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Patterns of Agroforestry Practices among Small-Holder Farmers in the Lake Victoria Crescent Zone (LVCAEZ) of Uganda

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Abstract: Agroforestry is increasing being recognition of a viable option for overcoming a large portion of the current global challenges of climate change mitigation and adaptation, food security and household income. To increase the contribution of agroforestry, there is urgent need to test the technological robustness of agro forestry through on-farm testing with farmers as a principle step in up-scaling the adoption of the technologies. A survey of 229 households was conducted in Mubende, Kaynga and Luwero districts in the Lake Victoria Crescent (LVC) of to determine the level of awareness of the various agro forestry technologies for livelihood improvement, assess opinions of farmers about the usefulness of agroforestry technologies and evaluate their choice of planting pattern and willingness to adopt new technologies if introduced. We found that the level of awareness of agroforestry technologies was generally low with only about 30% of the farmers having been exposed to at least one improved agroforestry technology. A large proportion of farmers were willing to adopt if the technologies were introduced although several constraints such as land shortage, limited access to planning materials labour intensiveness and lack of market may limit them. The most important socio-economic determinant is exposure to the technology. Training and sensitization are highly recommended approaches for promoting adoption of technologies that the National agricultural Advisory services should include as an integral ingredient of the advisory role. Germplasm of candidate species is should be developed and availed to farmers possibly through local nursery operators that are periodically supervised by NARO and NAADS.

Key words: Agroforestry, patterns, willingness, adoption, Lake Victoria Crescent, Uganda

INTRODUCTION

Agroforestry is increasing being recognition of a viable option for overcoming a large portion of the current global challenges of climate change mitigation and adaptation, food security and household income. The recent recognition of agroforestry as a greenhouse gas mitigation strategy under the Kyoto Protocol has earned it added attention (Nair *et al*., 2009; Syampungani *et al*., 2010). Efforts to increase the adoption of agroforestry and as a land management strategy are therefore highly needed, especially for small-holder farmers in sub Saharan Africa where small land holdings and high cost of inputs and poor market structures (Mukadasi and Maxwell, 2008).

Okia *et al*. (2009) expressed the urgent need to test the technological robustness of agro forestry through on-farm testing with farmers as a principle step in up-scaling the adoption of the technologies. Efforts by National Agricultural Research Organization (NARO) are geared towards improving farmer adoption of agro forestry technologies. Although, several efforts by government and Non-Government Organizations (NGOs) have be implemented to ensure the contribution of agro forestry to livelihoods of small-holder farmers, the levels of adoption of these technologies has been limited. Several factors accounting for this low uptake include land and labour shortage, lack of adequate planting materials for preferred species, gender differences at household level, limited knowledge about specific technologies (Franzel, 1999; Noordin *et al*., 2001; Mercer, 2004; Ogunlana, 2004). Kiptot *et al*. (2007) showed that the process of adoption of improved fallow agorforestry systems in Western Kenya was highly dynamic and variable with farmers planting and discontinuing or re-adopting them due to a whole range of factors of which soil fertility improvement is just one. These factors included incentives from projects, the tying of adoption to credit programs, prestige, participation in seminars/ tours and the availability of a seed market from projects promoting improved fallows.

Against this background, this baseline study was carried out in the LVCZ to establish the status and potential of promoting improved agro forestry technologies. The objectives of the study were to

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determine the level of awareness of the various agro forestry technologies for livelihood improvement, opinions about the usefulness and willingness to adopt these technologies if introduced.

MATERIALS AND METHODS

The study was conducted in the districts of Kayunga, Luwero and Mubende in the Lake Victoria Crescent Agro-ecological zone of Uganda (Fig. 1). The contemporary climate in this area is wet tropical with a mean annual precipitation of 1200 mm (distinctly bimodal distribution) and a mean annual temperature of 23°C at an elevation over 1 km above sea level. Due to the range in K-feldspar content and variable texture contrast, the soils are classified as a mixture of oxisols, ultisols and inceptisols (Fungo *et al*., 2011). Black and grey clays are also found in the flat, poorly drained, dambos (flat, channel-less poorly drained valley bottoms) with yellow sands on the sloping dambo margins. The topography is characterized by hills and ridges that are highly dissected by streams and drainage ways. The main economic activity of the people in the sampled districts is subsistence farming of bananas, beans, maize, rice, potatoes, cassava among other crops land use types include annual crops, plantation forestry, perennial cropping such as bananas, coffee and agro forestry. Large expanses of grazing lands are common in Luwero and Kayunga districts.

The districts of Kayunga, Luwero and Mubende were selected for this study because they ranked lowest among that least experienced agro forestry extension in the past decade (Okia *et al*., 2009). From each of these districts, two sub counties were selected using key informants. The sampling frame consisting of households was generated using the Local Councils of the villages in the selected sub counties. Using a list of random numbers, 80 farmers were selected from each district. Household interviews were held with the selected households using a structured questionnaire.

