Adoption of Agroforestry Systems by Farmers in Masaka District of Uganda

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Research

Abstract

High population density in Masaka district, Uganda, has led to increased pressure on land. This has resulted in reduced arable land and decreased soil fertility. In view of this, the Vi-Tree NGO Project has initiated a study to investigate the adoption of agroforestry systems by farmers in Masaka district with focus on the types of agroforestry systems practiced, incorporation of multipurpose tree and shrub species, crops grown, farm land size and land ownership, production and marketing problems, and the main items on which families expend money on. Data was collected using open-ended questionnaire interviews administered to 88 farmers randomly selected throughout the 22 subcounties of Masaka district. The results were analyzed using descriptive statistics. The findings showed that the main agroforestry systems practiced are agrosilvopasture, agrosilviculture and silviculture. The study revealed that 81 woody species (75 trees and 6 shrubs) are used. 69% of these are indigenous. The most important families are Fabaceae, Moraceae, Euphorbiaceae, Combretaceae and Myrtaceae. Bananas, cassava, beans, vegetables, maize and coffee are the main crops grown. The majority of farmers hold small farm lands (1- 3 acres). Primary production problems are pests and diseases while marketing problems are many including low prices, long distances from village to farm, lack of buyers and price fluctuations. The main items they spend money on are school fees, medicines, and essential commodities. The adoption of agroforestry systems by farmers is relatively high in Masaka district. This is probably due to high demand for land, soil fertility decline, erosion problems, and demand for woody products (e.g., timber, fuel wood, and fodder, food), contact with the Vi-Tree NGO Agroforestry Project extension agents, and need to increase crop yield. High levels of personal land ownership has probably contributed to the adoption of agroforestry systems to promote long-term production.

Introduction

Agroforestry is a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels (ICRAF 2006, Kang *et al*. 1990). Huxley and van Houten (1997) define agroforestry systems as land-use in which woody perennials (trees, shrubs, palms, bamboos) are deliberately used on the same land management unit as agricultural crops (woody or annual), animals or both, in some form of spatial arrangement or temporal sequence.

In Masaka district, Uganda, as in other parts of tropical Africa, local farmers have practiced agricultural systems that encourage the development of forests through fallows as part of sustainable land use. This traditional system is known as the bush fallow system or shifting cultivation. Shifting cultivation is characterized by short cropping

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periods (1-3 years), followed by long fallow periods of 6 or more years. During the fallow period, plant cover and leaf litter protect the soil from the impact of high rain intensity and improve soil fertility. The bush-fallow system was a sustainable and efficient way for restoring soil fertility and productivity, when arable land was abundant and human populations were low. Traditionally, this system used to produce a wide variety of products such as timber, fuel wood, fruits, vegetables, spices, resins, and medicines, primarily to meet household needs and to generate some income through sales in local markets (Roshetko *et al*. 2006).

Nowadays, due to rapid increase in human populations and subsequent demand for farm land and wood products, long fallow periods (over 10 years) have been shortened drastically. This has led to increased land degradation, increased weed infestation, and decreased food crop yields. Hence, this traditional system is no longer possible due to high pressure on land.

Agroforestry is now emerging as the promising land use option to sustain agricultural productivity and livelihoods of farmers (Syampunani *et al*. 2010). The new agroforestry system is therefore a sustainable production system (Kang & Van den Beldt 1990). It has many advantages for farmers. It allows a longer cropping period, more intensive cropping, and higher crop yields (Kang & Wilson 1987, Mosango 1999). It also allows rapid soil fertility restoration and reduces requirements for external inputs of fertilizer. The hedgerows in the system provide green manure and mulch for crops, biologically fixed nitrogen for companion crops, improve soil conservation, create favorable conditions for beneficial soil organisms, provide high-protein fodder for livestock, and staking material and/or firewood.

