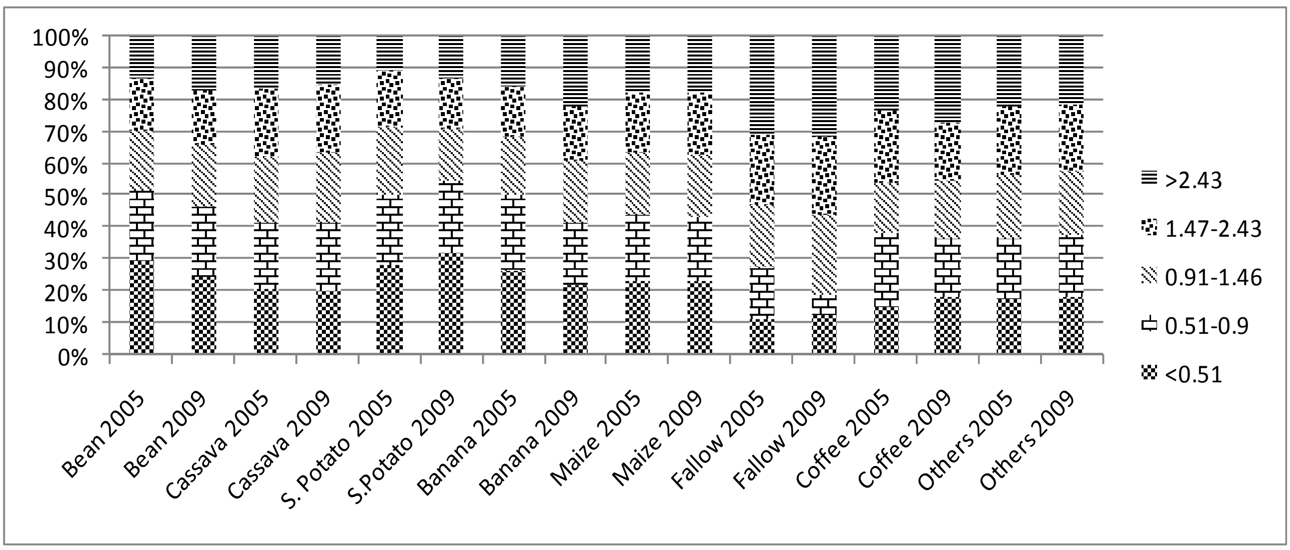

Figure 3. Share of land allocated to various crops in different land size categories in 2005 and 2009

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10)

In 2009, more land was under coffee than in 2005 for the households, which cultivated more than 2.43 ha. The proportion of land allocated to sweet potato among the households cultivating the least land size increased from 30 to about 35 percent in 2009. More than a fifth of land was allocated to beans, maize and banana for households cultivating small sizes of land.

Except for the few crops i.e. coffee, fallow and sweet potato that seemed to be allocated more than a third of cultivated area in the two years, all other crops failed to depict clear linkages between the allocated land size and the year. Shifts were observed on proportion of land allocated to beans, sweet potato and banana among the households cultivating less than 0.51 ha between 2005 and 2009. Proportion of land allocated to beans and banana reduced by about five percent, while those of sweet potato increased by about four percent in 2009. Share of land allocated to both banana and coffee, expanded by five percent between 2005 and 2009 among households cultivating above 2.43 ha.

4.1.2 Land Allocation to Crops Across Seasons

It was observed that households allocate small parcels of land to different crops, while they concurrently farm a large number of crops (Table 2). Out of approximately1.9 and 1.4 ha cultivated during the first and second seasons, maize was allocated 0.2 and 0.16 ha in the two seasons respectively.