The socio-economic characteristic of the households were presented as frequencies and percentages in tables. Chi-square test of was used to establish the dependence of some of the agro forestry practices to their

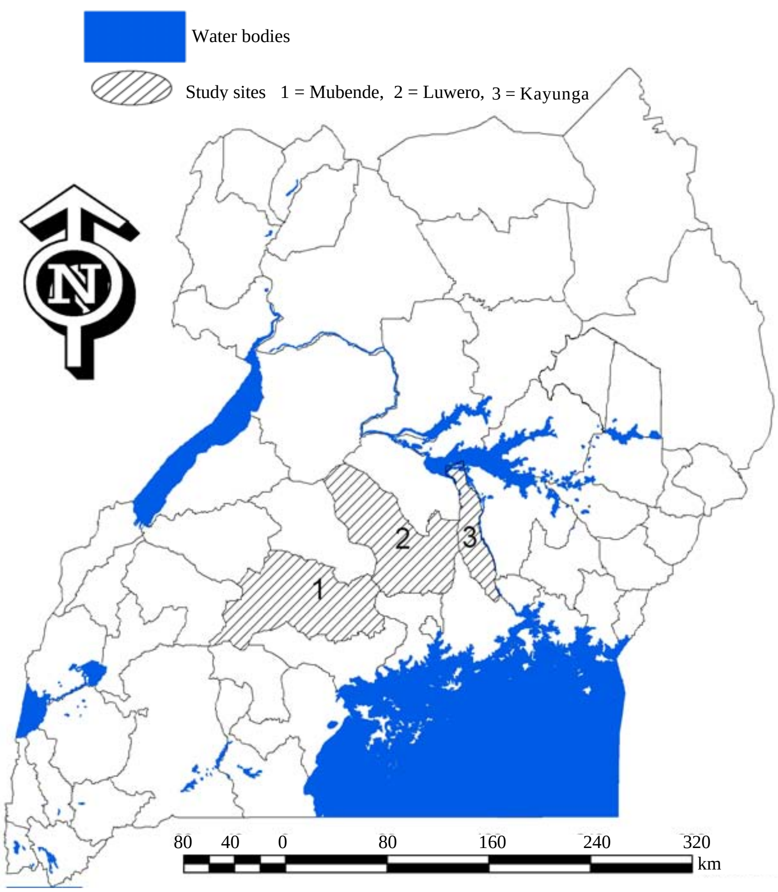

Fig. 1: Map of Uganda showing the location of sampled districts in the Lake Victoria Crescent agro-ecological zone of Uganda

benefits. Binary logistic regression was used to assess the socio-economic factors affecting the adoption of the three major agro forestry practices (home gardens, scattered plots and boundary planting).

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents: Majority (~84%) of the sampled households were male-headed. Approximately 57% of the respondents were aged between 30 and 50 years (Table 1). The 83% of the respondents were married while the rest were not married, divorced or widowed. Almost half of the respondents had not exceeded primary level education (about 7 years of formal education). The average number of people per household ranges between four and seven. Close to one half of the respondents have between 4 and 10 acres of land and 64% of the land is under the Mailo tenure system.

It is reasonable to say that where 33% of the respondents had received training on at least one aspect of agroforestry, the awareness is relatively inadequate. However, it is important to understand the various aspects in which they were trained and the relevance of these aspects to their farming practices. It is also important to understand whether the exposure to the train in any way affects the adoption and sustained use of the technologies. More importantly, it is necessary to further understand the areas of training that would be of more relevance for the livelihood of the farmers. By providing the relevant training, farmer adoption and of the technologies is more likely and.

Existing agro forestry technologies: The agro forestry technologies practices by farmers in the study area are shown in Table 2. Trees scattered on farmland represent the most frequently encountered practice by approximately 94% of the households in the area. Between 30 and 40% of the respondents practice boundary planting and establish home gardens. Several technologies are known to be practices in the zone but are not mentioned by farmers. These include apiary, sericulture and aquaforestry (Agea *et al*., 2007). The absence of these technologies is attributed to the limited samples but also on their rare occurrence.