This is why farmers in Masaka district have been encouraged by the Vi-Tree non-government organization (NGO) Project to practice agroforestry systems by growing crops with trees or shrubs simultaneously on the same land in order to overcome the reduction of arable land, assure food security and improve their livelihood. For this reason, the Vi-Tree NGO Project has introduced and promoted new agroforestry systems in Masaka district, emphasizing use of a system of alley farming. Thus, fast growing trees or shrubs - preferably woody legume nitrogen-fixing species – have been grown with crops or pastures. These trees are mostly established in the hedgerows with crops or pasture in-between. They are periodically pruned and managed during the cropping phase to prevent shading. The pruning of foliage and young stems are used as green manure or as mulch. Some portion of the tree foliage can be harvested and fed to livestock.

The purpose of this study was to investigate and assess the potential adoption of new agroforestry systems by farmers in Masaka district and their contributions to rural livelihood in terms of multiple land management, farm yield, availability of more products, increase in income and non reliance on fertilizer.

Methods

Study area

Masaka district is located in central Uganda. It is bordered in the north by the districts of Mubende and Mpigi, in the west by the districts of Mbarara and Rakai, in the south by the district of Rakai, and in the east by the Lake Victoria. It has an estimated area of 10,611 km^2 comprising of 6 counties with 22 sub-counties, including Masaka municipality.

The district has an altitudinal range of 1219-1524 m above sea level, characterized by flat topped hills of uniform height of about 1311 m. The area has a mean annual temperature of 20.8 °C with a minimum range of 14.5–16.0°C and a maximum range of 25.5-27.5°C. The Masaka district has a population of 836,736 people of which 423,184 are females and 415,550 are males. The population density is 248 persons per km^2. The Masaka district has 176,882 households with an average size of 4.3. The average annual population growth is 2.35%. The people of the area are predominately farmers and their main food crops include bananas, beans, maize, potatoes and cassava. The vegetation is short grass on hill tops and forests in the valleys, giving way to *Cyperus papyrus* L. in the swamps. Scattered natural forests are found along lakeshores.

Data collection and analysis

Data were collected from the twenty-two Masaka district subcounties. Farmers were interviewed using an open-ended questionnaire. The questionnaire sought information on respondents' attitude towards agroforestry systems, the tree/shrub species and crops grown, land size and ownership, production and marketing problems and family main expenditures. In most cases the questions were translated into the local language (Luganda) for the respondents to understand. Woody perennial species used in each agroforestry system were recorded, identified, and brought to the herbarium of Makerere University herbarium (MHU).

Relative prevalence (RP) (Hocking *et al*. 1996) was calculated for different trees/shrubs used in agroforestry system as a measure of importance. All results obtained were presented and discussed in terms of descriptive statistics.

Results

Agroforestry systems practiced in Masaka district

The study of agroforestry practices carried out in Masaka district revealed five types of agroforestry systems (Table 1). Most farmers practice Agrosilvipasture.

Table 1. Agroforestry systems in Masaka district, Uganda.

Agroforestry systems	Number of farmers	%
Agrosilvipasture	40	45.5
Agrosilviculture	29	32.9
Silvipasture	14	16.0
Apiculture	4	4.5
Agro-aqua-silviculture	1	1.1
Total	88	100

Species and family diversity, importance and relative prevalence

82 tree/shrub species, distributed among 28 families, were found to be grown with agricultural crops (Table 2). 77(93.9%) of species are trees and 45(54.9%) of species are indigenous. The dominant plant family is Fabaceae with 19 species (Table 3). The most common indigenous tree species based on PR are and *Ficus natalensis* Hochst. (RP=5.11) and *Markhamia lutea* (Benth.)

