Farmers' Adoption of Rotational Woodlot Technology in Kigorobya Sub-County of Hoima District, Western Uganda

Research

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Abstract

This paper evaluates, using logistic and multiple regression analyses, the socio-economic factors that influence farmers' decisions to adopt rotational woodlot technology in the farming systems of Uganda, based on a household survey carried out between May and December 2004, involving 120 farmers in Kigorobya sub-county, Hoima district. The analyses demonstrate that farmers make decisions about woodlot technology based on the household and field characteristics. The factors that significantly influenced the decision to adopt rotational woodlot technology included: gender, tree tenure security, seed supply, contact with extension and research agencies, soil erosion index, size of landholding, fuelwood scarcity, and main source of family income. To promote greater adoption of rotational woodlot technology, particular attention should be placed on the use of appropriate socioeconomic characterization, to better target technologies to areas with greater adoption potential.

Introduction

Many regions in Africa are presently facing severe shortages of fuel wood, fodder and food primarily due to increasing human and livestock populations and crop production using little or no external inputs (FAO 2003). Farmers resort to using marginal and erosion-prone soils and to encroaching upon forests (Nyirenda *et al*. 2001). In most parts of sub-Saharan Africa, the traditional long duration fallows and shifting cultivation, which helps to replenish soil fertility to some extent, are no longer possible. Over the last two decades, woodlots have become popular among the development agencies in Africa as a means of improving fuelwood supply to rural communities and generating income for households (Jacovelli & Caevalho 1999).

A rotational woodlot is a method involving growing trees with crops for two to three years until the trees start competing with the crops. Thereafter, the woodlot is left as a source of fuelwood, building poles or fodder while restoring soil fertility. Farmers then start cutting down the trees and growing crops between the stumps four to five years later (Nyadzi *et al*. 2003). Rotational woodlot technology involves growing trees and crops on farms in three inter-related phases: (i) An initial tree establishment phase in which trees are intercropped with crops; (ii) a tree fallow phase; and (iii) a cropping phase after harvesting the trees. Each of these phases can be managed specifically to provide products and services of economic, social and environmental value.

Some studies in developing countries have stressed a scarcity of fuelwood as one of the key factors to motivate farmers in adopting rotational woodlot technology (Jacovelli & Caevalho 1999, Nyadzi *et al*. 2003). As long as fuel wood could be collected without paying for it, farmers had little incentive to plant fuelwood producing trees (FAO 2003). Nyadzi *et al*. (2003), however, reported that high fuel wood demand stimulates tree production, and that this is only the case when there is a fuel wood crisis. Thus, the high cost

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of fuel wood may motivate farmers to establish woodlots (Yin & Hyde 2000).

Past studies (Masangano 1996, Omuregbee 1998) have identified some of the farmers' characteristics that may influence adoption of agroforestry technologies. These include the age, gender, and education level of the household head, wealth, family size, group membership and farm resources (such as farm size, land tenure, credit, or other inputs, and availability of labor). Farmers' adoption behavior, especially in low income countries is influenced by a complex set of socioeconomic, demographic, technical, institutional and bio-physical factors (Masangano 1996). This paper, therefore, evaluates the socioeconomic factors that influence farmers' decisions to adopt rotational woodlot technology in the farming systems in Kigorobya sub-county, Hoima district, western Uganda.

Materials and Methods

Description of Study Area

The study was conducted in Kigorobya sub-county, Hoima district between July and September 2005. The district is located in mid-western Uganda (1°00' - 2°00' N, 30°30' - 31°45' E). It is bordered by Lake Albert on the west, Kibaale on the south, Masindi to the northeast and Kiboga to the east). It has a population of about 341,700 people and a total area of 5,775 square kilometers. It lies at an altitude of 600 – 1000 m above sea level with undulating hills and predominantly savannah grasslands. The climate is characterized by small variations in temperature and humidity throughout the year. Mean annual rainfall ranges from 700 – 1000 mm, most of which is received between October and April. Mean annual temperature is approximately 28°C with a range of 15 - 32°C. Vegetation varies widely ranging from medium altitude moist forests through forest/savannah mosaic, swamp to post cultivation communities (Oluka-Akileng *et al*. 2000). The soils are mainly yellowish-red clay loams on sedimentary beds that occupy parts of Bugahya and Buhaguzi counties (Siriri & Bekunda 2001).