Table 2. Land allocation to different crops in 2005 and 2009 across sub-regions

	Overall	Central 1	Central 2	East Cent.	Eastern	North	West Nile	Western	South West
				-----------------------Average area allocated to different crops in ha----------					
Season 1									
Cultivated area	1.904	1.78	2.15	1.72	2.0	1.72	1.90	1.86	1.98
Banana	0.12	0.24	0.16	0.04	0.04	0.0	0.04	0.12	0.24
Bean	0.12	0.12	0.12	0.04	0.08	0.16	0.04	0.12	0.16
Cassava	0.16	0.12	0.16	0.20	0.20	0.16	0.36	0.16	0.08
Maize	0.20	0.12	0.28	0.32	0.20	0.20	0.12	0.24	0.12
Coffee	0.04	0.12	0.16	0.08	0.04	0.0	0.04	0.08	0.04
Sweet potato	0.08	0.08	0.16	0.16	0.04	0.04	0.04	0.04	0.08
Fallow	0.12	0.08	0.08	0.08	0.16	0.12	0.45	0.04	0.08
Other non-major crps	1.05	0.93	1.01	0.89	1.26	1.09	0.85	1.09	1.17
Season 2									
Cultivated area	1.38	1.46	1.78	1.34	1.3	0.93	1.74	1.09	1.42
Banana	0.12	0.24	0.16	0.04	0.04	0.0	0.0	0.12	0.24
Bean	0.12	0.12	0.16	0.08	0.08	0.08	0.04	0.08	0.16
Cassava	0.14	0.08	0.16	0.24	0.24	0.16	0.36	0.08	0.08
Maize	0.16	0.12	0.28	0.36	0.08	0.12	0.04	0.16	0.12
Coffee	0.04	0.12	0.12	0.08	0.04	0.0	0.04	0.04	0.04
Sweet potato	0.08	0.08	0.16	0.12	0.08	0.04	0.04	0.04	0.08
Fallow	0.12	0.08	0.12	0.04	0.24	0.12	0.41	0.04	0.08
Other non-major crps	0.57	0.61	0.61	0.41	0.53	0.45	0.73	0.53	0.65

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10)

Cassava was allocated 0.16 ha in both the first and second seasons. Both beans and banana were allocated equivalent parcels of approximately 0.12 ha in each of the two seasons. Sweet potato was allocated 0.08 ha of land in both seasons while fallow occupied 0.12 ha in each of the seasons. Other non-major crops occupied 1.05 ha, which accounted for more than a half of the cultivated land in the first season. In the second season however, other non-major crops occupied 0.57 ha of land, which accounted for about 40 percent of cultivated land.

No major changes were observed between the areas allocated to crops in the first and second season especially among the specified crop enterprises. However, there was variation across the sub-regions. Noticeable change was mainly in the reduction of share of land allocated to other non-major crops between the two seasons. In the first season, the area under cultivation ranged between 1.78 and 2.15 ha in all the sub-regions. A reduction was observed between the sizes of land cultivated in the first season and that in the second season across all sub-regions. While average land sizes allocated to the majorly specified crops remained constant between the two seasons, those for other non-major crops decreased in tandem with reduction of cultivated area observed between the seasons.

Among the specified major crops, maize was allocated the most land in Central 2, East Central, Eastern, North and Western during the first season. Cassava and banana were allocated the largest proportion of land among the specified major crops in West Nile and South West respectively during the first and second season. Perennial and semi-perennial crops including coffee, banana and cassava maintained the same area over seasons as expected, due to the fact that farmers rarely remove these perennials after initial propagation.

A number of reasons could be associated with the observed cropping patterns where farmers are propagating a variety of crops but allocating each a small proportion of land. Some of the factors attributed to the observed cropping patterns include: production for households' consumption, risk averseness for investment in monoculture farming system, and balancing households' resource allocation for optimal returns. The risk in agricultural production may be as a result of losses associated with droughts, diseases and pestilence, and produce market failures. Although the observed production system is good for households' nutritional needs, it hinders agricultural transformation in a number of ways (MAAIF, 2010). First, it limits profits from production, as the cost of assembling produce for the market is quite high to achieve an economic consignment. Secondly, the low returns from little amount produced per crop fail to motivate farmers to adopt high yielding technologies (Mbah, *et. al.,* 2007).

4.1.3 Dynamics of Land Allocation to Crop Production between 2005 and 2009

Over the duration between the two panels, major shifts were observed in the absolute land area allocated to crops. Figure 4 shows the percentage change of land allocated to various crop enterprises between 2005 and 2009. Overall, the size of land cultivated decreased by seven percent between the two durations of data collection. Sweet potato experienced the highest expansion of about 40 percent, followed by beans with 20 percent. At the national level the major losers on land allocation included fallow, coffee, other non-major crops and maize.