Table 2. Plant species used in agroforestry systems in Masaka district, Uganda. BF=biological form, St=status, T=tree, S=shrub, E=exotic, I=indigenous. Local names in Luganda

BF	St	Plant species	Local name	Prevalence	Function/Uses
		ANACARDIACEAE			
T	E	*Mangifera indica* L.	**Muyembe**	2.79	Fruit,shade, forage, firewood
		APOCYNACEAE			
T	I	*Funtumia elastica* (Preuss) Stapf	**Nkago**	0.26	Fuel wood, shade, rubber [latex]
T	E	*Thevetia peruviana* (Pers.) K. Schum.	None	0.00	Tool handles, soil conservation
		ARALIACEAE			
T	I	*Polyscias fulva* (Hiern) Harms	**Setala**	0.01	Timber, carvings, mulch, fuel wood
		ASPARAGACEAE			
S	I	*Dracaena fragrans* (L.) Ker Gawl.	**Oluwaanyi**	0.02	Boundary mark, hedge
		ASTERACEAE			
S	I	*Vernonia amygdalina* Delile	**Mululuuza**	0.00	Medicinal
S	I	*Vernonia auriculifera* Hiern	**Kikokooma**	0.03	Toilet paper, fuel wood
		BIGNONIACEAE			
T	E	*Jacaranda mimosifolia* D. Don	**Mujakalanda**	0.06	Fuel wood, timber, bee forage
T	I	*Markhamia lutea* (Benth.) K. Schum.	**Musembe**	3.18	Building poles, fuel wood
T	I	*Spathodea campanulata* P. Beauv.	**Kifabakazi**	0.03	Medicinal, fuel wood, timber
		BORAGINACEAE			
T	I	*Cordia africana* Lam.	**Mukibi**	0.09	Fuel wood, building, shading
		BURSERACEAE			
T	I	*Canarium schweinfurthii* Engl.	**Muwafu**	0.00	Fuel wood, building, timber
		CASUARINACEAE			
T	E	*Casuarina equisetifolia* L.	**Kalivaliyo**	1.30	Fuel wood
		CLUSIACEAE			
T	I	*Garcinia buchananii* Baker	**Nsaali**	0.00	Poles, building, shade
		COMBRETACEAE			
T	I	*Combretum molle* R.Br. ex G. Don	**Ndagi**	0.00	Timber, fuel wood
T	I	*Terminalia brownii* Fresen.	**Nkalati**	0.02	Timber, fuel wood

BF	St	Plant species	Local name	Prevalence	Function/Uses
T	I	*Terminalia glaucescens* Planch.	**Muyati**	0.01	Bee hives, charcoal, firewood
T	I	*Terminalia ivorensis* A. Chev.	**Muyati**	0.00	Fuel wood, charcoal, timber, coffee shade
T	E	*Terminalia mantaly* H. Perrier	**Muyati**	0.22	Shade, ornamental
		EUPHORBIACEAE			
T	E	*Aleurites moluccanus* (L.) Willd.	**Kabakanjagala**	0.00	Fuel wood, food & oil [seeds],
T	I	*Bridelia micrantha* (Hochst.) Baill.	**Katazamiti**	0.00	Building poles, fodder
T	I	*Croton macrostachyus* Hochst. ex Delile	**Musogasoga**	0.08	Coffee shade, fuel wood, fodder
T	I	*Croton megalocarpus* Hutch.	**Nkulumire**	0.09	Fuel wood, poles, bee forage
T	I	*Croton sylvaticus* Hochst.	**Musogasoga**	0.00	Fuel wood, timber, shade, poles
T	E	*Euphorbia tulearensis* (Rauh) Rauh	**Nkoni**	0.00	Medicine, fish poison [latex]
S	E	*Ricinus communis* L.	**Nsogasoga**	0.00	Medicine [castor oil], oil [seeds]
T	I	*Sapium ellipticum* (Hochst.) Pax	**Musasa**	0.11	Medicine, tool handles, fuel wood
		FABACEAE			
T	E	*Acacia hockii* De Wild.	**Kasaana**	0.01	Firewood, medicine [roots], ropes [bark], fencing.
T	E	*Acacia mearnsii* De Wild.	**Nsaana**	0.02	Firewood, utensils [pestles], medicine, fodder, nitrogen fixation.
T	I	*Acacia sieberiana* DC.	**Mweramanyo**	0.00	Firewood, timber, fodder, tool handles, nitrogen fixation, gum, fences
T	E	*Acrocarpus fraxinifolius* Arn.	-	0.00	Fuel wood, bee forage, shade
T	E	*Albizia chinensis* (Osbeck) Merr.	**Mugavu**	0.00	Firewood, timber, poles
T	I	*Albizia coriaria* Welw. ex Oliv.	**Mugavu**	0.01	Firewood, timber, poles
T	I	*Baikiaea insignis* Benth.	**Nkobakoba**	0.00	Fuel wood, timber, shade
T	E	*Calliandra calothyrsus* Meisn.	**Kaliyandura**	101.80	Fodder, nitrogen fixation, hedge
T	I	*Entada abyssinica* Steud. ex A. Rich.	**Mwoloola**	0.06	Firewood, medicine
T	I	*Erythrina abyssinica* Lam.	**Ejirikiti**	0.00	Utensils, bee forage, nitrogen fixation, live fence, mulch
T	E	*Gliricidia sepium* (Jacq.) Kunth ex Walp.	**Jiliricidiya**	0.30	Fuel wood, posts, fodder, shade, bee forage.
T	E	*Leucaena leucocephala* (Lam.) De Wit*	**Lusiina**	0.22	Fodder, fuel wood, mulch, wind break, nitrogen fixation
T	I	*Mimosa scabrella* Benth.	**Mimosa**	0.35	Fuel wood, mulch, timber, coffee shade, soil conservation, nitrogen fixation
T	I	*Piliostigma thonningii* (Schumach.) Milne-Redh.	**Bauhinia**	0.01	Food, fodder, shade, tannin