Subsistence agriculture is the major economic activity, employing about 84% of the population (UBOS 2002). The bulk of the agricultural production is from manually cultivated rain-fed crops such as tobacco, cotton, sugarcane, and food crops. Typical food crops are maize, cassava and sweet potatoes. Kagorobya sub-county. was selected as a study site because it is economically backward with a subsistence economy. In each village there exists well documented secondary data on farmers that have adopted the woodlot technology (MWLE 2002).

Data Collection

Data for the study were collected through a cross sectional farm-level survey carried out between May and December 2004, by means of a structured questionnaire. The questionnaire was administered to 120 farmers to determine the profile of farmers' socio-economic variables and farm characteristics. The survey was done in two stages (Arkin & Cotton 1963). In the first stage, focused group discussions were used to obtain background information on the adoption of rotational woodlot technology. This information was used to design a structured questionnaire administered to respondents during the second stage of the survey. Selection of the survey villages was accomplished through a stratified random sampling procedure. A complete list of villages where rotational woodlot technology has been previously introduced was available (FAO 2003).

Sample villages were selected based on the number of years of farmer exposure to woodlot technology, number of farmers exposed to woodlot technology, and an informed assessment by key informants on the extent of the adoption of rotational woodlot technology in each village. From each selected village, lists were developed of (a) all farmers who had been exposed to woodlot technology, and (b) those without such knowledge. A random sample was taken from each of the two groups of farmers. Descriptive statistics were used to describe the farmers' socio-economic characteristics, while simultaneous equation logistic models were employed to estimate the intensity of adoption (Maddala 1983). A series of explanatory variables included: gender of farmer, education level of farmer, family size, memberships to farmers' organizations, contact with extension agency, tree tenure security, fuel wood scarcity index, supply of planting materials, household source of income, and size of landholding (Table 1).

Analytical Model

A two-stage regression approach was adopted. In the first stage, a discrete variable logit assessment of the choice to adopt or not was carried out. In this case, a 100 percent sample was included in the model because it is a reasonable first choice for any farmer. The choice of the farmer to adopt woodlot technology or not was framed as a binary-choice model which assumed that individuals were faced with a choice between two alternatives and the choice depended on identifiable characteristics. The probability of adopting choice, $\Pr(T_i = 1)$, was cumulative density function F evaluated at $\chi_i\beta$, where χ_i is a vector of explanatory variables and β an unknown parameter (Maddala 1983). This kind of cumulative density function can be modeled using logistic probability function, which has the following form: $\chi\beta$

Choice to adopt rotational woodlot $= \Pr(T_i = 1) = \dfrac{\exp(\chi_i\beta)}{1+\exp(\chi_i\beta)}$ ....(1)

The Statistical Package for Social Scientists (SPSS VER. 11) program for Windows was used for the analysis. The estimated model was:

$$WOOD = b_0 + b_1(GND) + b_2(HSIZ) + b_3(EDUC) + b_4(EXT) + b_5(EROS) + b_6(FINC) + b_7(FWD) + b_8(TENUR) + b_9(ORG) + b_{10}(LND) + b_{11}(SEED)...(2)$$

The qualitative dependent variable is woodlot technology (WOOD), which takes on the value of 1 if the farmer adopted woodlot technology and its variants, and 0 if no adoption occurred. Explanatory variables and justification are discussed below. Gender (GND) is a dummy variable that indexes the gender of the farmer; it has a value of 1 for men and 0 for women. It was hypothesized that GND is negatively related to the adoption of rotational woodlot technology. Size of household (HSIZ) measures the number of people living in the household. It is expected that the larger the number of members in the household the greater will be the availability of family labor for woodlot establishment and management. Farmer education (EDUC) measures the level of education of the farmer. It takes the value 1, if no formal education; 2, if completed primarily level; 3, if completed secondary level; and 4 if University graduate. Education thus is expected to have a positive effect on the decision to adopt woodlot technology. Contact with extension (EXT) measures the contact of farmers with extension and research agencies that work on woodlot technology. It takes the value of 1 if the farmer had contacts with such agencies, and 0, otherwise. It was hypothesized that EXT positively influenced decisions