In Central 1, cassava, maize and beans experienced the highest levels of expansion at 39, 33 and 28 percent respectively. Areas allocated to other non-major crops, beans, coffee, maize and sweet potato expanded by 70, 55, 49, 20 and 15 percent respectively in Central 2 while the area allocated to banana cultivation declined by 20 percent. Although a decline in cultivated area in East Central was reported, high expansions of 81, 72 and 34 percent were observed on the share allocated to sweet potato, beans and coffee. On average, households' total cultivated land reduced in Eastern, North, West Nile and Western. A sharp increase of share of land allocated to coffee and banana was observed in North and West Nile. Land allocated to cassava and beans increased while fallow reduced between the duration of the panel. Changes recorded on cropping patterns for the North sub-region are attributed to resettlement and restoration of peace after decades of political disturbances.

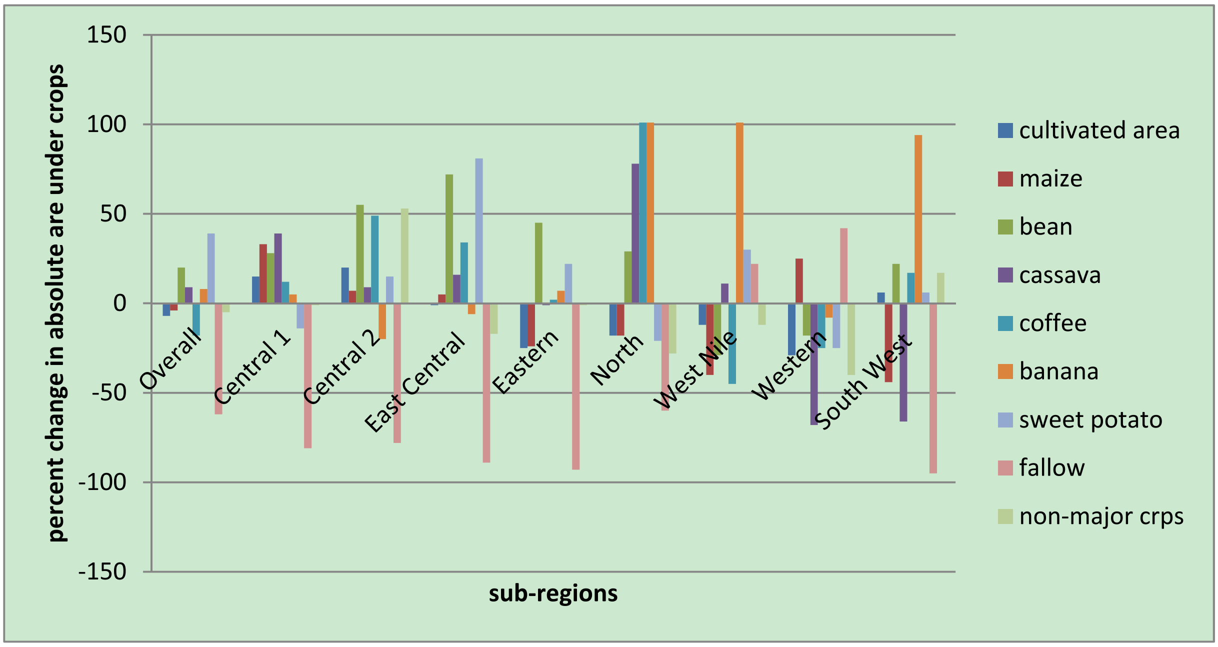

Figure 4. Percentage change of land allocated to different crops between 2005 and 2009

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10)

There was a decrease in land left to fallow in South West, Eastern, East Central, Central 2 and Central 1 implying that there is an increasing land demand for production. The area allocated to other non-major crops decreased in the Western, West Nile and East Central.

4.2 Analytical Results

Table 3 shows the discrete change of explanatory variables derived from the results of fractional multinomial logit estimates of land share allocated to crops by households. The results were robust and significant at P<0.01. In the analysis, the share of land allocated to banana was used as the base value. As cultivated area shifted from minimum to maximum value, share of land allocated to sweet potato decreased by 47 percent (t-value = 3.09) while those of fallow, coffee and other non-major crops increased significantly by 13, 3 and 49 percent respectively.