BF	St	Plant species	Local name	Prevalence	Function/Uses
T	E	*Senna siamea* (Lam.) H.S. Irwin & Barneby	**Gasiya**, **Omuzungu**	0.02	Medicinal, fuel wood, shade, soil conservation
T	E	*Senna spectabilis* (D.C.) H.S.Irwin & Barneby	**Gasiya**, **Omuzungu**	1.05	Charcoal, poles, bee keeping, forage, wind break
T	E	*Sesbania sesban* (L.) Merr.	**Muzimbandeya**	14.40	Nitrogen fixation, shade, soap, fodder, fuel wood
T	E	*Tamarindus indica* L.	**Mukoke**	0.02	Fruit, fuel wood
S	I	*Tephrosia vogelii* Hook.f.	**Muluku**	0.03	Pesticide
		LAURACEAE			
T	E	*Cinnamomum verum* J. Presl	**Mudalasiini**	0.00	Fuel wood, spice for tea
T	E	*Persea americana* Mill.	**Ovakaddo**	0.84	Fruit
T	I	*Beilschmiedia ugandensis* Rendle	**Mwasa**	0.00	Fuel wood, timber, food.
		MELIACEAE			
T	E	*Azadirachta indica* A. Juss.	**Nnimu**	0.02	Medicinal
T	I	*Khaya anthotheca* (Welw.) C.DC.	**Munyanya**	0.00	Fuel wood, timber, shade
T	E	*Melia azedarach* L.	**Mutankuyege**	2.28	Fuel wood, timber, poles, medicine, wind break
		MORACEAE			
T	I	*Antiaris toxicaria* Lesch.	**Kirundu**	0.00	Poles, fuel wood
T	E	*Artocarpus heterophyllus* Lam.	**Kifenensi**	1.85	Firewood, food, shade, lorry bodies
T	E	*Ficus elastica* Roxb. ex Hornem.	**Para**	0.00	Firewood, shade, avenue ornamental
T	I	*Ficus maitin* Pittier	**Muserere**	0.09	
T	I	*Ficus mucuso* Welw. ex Ficalho	**Kabalira**	0.00	Fuel wood, timber, carving
T	I	*Ficus natalensis* Hochst.	**Mutuba**	5.11	Medicine, shade, fencing, bark cloth
T	I	*Ficus ovata* Vahl	**Kookwe**	0.00	Poles, shade, soil conservation, fence, bark cloth
T	I	*Ficus sur* Forssk.	**Kabalira**	0.00	Timber, mortars, beer, canoes, food, ceremonial
T	I	*Ficus sycomorus* L.	**Luwawu**	0.00	Canoe timber, sand paper [leaves]
T	I	*Milicia excelsa* (Welw.) C.C. Berg	**Muvule**	0.08	Firewood, timber, shade, mulch, ornamental
T	E	*Morus alba* L.	**Nkenene**	0.40	Firewood, food, fodder, windbreak, fencing, shade
		MYRISTICACEAE			
T	I	*Pycnanthus angolensis* (Welw.) Warb.	**Munaaba**	0.00	Shade, ornamental, soap, illuminant.
		MYRTACEAE			
T	E	*Callistemon citrinus* (Curtis) Skeels.	**Nyambaddezitonya**	0.13	Fuel wood, medicinal, bee forage, wind break.
T	E	*Eucalyptus globulus* Labill.	**Kalitunsi**	0.09	Poles, fuel wood, timber