to establish woodlot of the farm field. Source of income (FINC) measures the farmer's main source of income and it takes the value 1, if the main source is agriculture, and 0 if otherwise. Studies have shown that agriculture as the main source of income has a negative impact on the adoption of new agroforestry technologies (Adesina *et al.* 2000, Nyirenda *et al.* 2001). Fuelwood scarcity (FWD) indexes the extent of wood scarcity in the village where the farmer is located. It takes the value of 1, if fuel wood is abundant in the village; 2, if scarce and 3, if very scarce. It is hypothesized that as the extent of fuel wood scarcity intensifies, farmers may have greater incentives to adopt woodlot technology.

In this study, soil erosion level (EROS) measures the extent of soil erosion in the village where the farmer is located. It takes on the value of 1, if no erosion problem at all; 2, if it is a minor problem; and 3, if it is a severe problem. Tree tenure security (TENUR) indexes the security of tree rights on the private farm. It takes the value 1 if farmer has secure tenure rights and 0 otherwise. TENUR is positively related to adoption of woodlot technology. It is expected that if farmers have a complete bundle of rights, the likelihood of adopting rotational woodlot technology will increase. Membership to farmer organization (ORG) indicates if the farmer is a member of a farmers' association.

Membership to farmers' organization was hypothesized to positively influence the adoption of woodlot technology. Size of landholding (LND) is a dummy variable, which indexes whether the farmer has sufficient land. It takes the

Table 1. Farm household socioeconomic characteristics in Kigorobya sub-county, Hoima district, Uganda between July and September 2005. (N = 120).

Variable	Percentage
Adopters of rotational woodlot technology	72
Farmers age	
<18	43
19-29	23
30-39	62
=>40	51
Education per family in schooling year	
0	21
<5	64
=>6	15
Mean	03
Size of household members	
1-4	20
5-7	40
8-10	23
=>10	17

Variable	Percentage
Amount of landholding	
<1ha	32
1-2	32
2.1– 5	22
=>5	14
Mean (2.4 ha)	
Source of family income	
Agriculture	57
Non-agriculture	43
Sources of information about woodlot technology	
NAADS	40
NGO	23
Self experimentation	02
Farmer to farmer	33
Other sources	02
Farmers aware of forestry extension activities	
Aware	27
Not aware	73

value of 1 if yes and 0 otherwise. It is expected that farmers owning big portions of land may face less pressure to establish woodlots on their own farms and this may negatively affect adoption of woodlot technology. Supply of planting material (SEED) measures the extent of availability of planting materials in the village. The seed supply takes the value 4, if National Tree Seed Center is the major source of planting materials; 3, if own farm; 2, if from open market; and 1 if it is from other sources.

Part of the taxonomical work was carried out at the Herbarium, Botany Department, Makerere University, Kampala, Uganda (MHU) where voucher specimens are deposited.

Results

Field Survey Results

The results presented in Table 1 show that average size of landholding in the area is 2.4 hectares of land. Approximately 64% of the households own less than 2 hectares and only 14% of the remaining households own over 5

hectares of land. Thus, a considerable number of farmers possessed a very limited amount of farm land to be used for production of household food and fuel wood. The median size of household members was 8 persons. Agriculture was the main source of income for approximately 57% of the households. Forty percent of the farmers reported that they obtained technical information on rotational woodlot technology from the National Agricultural Advisory Services, a program under the Ministry of Agriculture, and 23% from non-government organizations in the area. Only 27% of the farmers were aware of the activities of the forestry extension programs. About 48% of the respondents mentioned natural regeneration as their source of seedlings, and a few farmers (4%) acquired planting materials from the National Tree Seed Centre. The soil erosion index was rated high (60%) and therefore many farmers planted trees on their private farm fields. Nearly all respondents (99%) rely on biomass as a source of energy. Due to the general poverty in the rural areas, only 1% of the households can afford to purchase the commercial fuels such as electricity and petroleum products.

Table 2. Socio-economic and bio-physical field conditions in Kigorobya sub-county, Hoima district, Uganda between July and September 2005. 1US$ = 1880 shillings (in 2005).