Table 3: Discrete change for factors influencing share of land allocated to crop for the fractional multinomial logit model

Share of	banana		bean		cassava		sweet potato		maize		fallow		coffee		non-major crops	
	dy/dx.	*t-value*	*dy/dx.*	*t-value*	*dy/dx.*	*t-value*	*dy/dx.*	*t-value*	*dy/dx.*	*t-value*	*dy/dx*	*t-value*	*dy/dx.*	*t-value*	*dy/dx.*	*t-value*
[1]Continuous variable Min - -→ Max																
Areacult_log	-0.037	0.47	-0.101	-0.47	-0.027	0.64	-0.472	-3.09	-0.005	1.05	0.129	8.04	0.026	4.62	0.487	4.05
Distaoutmar_log	-0.027	-2.19	0.003	2.19	0.001	1.99	0.021	2.92	0.043	3.66	0.025	3.08	-0.019	-1.59	-0.046	2.04
Adultratio_log	-0.005	1.38	-0.046	-1.38	0.011	0.72	-0.008	-0.07	-0.022	-0.47	0.016	1.32	0.005	1.1	0.048	0.74
hsize	0.019	2.03	-0.029	-2.03	-0.026	-1.81	0.084	1.53	0.022	-0.35	-0.005	-0.85	0.012	0.47	-0.077	-1.77
Hheadedu-log	0.018	1.98	-0.005	-1.98	0.009	-1.1	0.007	-0.99	0.002	-1.43	0.012	-0.08	-0.006	-2.25	-0.037	-2.23
Dummy variables																
hhsex	-0.011	-2.05	0.003	2.05	0.007	2.12	-0.016	-0.18	0.007	2.25	-0.001	0.89	0.001	1.5	0.010	2.13
Fertiliser use	0.018	3.29	-0.003	-3.29	-0.021	-4.41	0.001	-2.4	-0.024	-4.99	-0.010	-3.2	0.005	-0.47	0.035	-2.88
Hiring labour	-0.002	-0.03	-0.003	0.03	0.002	0.54	0.007	1.3	0.020	2.5	-0.008	-1.18	-0.002	-0.74	-0.015	0.12
Central 1	0.015	0.49	0.007	-0.49	-0.024	-1.37	0.014	-0.15	0.007	-0.45	-0.008	-0.47	-0.005	-0.9	-0.005	-0.79
Central 2	-0.017	-0.47	-0.018	0.47	0.003	1.14	0.043	1.98	0.061	2.2	-0.019	-0.26	0.000	0.63	-0.053	0.92
East Central	-0.043	-1.63	-0.047	1.63	0.023	3.81	0.040	3.77	0.125	5.05	0.005	1.46	-0.008	1.16	-0.096	3.17
Eastern	-0.046	-3.00	-0.023	3.00	0.041	4.7	-0.019	2.45	0.011	3.67	0.057	2.45	-0.015	0.09	-0.006	4.15
North	-0.081	-6.66	0.011	6.66	0.051	7.34	-0.027	5.07	0.024	6.79	0.033	3.98	-0.029	-0.28	0.019	6.86
West Nile	-0.053	-3.22	-0.058	3.22	0.133	7.72	-0.021	3.93	-0.037	4.02	0.161	4.02	-0.015	1.09	-0.110	5.48
Western	-0.018	-0.9	-0.006	0.9	-0.035	-0.06	-0.022	0.07	0.015	1.34	-0.010	0.08	-0.010	-0.65	0.086	1.58
South West	0.013	-0.51	0.043	0.51	-0.087	-3.56	0.030	0.37	-0.053	-2.18	-0.012	-0.61	-0.017	-2.29	0.083	-0.31

Observation = 2154 Wald chi2(112) = 2539.2 Log pseudolikelihood= - 3290 Prob > chi2=0.0000

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10

Significant shifts on share of land allocated to beans, sweet potato, maize, fallow and non-major crop were observed as the distance from output market changed from the minimum to maximum. Other significant shifts in share of land allocated were observed in cases of household size (for the case of land allocated for beans) and increase in the education of the household head (for the case of coffee and non-major crops).

The gender of the household head significantly influences the share of land allocated to beans, cassava, maize and non-major crops. Households headed by men allocated higher proportion of cultivated land to non-major crops, maize, cassava and beans. Households that reported using fertilizers allocated significantly higher proportion of land to banana than any of the other crops. Only the share of land allocated to maize showed significant (t-value=2.5) shifts with households involved in hiring of labour.