BF	St	Plant species	Local name	Prevalence	Function/Uses
T	E	*Eucalyptus grandis* W. Hill	**Kalitunsi**	0.14	Poles, fuel wood, timber
T	E	*Psidium guajava* L.	**Peera**	0.47	Fruit, fuel wood
T	E	*Syzygium cumini* (L.) Skeels	**Jambula**	0.01	Fuel wood, timber, food
		PHYLLANTHACEAE			
T	I	*Uapaca guineensis* Müll.Arg.	**Munamagulu**	0.00	Fuel wood
		PODOCARPACEAE			
T	I	*Podocarpus latifolius* (Thunb.) R. Br. ex Mirb.	**Musenene**	0.19	Fuel wood, timber, shade
		PROTEACEAE			
T	E	*Grevillea robusta* A. Cunn. ex R.Br.	**Kalwenda**	149.30	Coffee shade, fuel wood, building material
		PUNICACEAE			
T	E	*Punica granatum* L.	**Nkomamawanga**	0.02	Food, fence,
		RHAMNACEAE			
T	I	*Maesopsis eminii* Engl.	**Musizi**	3.90	Fuel wood, fodder, shade,
		ROSACEAE			
T	E	*Eriobotrya japonica* (Thunb.) Lindl.		0.10	Fruit, Building material, fuel wood
		RUBIACEAE			
T	I	*Vangueria apiculata* K. Schum.	**Matuggunda**	0.01	Firewood, poles, food
		RUTACEAE			
T	E	*Citrus limon* (L.) Osbeck	**Ennimu**	0.01	Fruit
T	E	*Citrus reticulata* Blanco	**Mangadda**	0.00	Fruit
T	E	*Citrus sinensis* (L.) Osbeck	**Mucungwa**	0.00	Fruit
T	I	*Teclea nobilis* Delile	**Enzo**	0.00	Building material, fuel wood
		SALICACEAE			
T	I	*Dovyalis caffra* (Hook.f. & Harv.) Warb.	-	0.16	Fruit jam, live fence, ornamental
		SOLANACEAE			
S	I	*Cyphomandra betacea* (Cav.) Sendt.	**Munyanya**	0.10	Food [jam, fruit, vegetable]

Table 3. The most important plant families in Masaka district, Uganda.

Family	Number of species	% (N=81)
Fabaceae	19	23.4
Moraceae	11	13.6
Euphorbiaceae	8	9.9
Combretaceae	5	6.2
Myrtaceae	5	6.2
Rutaceae	4	4.9

K. Schum. (RP=3.18). The most common exotic species are *Grevillea robusta* A. Cunn. ex R.Br. (RP=149.3) (from Australia) and *Calliandra calothyrsus* Meisn. (RP=101.8) (from Central America). Many exotic tree species are woody legumes used to fix nitrogen.

Crops grown with trees and agroforestry commodities

Table 4 shows that the most prevalent crop grown with trees is banana (65.9%). (It is the major food crop for Baganda people living in Masaka district.) This is followed by cassava grown by 13.6% of farmers. (Cassava is used as a food and harvested when there are no mature banana fruits in the farm.) A few farmers in Masaka district (5.7%) do not grow crops with trees but practice the older farming system of bush fallow.