Variable	Percentage	Variable	Percentage
Source of seeds & planting materials		**Soil erosion index**	
National Tree Seed Centre	4	High	59
Natural regeneration	48	Low	40
Market	16	**Reasons for adopting rotational woodlot technology**	
Own nursery	12	Domestic consumption (Fuel wood, construction materials, food) supply	68
Other farms	20		
Location of trees on farm		Source of household income	54
Homegarden	27	Social & financial safe net	38
Crop land	07	Soil conservation & protection of ecological balance	42
Home compound	50		
Boundaries	04	Wind breaker	18
Woodlots	08	Biodiversity and wildlife habitat	05
Roadside	03	Ornamental	04
Public land	01	Others	02
Source of energy		**Constraints to establishment of woodlots**	
Firewood	93	Seedling supply	20
Charcoal	03	Lack of technical knowledge	21
Agricultural residues	03	Land scarcity	23
Commercial fuels	01	Land & tree tenure	09
Distance in hours		Culture and traditions constraints	01
< 1 hour (including on farm sources)	80	Lack labor and capital	10
1 - 3 hours	18	Lack of interest	03
> 3 hours	02	Others e.g diseases, competition with food crops	11

Empirical Model

Binary logit coefficients (Table 1) showed that seven explanatory variables were significant in explaining farmers' adoption of rotational woodlot technology. These were: tree tenure security (TENUR), seed supply (SEED), contact with extension and research agencies (EXT), soil erosion index (EROS), size of landholding (LND), fuel wood scarcity index (FWD), main source of family income (FINC) and gender of the farmer (GND).

Table 3. Binary logit model of the household characteristics influencing adoption of rotational woodlot technology in Kigorobya sub-county, Hoima district, Uganda between July and September 2005. Variables: gender (GND), farmer education (EDUC), household size (HSIZ), contact with extension (EXT), soil erosion level (EROS), source of income (FINC), fuelwood scarcity (FWD), tree tenure security (TENUR), membership to farmer organization (ORG), size of landholding (LND), and supply of planting material (SEED).

Variable	Coefficient estimate	Standard error	p-value
Constant	-9.869	3.855	0.0143
GND	1.258	1.137	0.0926*
EDUC	0.548	0.139	0.3706
HSIZ	-0.097	0.304	0.7503
EXT	2.811	1.143	0.0139**
EROS	-0.102	0.051	0.0442**
FINC	-0.442	0.197	0.0202**
FWD	-1.954	0.567	0.0006***
TENUR	2.886	0.875	0.0009***
ORG	7.071	9.466	0.4552
LND	-0.435	0.186	0.0242**
SEED	2.07	0.802	0.0011***

Unrestricted Log likelihood function - 36.60; Restricted Log likelihood Function (-57.6); Degrees of freedom 45; Significance level (0.01) McFadden's R^2 = 0.36; Chi Squared (42.02). The asterixes: *, **, *** refer to significance at P = 10%, 5%, and 1% respectively.

Trees and ShrubsGrown

Trees commonly cultivated include *Melia azedarach* L., *Markhamia lutea* (Benth.) K. Schum., *Vitellaria paradoxa* C.F. Gaertn., *Senna spectabilis* (DC.) H.S. Irwin & Barneby, *Tamarindus indica* L., *Eucalyptus* spp., *Citrus* spp., *Mangifera indica* L., and Sodom apple. There are also a number of trees planted as boundary marks and fences. These include: *Ficus* sp., *Euphorbia* spp., *Cascabela thevetia* (L.) Lippold, and **Ejumukla**. Some times trees are found scattered among crops in the field or, as seen on several occasions, beneficial trees are left stranding in the area; for example, *Combretum* spp., and *Ficus* spp.

are often left scattered in cassava fields. This is a form of mixed intercropping where the tree component provides the environmental services and products to the household, whereas the annual crops provide the domestic food requirement. The tree products include fruits, vegetables, pods, seeds, firewood for energy provision, fodder for livestock. For example, *Harrisonia abyssinica* Oliv. and *M. indica* provide fodder to goats, sheep and cattle. Most of the indigenous tree species and shrubs are scattered in the fields or are found around courtyards, boundaries, and fences (Table 4).