Sub-regional variables were observed to be significant in influencing the share of land allocated to crops. In Central 1, no significant shifts in the share of land allocated to crops were observed in relation to banana. The share of land allocated to maize increased by six percent (t-value =2.2) in Central 2 and by 13 percent (t-value =5.1) in East Central, while that of cassava and sweet potato increased by two percent (t-value =3.8) and four (t-value =3.77) respectively. Non-major crops were allocated 10 percent more land in East Central. In the East, the share of land allocated to cassava, maize and fallow increased by four, one and six percent respectively. In the North, beans, cassava, maize and fallow were allocated more land while the land allocated to sweet potato declined by three percent. In West Nile, farmers preferred to allocate significantly more land to cassava (13%) and fallow (16%) while reducing allocations to non-major crops (11%), beans (5%) and banana (5%). Cassava, maize and coffee were main losers on land share in the South West.

Table 4. Marginal effect at the mean for continuous variables influencing share of land allocated to crop for the fractional multinomial logit model 1

Share of	Banana		Beans		Cassava		Sweet potato		Maize		Fallow		Coffee		Non-major crops	
	dy/dx	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*	*dy/dx*	*t-value*
Areacult_log	-0.008	-2.857	-0.017	-5.667	-0.011	-3.029	-0.026	-7.970	-0.008	-2.162	0.020	8.609	0.004	3.154	0.046	7.172
Distoutmar_log	-0.004	-2.643	0.000	0.182	0.000	0.037	0.003	1.875	0.006	2.952	0.004	2.176	-0.003	-3.378	-0.007	-1.919
Adultratio_log	-0.002	-0.440	-0.019	-3.133	0.005	0.701	-0.004	-0.600	-0.010	-1.492	0.007	1.321	0.002	0.960	0.020	1.563
Hsize	0.001	1.475	-0.001	-1.368	-0.001	-1.146	0.003	3.846	0.001	1.111	0.000	-0.250	0.000	1.382	-0.003	-1.556
Hheadedu-log	0.007	1.971	-0.002	-0.488	0.003	0.681	0.003	0.605	0.001	0.138	0.004	1.194	-0.002	-1.118	-0.014	-1.588

Observation = 2154 Wald chi2(112)= 2539.2 Log pseudolikelihood= - 3290.2 Prob> chi2=0.0000

Source: Authors' calculation based on UNHS (2005/06) and UNPS (2009/10

The sub-region effects on the predicted chances were influenced by agro-ecological characteristics of different areas and socio-economic characteristics (Ebanyat, *et al.,* 2010; Jaetzold, *et al.,* 2005). Agro-ecological characteristics influence crop's enterprises that have been promoted in an area and how they have been performing in terms of yields, thereby influencing farmers' perception (Wortman and Eledu, 1999). Socio-economic characteristics and cultural practices of communities found in different geographical locations are dissimilar. These different geographical locations define the sub-regions with varying population densities, culinary behaviors (Smith *et. al.,* 2001), agricultural activities of choice, land availability (Mponela *et. al.,* 2011), labour availability for various enterprises needs and development of facilitative service for crop enterprises (Bagamba, *et. al.,* 2009).

Table 4 shows the marginal effects for continuous variables at the mean (see Appendix D for variables' means). All food crops (banana, beans, maize, cassava and sweet potato) were allocated significantly decreasing share of land compared to other crops. Decrease in the share of land allocated to major food crops as cultivated land increases, indicates that households target food security first in land allocations. The share of land left fallow, an important soil replenishing strategy (Aguilera, *et. al.* 2013), was increasing by five percent at the mean of cultivated land. Marginal effect for share of land allocated to banana and coffee were decreasing while that of maize was increasing at the mean distance to the output markets. Sweet potato was preferred for more land allocation at the mean household size.

5. Conclusion and Policy Implications

Small landholding was observed to be a challenge for agricultural production, resulting in households cultivating land where they lacked ownership rights. Households across sub-regions and time practiced crop diversification in small sizes of land by. Non-major crops occupied the largest proportion of land both at national level and across sub-regions, seasons and cultivated land size categories. The cropping pattern and land allocation could be considered as major constraints to agricultural commercialization in Uganda, as they discourage the scale of production and high yielding technology adoption. It is suspected that the high risk associated with agricultural production, households' culinary behaviors and desire for food production does affect the cropping patterns.