Table 4. Crops grown with trees in Masaka district, Uganda.

Crops	Number of farmers	%
Banana	58	65.9
Cassava	12	13.6
Beans	4	4.5
Maize	4	4.5
Vegetables	3	3.4
Coffee	2	2.3
None	5	5.7
Total	88	100.0

Land size and sources of land for farms

Many farmers (43%) have small land areas which range from 1 to 3 acres (0.4-1.2ha) (Table 5).

Table 5. The size of land in the agroforestry systems in Masaka district, Uganda.

Land size (acres)	Number of farmers	%
1 - 3	43	48.9
4 - 6	32	36.4
7 - 9	6	6.8
10	7	7.9
Total	88	100.0

The most common land tenure for farmers (70.5%) is personal ownership (Table 6).

Table 6. Land ownership in Masaka district, Uganda.

Land ownership	Number of farmers	%
Personal	62	70.5
Borrowed	18	20.4
Rented	6	6.8
Communal	2	2.3
Total	88	100

Production and marketing problems

The main production problems faced by the farmers in Masaka district are pests and diseases (13.6%) (Table 7). However, many farmers (39.8%) report no production problems. In contrast, one third of farmers face at least three of the production problems listed.

Table 7. Production problems in Masaka district, Uganda.

Problems	Number of farmers	%
At least 3 problems	30	34.1
Pests/diseases	12	13.6
Termites	5	5.7
Soil erosion	3	3.4
Long distance	2	2.3
Fertilizers	1	1.1
No problem	35	39.8
Total	88	100

The principal marketing problems are similar in scale including low prices, long distance from village to farm, lack of buyers, and price fluctuations (Table 8). However 25% of farmers did not report having any marketing problem.

Table 8. Marketing problems in Masaka district, Uganda.

Problems	Number of farmers	%
Low prices	18	20.5
Long distance	17	19.3
Lack of buyers	14	15.9
Price fluctuations	13	14.8
Lack of storage	4	4.5
No problem	22	25.0
Total	88	100.0

Farmers' family expenditure

The main items farmers spend money on are school fees, medicines, and essential commodities (Table 9).

Table 9. Family expenditure in Masaka district, Uganda.

Expenditure	Number of farmers	%
School fees	49	55.7
Medicine	19	21.6
Essential commodities	19	21.6
Transport	1	1.1
Total	88	100

Discussion

The results indicate that farmers practice different types of agroforestry systems in Masaka district while some farmers practice specialized agroforestry systems (Young 1989), namely apiculture and agro-aquaculture Nair (1989). This shows that the farmers of Masaka dis-

trict are involved in the multiple land use management. This implies a mix of crops, trees/shrubs, fish and animals. This allows farmers to produce a variety of crop products (see Table 2).

Farmers in Masaka district hold small land sizes (0.4-1.2ha). Franzel *et al*. (2001) found in Zambia that farmers also hold comparable land size (0.36 ha) and Thangala *et al*. (2008) report comparable average land holdings in Zimbabwe (0.43-0.6 ha) and Malawi (0.5-1.1 ha). According to these authors, the total land used by small holder farmers practicing agroforestry is on average less than a hectare since they produce mostly for home consumption and sell their produce individually on-farm or at local markets. Despite small arable land size, they get some revenue from the agroforestry products sold. Agea *et al*. (2005) came to similar conclusions in Mukono district, Uganda.

Despite the fact that farmers hold small arable lands, they are able to increase farm yield by producing a variety of crops, livestock and wood products for both home consumption and local markets. In spite of this, they do face some production and marketing problems. Pest, diseases and termites negatively affect crop production as they reduce crop yield. Most farmers are poor and cannot afford fertilizers, and have farms far from where they live. Pest and diseases, soil erosion, long distance from the village to farm and termites are the main limiting factors for crop production cited by farmers.