Table 4. Trees and shrubs and their location in the farmer's fields in Kigorobya sub-county, Hoima district, Uganda between July and September 2005. Locations: B=Boundary, C=Courtyard, H=Home garden, S=Scattered.

Species	Locations			
	B	C	H	S
Mangifera indica L.		X		X
Tamarindus indica L.			X	X
Vitellaria paradoxa C.F. Gaertn.		X		X
Albizia coriaria Welw. ex Oliv.				X
Senna spectabilis (DC.) H.S. Irwin & Barneby			X	
Melia azederach L.		X		
Combretum spp.				X
Ficus dekdekena (Miq.) A. Rich.				X
Ficus glumosa Delile				X
Ficus sycomorus L.	X	X		X
Erythrina abyssinica Lam. ex DC.				X
Acacia sieberiana DC.				X
Citrus spp.		X	X	
Vitex doniana Sweet				X

The most practiced forms of agroforestry are seen to be home gardens and trees on cropland as well as planting trees on home compounds (50%). However, many homes have one to four different species of trees on home compounds, used especially to provide shade in the dry season. *Citrus* species have been found to be the most favored and have been planted in most home gardens (Table 5). This *Citrus* is used mainly as a source of food (fruit) and fire wood, as well as a source of income through the sale of the fruit.

None of the respondents planted trees on grazing land and public places. This is because farmers who keep livestock graze them on naturally growing pastures despite the fact that grazing land is dwindling, as reported by the respondents. No initiative or measure such as modern agroforestry has been taken to improve the quality and quantity of the palatable livestock pasture. However, there are some naturally growing indigenous trees like *Acacia*

Table 5. Trees grown by the local community (N = 269) in Kigorobya sub-county, Hoima district, Uganda between July and September 2005.

Species	Frequency	%
Citrus spp	36	13.4
Mangifera indica L.	34	12.6
Emalaina	21	7.8
Melia azederach L.	21	7.8
Senna spectabilis (DC.) H.S. Irwin & Barneby	21	7.8
Carica papaya L.	20	7.4
Anacardium occidentale L.	14	5.2
Tamarindus indica L.	13	4.8
Eucalyptus spp	12	4.5
Passiflora edulis Sims	12	4.5
Artocarpus heterophyllus Lam.	7	2.6
Markhamia lutea (Benth.) K. Schum.	7	2.6
Psidium guajava L.	7	2.6
Ejumula	5	1.9
Albizia coriaria Welw. ex Oliv.	4	1.5
Callitropsis lusitanica (Mill.) D.P. Little	3	1.1
Cocos nucifera L.	3	1.1
Milicia excelsa (Welw.) C.C. Berg	3	1.1
Vitellaria paradoxa C.F. Gaertn.	3	1.1
Cedrela odorata L.	2	0.7
Eboboryei	2	0.7
Ficus sur Forssk.	2	0.7
Ficus sycomorus L.	2	0.7
Grevillea robusta A. Cunn. ex R. Br.	2	0.7
Persea americana Mill.	2	0.7
Pines	2	0.7
Cascabela thevetia (L.) Lippold	2	0.7
Combretum collinum Fresen.	1	0.4
Delonix regia (Bojer ex Hook.) Raf.	1	0.4
Jacaranda mimosifolia D. Don	1	0.4
Kigelia africana (Lam.) Benth.	1	0.4
Musanga cecropioides R. Br. ex Tedlie	1	0.4
Syzygium lusitanica **Authority**	1	0.4
Vitex doniana Sweet	1	0.4

spp., *Erythrina* spp., *Albizia* spp., *Vernonia* spp., and *Combretum* spp. These play a big role in providing shade and improving the growth of pastures underneath.

Most farmers prefer planting fruit trees to planting non-fruit bearing trees. These trees serve a number of functions in the daily life of the people. The main uses as reported by the farmers are: Food, medicine, fuel wood, building poles, shade, windbreaks, source of income through the sale of firewood and/charcoal, soil fertility improvement and so on. Traditional furniture tree species are frequetnly used. These include: *Maesopsis eminii* Engl., *Lovoa trichilioides* Harms, *Funtumia elastica* (Preuss) Stapf, *Entandrophragma angolense* (Welw. ex C. DC.) C. DC. and *Podocarpus latifolius* (Thunb.) R.Br. ex Mirb. Non-traditional furniture tree species found in the area included *Xylopia eminii* Engl., *Grevillea robusta* A. Cunn. ex R.Br., *Jacaranda mimosifolia* D. Don, *Artocarpus heterophyllus* Lam., *M. indica*, *Coffea robusta* Linden and *Ficus natalensis* Hochst. (Table 6).