Despite the households' increasing land ownership between 2005 and 2009, a reduction in the cultivated area was observed across all the sub-regions within the time period. No drastic shift was observed in cropping system between 2005 and 2009.However, shift in the share of land allocations among crops was observed. Sweet potato and beans experienced widest expansion between 2005 and 2009.A major decline was observed on the land left under fallow, an indication that land resource has become limited. Other crops that were observed to have their share decline include other non-major crops, coffee and maize. Both banana and coffee were gaining prominence in West Nile and the North. Large land holdings appeared to attract coffee and fallow while small sizes of land were mostly associated with sweet potato farming. Although sweet potato is not among the prioritized crops (MAAIF, 2010), it is a popular food security crop for households cultivating small sizes of land (UBoS, 2010).

Prioritized crops in the DSIP should be targeted for promotion and expansion at sub-regional level. The results show that land allocation varies across sub-regions and hence the latter best represents the agro-ecological zones for targeting purposes. For example, maize is likely to be adopted in Central 2, East Central, Eastern, and North, but will require more efforts for acceptance in the West Nile and South West. Cassava will be favored for expansion by households in the East Central, Eastern, North and West Nile. It will be difficult to convince households in North and West Nile to expand the farming of beans. The land that could be converted from fallow to the DSIP's prioritized crops is more available in the North, Eastern and West Nile than in the other sub-regions. Other socio-economic factors that will have significant effect in expansion of DSIP targeted crops include available household cultivable land, distance from the output market and gender of the household head.

Necessary interventions are required in the sweet potato enterprise as the land allocated to the crop is expanding, even though cultivated land area is decreasing. The interventions could include research, promotion and value addition. Although prioritized most favourably for expansion (MAAIF, 2010), intensification and zoning, more effort is also required to ensure that farmers in East Central, North, West Nile and South West increase the shares of land allocated to maize and coffee. This is because the results show that with time, the crops are losing out to other crops. Interventions are also necessary for coffee in West Nile because its share has been on a decrease, although prioritized as the second most important crop requiring expansion and promotion.

Studies on dynamics of land ownership need to be undertaken to provide insights on how households own land, existence of distribution justice and opportunity for interventions by the government. The government should guide land ownership process to ensure that its outcomes will make agriculture sustainable within the land laws, and allow coexistence between households and among communities. We also recommend more studies on interventions necessary for breaking the practice of households managing many crops, while allocating small portions of land to each of the crops. Some of the issues which should be addressed include the understanding of crops' profitability at different levels of land allocation; the effects of insurance against natural disasters; improving produce farm-gate prices and other agricultural facilitative services e.g. irrigation infrastructural development which the farmers would have on the household cropping patterns.

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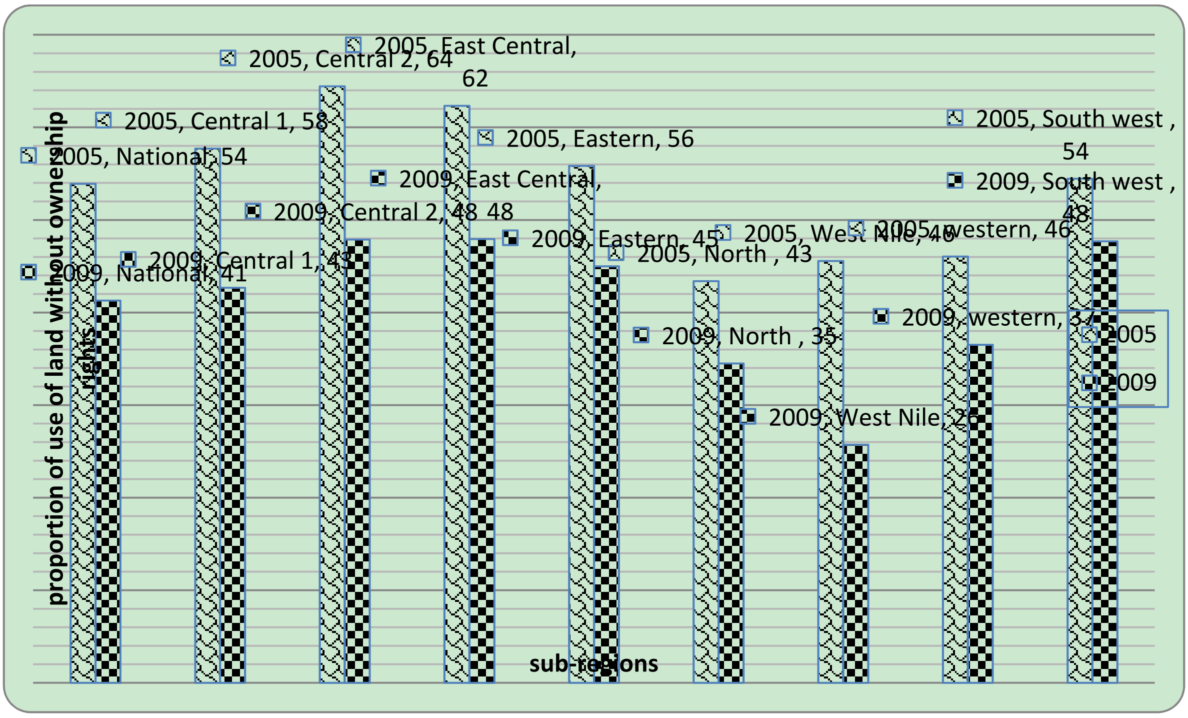
Appendix A. Description of variables used in the estimation of parameter using the fractional multinomial logit model