Four marketing problems (low prices, price fluctuations, lack of storage, long distance to the market, and lack of buyers at home level) are comparable to results in Mukono district (Agea *et al*. 2005) where the physical nature of the product, handling and lack of transport and storage facilities present serious marketing problems. According to Ngategize and Kaboyo (2001), the availability of good transport and storage facilities are key determinants of good price for farmers' products. According to Agea *et al*. (2005), selling of the produce individually and locally does not offer better income to farmers because local buyers offer only low prices.

Land tenure plays a great role in agroforestry adoption. In Masaka district, personal ownership (divided inheritance or purchased) is the most prevalent category. This type of land tenure provides long-term security that is required for agroforestry adoption (Suyanto *et al*. 2005). This likely explains why the majority of farmers in Masaka district are involved in agroforestry. Farmers renting land do not practice agroforestry because they hold land for a short time.

The study revealed a diversity of trees and shrubs involved in the Masaka district agroforestry systems. More than half are indigenous but the exotic species are much more preferred. As reported in literature (Kebebew *et al*. 2011), woody species grown with crops in agroforestry have many advantages. They are known to restore and sustain soil fertility through nutrient cycling, provide mulch and fodder for livestock, and reduce soil erosion. Moreover, woody legumes used in agroforestry replace fallow with continuous cropping, and hence reduce pressure on land by minimizing demand for arable land.

The study showed that farmers' adoption of agroforestry systems is relatively high in Masaka district. The adoption of agroforestry systems by farmers has been made possible by several factors, namely high demand for land due to increasing population, soil fertility decline, erosion problems, and demand for woody products such as fuel wood and fodder, increased crop yield, and contact with the Vi-Tree NGO Agroforestry Project extension. Personal land ownership has also facilitated the adoption of agroforestry systems in Masaka district since majority of farmers hold personal land. In contrast, other types of land ownership may hinder the adoption of agroforestry systems, for example rented or borrowed lands, because farmers cannot use the land for long-term production. This has been pointed out in West and Central Africa countries, Benin, Nigeria, and Cameroon. Thangata *et al*. (2008) concluded that the potential adoption of agroforestry by farmers in Malawi, Zimbabwe and Zambia depends on household composition, farm size, availability of draft power, and a seed selling incentive. However, in Cameroon, Nkamleu and Manyong (2005) found that the gender of farmer, household family size, level of education, farmer's experience, membership within farmers' associations, contact with research and extension, security of land tenure, agro-ecological zone, and distance of the village from nearest town, village accessibility and income from livestock facilitate the adoption of agroforestry systems.

Conclusion and Recommendation

The potential adoption of agroforestry in Masaka district is seen as a means to improve food security and farmers' livelihood. Among factors facilitating this adoption is personal land ownership. Although all the trees and shrubs grown with crops have potential role in agroforestry systems, the woody leguminous species are the most important group because of their economic uses and ecological adaptability (Nair *et al*. 1984, Mosango 1999). In fact, woody leguminous species have the added advantage because of their capability for nitrogen fixation. Hence, replacing the less productive woody species with fast growing nitrogen fixing species, such as *Leucaena leucocephala* (Lam.) De Wit, *C. calothyrsus*, *Sesbania sesban* (L.) Merr., *Gliricidia sepium* (Jacq.) Kunth ex Walp., *Erythrina abyssinica* Lam., and *Mimosa scabrella* Benth., will increase crop yield, provide farmers with more fuel, fodder and green manure (see Table 2) and improve farmer's livelihood.

Most of the leguminous species used were introduced by the Vi-Tree NGO Project. It is therefore important to select and test several local legume species (Table 2) to test

for improved agroforestry practices. Moreover, trees with a low relative prevalence should be planted around Masaka district in numerous uninhabited areas and forest reserves so that they can be saved from possible extinction and used later when need arises.

Finally, in order to meet the demand for food and for other wood products in Masaka district, farmers should be encouraged to practice agroforestry systems. The implementation of improved agroforestry systems allows alleviating pressure on natural forests, increasing crop yield, providing farmers with more income and improving their livelihood (Russo 1996).

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