Discussion

The study revealed that farmers' adoption of rotational woodlot technology is influenced by the interacting farm household socio-economic characteristics such as gender of farmer, contact with extension and research agencies, soil erosion index , tree tenure security, seed supply, size of landholding, fuel wood scarcity index, and main source of family income.

Gender of the farmer was found to be significant and positively related to the adoption of woodlot technology. This suggests that men are more likely to establish woodlots on their fields than women. Adesina *et al*. (2000) argued that because rotational woodlot farming is primarily a tree-based technology, women may be less likely to adopt it because of either lack of rights to grow trees or secure land rights. This may reflect the traditional bias against women in inheriting lands or having secure land or tree rights, or the inherent gender-bias in testing and demonstration of the technology. Masangano (1996) found that female farmers are less likely to use new technologies. Our field observations revealed that limitations on women in the decision making process and participation in forestry related matters further reinforces their limited access to forest resources.

The contribution of National Agricultural Advisory Services to encourage farmers to establish woodlots has been poor, and only 23% of the farmers have access to advisory services (Table 2). Thus, more widespread knowledge of the activities of the forestry extension programs could have a positive impact on farmers' decision to manage woodlots on their farm fields (Adesina *et al*. 2000, Nyirenda *et al*. 2001).

Our study supports the findings of Adesina *et al*. (2000), and Masangano (1996) that adoption of any innovation,

Table 6. Tree species found in Hoima district, Uganda between July and September 2005 (N = 60).

Local Name	Botanical name	Traditional furniture tree species)	Non-traditional furniture tree species
Mugavu	*Albizia coriaria* Welw. ex Oliv.	√	
Nongo	*Albizia gummifera* (J.F. Gmel.) C.A. Sm.		√
Kirundu	*Antiaris toxicaria* Lesch.	√	
Ffene	*Artocarpus heterophyllus* Lam.		√
Mwasa	*Beilschmiedia ugandensis* Rendle		√
Nkuzanyana	*Blighia unijugata* Baker	√	
Cyprus	*Callitropsis lusitanica* (Mill.) D.P. Little	√	
Muwafu	*Canarium schweinfurthii* Engl.		√
Nkalati	*Chrysophyllum albidum* G. Don		√
Mumwanyi	*Coffea robusta* Linden		√
Mukebu	*Cordia millenii* Baker	√	
Mukusu	*Entandophragma angolense* (Welw. ex C.DC.) C.DC.	√	
Kalitunsi	*Eucalyptus grandis* W. Hill ex Maiden	√	
Mutuba	*Ficus natalensis* Hochst.		√
Katoma	*Ficus* sp		√
Nkago	*Funtumia elastica* (Preuss) Stapf	√	
Greveria	*Grevillea robusta* A. Cunn. ex R. Br.		√
Mugu	*Harungana madagascariensis* Lam. ex Poir.		√
Jacaranda	*Jacaranda mimosifolia* D. Don		√
Mahogany	*Khaya anthotheca* (Welw.) C.DC.	√	
Munyama	*Khaya grandifoliola* C.DC.	√	
Nkoba	*Lovoa trichilioides* Harms	√	
Musizi	*Maesopsis eminii* Engl.	√	
Muyembe	*Mangifera indica* L.		√
Nkunya	*Manilkara cuneifolia* (Baker) Dubard		√
Musambya	*Markhamia lutea* (Benth.) K. Schum.	√	
Mvule	*Milicia excelsa* (Welw.) C.C. Berg	√	
Mpewere	*Newtonia buchananii* (Baker f.) G.C.C. Gilbert & Boutique	√	
Pine	*Pinus caribaea* Morelet	√	
Podo	*Podocarpus latifolius* (Thunb.) R.Br. ex Mirb.		√
Settaala	*Polyscias fulva* (Hiern) Harms	√	
Munaba	*Pycnanthus angolensis* (Welw.) Warb.		√
Musasa	*Sapium ellipticum* (Hochst.) Pax		√
Sekoba	*Trichilia dregeana* Sond.		√
Muyovu	*Uapaca guineensis* Müll. Arg.		√
Nsagalanyi	*Xylopia eminii* Engl.		√