Variable		Observation	Mean	Std
Dependent multivariate variable				
Share of cultivated land allocated to beans		3645	0.08	0.10
Share of cultivated land allocated to cassava		3645	0.11	0.15
Share of cultivated land allocated to sweet potato		3645	0.06	0.10
Share of cultivated land allocated to banana		3645	0.07	0.13
Share of cultivated land allocated to maize		3645	0.11	0.15
Share of cultivated land allocated to fallow		3645	0.05	0.14
Share of cultivated land allocated to coffee		3645	0.03	0.07
Share of cultivated land allocated to other non-major crops		3645	0.50	0.23
Explanatory variables				
Areacult_log	Total cultivated area by households in acres in a year.	3588	1.07	0.98
hhsex	Dummy of sex of the household head (male=1)	1823		
hsize	Number of family members in a household	3645	5.86	2.89
Central 1	Central 1 sub-region is a dummy for the sub-region against others (Central 1=1 while otherwise=0)	362		
Central 2	Central 2 sub-region is dummy for the subregion against others (Central2=1 while otherwise=0)	321		
East Central	East Central sub-region is dummy for the sub-region against others (East Central2=1 while otherwise=0)	386		
Eastern	Eastern is dummy for the sub-region against others (Eastern =1 while otherwise=0). This dummy also includes Karamoja, and areas which have been later made into a different sub-region.	542		
North	North sub-region is dummy for the sub-region against others (North=1 while otherwise=0)	581		
West Nile	West Nile sub-region is dummy for the sub-region against others (West Nile=1 while otherwise=0)	309		
Western	Western is dummy for the sub-region against others (Western =1 while otherwise=0)	340		
South West	South West sub-region is dummy for the subregion against others (South West=1 while otherwise=0)	1088		
Fertiliser use	Dummy for use of fertilizer =1 , otherwise=0	838		

Hiring labor	Dummy for hiring labor (hiring of labor=1, non-hiring=0)	2150		
Distaoutmar_log	Log of the distance of output/produce markets from the household	3645	1.71	1.32
Hheadedu-log	Household head years education	3645	0.46	0.50
Adultratio_log	Share of adults in a household	3645	0.72	0.45

Appendix B. Proportion of households cultivating land for which they have no ownership rights



Appendix C FMNL estimated statistics for both the dependent and independent variable

Independent variable	mean	std	min	max
Areacult_log	1.065	.9834	-6.215	3.555
Distaoutmar_log	1.732	1.312	-2.303	4.718
Adultratio_log	3.805	0.4428	2.303	4.605
hhsex	0.7367	0.4405	0	1
hsize	6.014	2.889	1	23
Hheadedu-log	1.71	0.5682	0	2.773
Fertilizer use	0.2305	0.4212	0	1
Hiring labour	0.5866	0.4925	0	1
Central 1	0.0915	0.2883	0	1
Central 2	0.0814	0.2734	0	1
East Central	0.0975	0.2967	0	1
Eastern	0.1369	0.3438	0	1
North	0.1468	0.3539	0	1
West Nile	0.0781	0.2683	0	1
Western	0.0859	0.2803	0	1
South West	0.2749	0.4465	0	1

dependent variable	Mean(x)
E(banana proportion x) =	0.0493
E(bean proportion x) =	0.0875
E(cassava proportion x)=	0.0917
E(sweet potato proportion x) =	0.0663
E(maize proportion) =	0.0922
E(fallow proportion x) =	0.0347
E(coffee proportion x) =	0.0168
E(non-major crop proportion x)=	0.5616