technology or agricultural practice will be accelerated if farmers have an accurate understanding of the principles underpinning extension recommendations. At the policy level, this implies that improving the quality of the National Agricultural Advisory Services system is of paramount importance in Uganda (Buyinza 2002).

For sustainability of the adoption of woodlot technology, a sustainable supply of planting materials in the form of seeds and seedlings is one of the pre-requisites. The majority of farmers interviewed depend on natural regeneration (48%) and the open market as sources of planting materials (Table 2). Currently, the National Tree Seed Centre is not popular among farmers, and only 4% of the farmers interviewed obtained seeds from tree seed center. Farmer preferred to collect seedlings from their own superior trees (12%) or from neighbors within the village. These results concur with those of Nyadzi *et al*. (2003) who reported that rotational woodlot technology depends on a reliable supply of quality planting materials.

The positive and significant sign on FWD implied that farmers in villages facing increasing fuelwood scarcities were more likely to adopt woodlot technology. Adesina *et al*. (2000) found that most of the fuel wood consumed by the farm households in forest margins of southwest Cameroon come from their food crop fields. Incidentally, it's within food crop fields that farmers establish woodlots. Woody perennial trees used in woodlots can further help farmers to increase the supply of fuel wood from their food crop fields (Buyinza 2002). Since farmers in villages with fuel wood scarcity were found to have higher likelihood of establishing woodlots, development efforts should target such villages, provided the level of fuel wood scarcity is not very serious. If it were, wood lots would be more appropriate in these areas. Since, tree farming requires that farmers set aside a part of their land for growing trees, the cultivatable area for food crops have to be reduced.

The farmers that have big landholdings are less likely to adopt woodlot farming. Farmers in villages where land is scarce are less likely to adopt woodlot farming because of the belief that trees will compete with the food crops. Wood fuel accounts for about 90% of energy used in Uganda (Falkenberg & Sepp 1999). Growing trees as woodlots on farms in rotation with crops is considered a potential technology to overcome the shortage of wood, which is a common problem to many parts of Uganda (Jacovelli & Caevalho 1999).

The fact that woodlot farming requires farmers to set aside part of their land for growing trees, results in the cultivable area under food crops being reduced. Farmers with smaller plots of land may view tree planting as competing with food crops, thus reducing incentives to establish woodlots. Nyadzi *et al*. (2003), reported that farmers in villages facing high land pressure may lack enough land for experimentation with agroforestry technologies. Since

land availability is an important factor that determines development of each of the components in the woodlot farming system, variation in the size of holding affects the tree cropping intensity.

Farmers motivated to plant trees are faced with a shortage of available labour for food crop production (Adesina *et al*. 2000). Thus farmers whose main source of income is agriculture might be discouraged to allocate family labor for woodlots activities. About 10% of the farmers reported that a shortage of labour and capital to allocate for woodlot activities was a constraint to woodlot practices (Table 3). Trees provide at least 96% of the energy requirements in the study village (Table 2). Jacovelli & Caevalho (1999) reported that in Uganda, biomass fuel is the principal energy source for household needs and about 52% of the biomass fuel comes from trees.

The farmers adopted woodlot technology mainly to provide for domestic consumption requirements such as firewood, construction materials (68%) and source of household income (54%). About 42% of the farmers interviewed reported that they had established woodlots as a financial security measure during declining revenues from the current marketable food crops. It has been shown (Falkenberg & Sepp 1999) that fuel wood demand is an important factor in the inducement to plant trees.

In conclusion, this study has shown that the household and farm-level characteristics of gender, size of landholding, fuel wood scarcity, main source of family income, tree tenure security, reliable seed supply, contact with extension and research agencies, and soil erosion index of village impact the adoption of rotational woodlot technology.

Acknowledgements

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