The major agro forestry species grown on farms are shown in Table 3. The major objectives for which farmers grow trees on farm include food, timber and poles and

Table 1: Socio-economic characteristics of the respondents

Variables	Levels	Frequency	Percentage
Sex	Female	34	14.8
	Male	193	84.3
Age of household head	<31 years	19	8.3
	31-40 years	61	26.6
	41-50 years	69	30.1
	51-60 years	44	19.2
	>60 years	35	15.3
Marital status	Single	9	3.9
	Married	189	82.5
	Widowed	20	8.7
	Separated	11	4.8
Formal education	None	5	2.2
	Primary	111	48.5
	Ordinary level	50	21.8
	Advanced level	6	2.6
	Tertiary	30	13.1
Household size	1-3 persons	46	20.1
	4-7 persons	96	41.9
	>7 persons	86	37.6
Land holding	<1 acre	25	10.9
	1-3 acres	75	32.8
	4-10 acres	94	41.0
	>10 acres	32	14.0
Land tenure system	Mailo	146	63.8
	Public	42	18.3
	Leasehold	11	4.8
	Freehold	16	7.0
Agro forestry as one of the sources of income	None	42	18.3
	Low (25% of household income)	68	29.7
	Medium (50% of household income)	11	4.8
	High (75% of household income)	10	4.4
Ever received any agro forestry technology	None	173	75.5
	Yes	52	22.7
Ever received any agro forestry training	No	149	65.1
	Yes	76	33.2
Ever visited agro forestry demonstration site	No	147	64.2
	Yes	62	27.1

Table 2: Agro forestry technologies practiced by farmers in Kayunga, Luwero and Mubende, Lake Victoria Crescent zone of Uganda

Existing agro forestry technologies	Kayunga	Luwero	Mubende	Total	Percentage
Scattered tree planting	67	70	76	213	93.8
Boundary planting	48	17	23	88	38.8
Home garden	22	20	26	68	30.0
Fodder bank	9	4	0	13	3.1
Trees in range lands	4	0	3	7	5.7
Fruit trees	2	0	0	2	0.9
Timber woodlots	2	0	0	2	0.9

Table 3: Agro forestry tree species and the technologies in which they are use in Kayunga, Luwero and Mubende, Lake Victoria Crescent zone of Uganda

Primary objective	Agro forestry tree species grown	Home garden	Scattered tree planting	Boundary planting	Range lands
Food security	*Autocapus heterophylus*	60	146	63	3
	Mangifera indica	47	108	53	3
	Persea americana	37	91	38	2
	Carica papaya	22	34	13	0
	Gavea guajava	8	6	2	0
	Orange	3	9	4	0
Timber/poles	*Makhamia lutea*	22	69	47	4
	Albizia sp.	6	11	4	1
	Mivule	8	21	12	1
	Mugavu	31	83	26	3
	Mukebu	0	1	1	0
Environmental benefits	*Caliandra callothaius*	4	13	9	1
	Maesopsis eminii	26	67	43	3
	Ficus nantalesis	46	129	58	3
	Mikokowe	2	7	4	0
	Acacia sp.	4	5	4	0

bio-environmental improvement (soil fertility, shade, wind and support). The most common tree species include planted for food include *Autocapus heterophylus*, *Mangifera indica* and *Persea americana* but others like *Carica papaya*, *Gavira gujava* and oranges are also grown by some few farmers. *Makhamia lutea*, *Maesopsis eminii* and *Albizia* sp. are the most common species for timber and poles. There also exist some farmers who maintain *Milicea excelsa* that are found growing on their farmers. Although, the later species is liked by many people for its high quality timber, no farmer was found planting the tree.

The partner of arrangement of the trees or farm is usually home gardens, tree scattered on farm land or boundary planting. Case of rangeland trees fodder banks and allays were also report but with very cases. Trees more commonly found in home gardens are those meant for food while those for timber and environmental modification are predominantly scattered or planted on boundaries and in range lands. Okia *et al.* (2009) attributed the patterns to respond to the problem or opportunity domain of the LVCZ; available market of farm produce due to urban population, low soil fertility due to highly weathered and acid soils and poles and field wood. The dominance of scattered tree practice is attributable to the limited labour required to establish and manage geometrically organized trees on farm. As Adesina *et al.* (2000) noted, it is also probably due to the random manner in which small-scale farmers plant the crops in space and time so that the predictability of future crop-tree arrangement is difficult to determine. It is important also to note that many farmers do not actually plant but tend trees that regenerate by natural means. In this way, scattered trees are likely to dominate. The arrangement also largely depends on the farmers knowledge of the interaction between the target tree and the crops mostly planted on the plot (Feder *et al*., 1985; Besley and Case 2003; Franzel, 1999; Ajayi *et al*., 2003). Many fruit trees are not known to have allelopathetic effects and so many times famers plant them in other than at the plot boundary. However, some species like *Eucalyptus* sp. are rarely if ever, planted inside the plot because of their perceived effect on plants.

A farmer's choice to practice an agroforestry technology will depend on the objective (s) he/she has for so doing. Economic benefits seem to override other benefits of agroforestry according to some studies, especially if the farmer's income is comparatively low. Income from sale of agroforestry products attracts many farmers to adopt a net technology. For example, scattering of *Autocapus heterophylus* on farm is a common practice by many farmers as they usually sale the fruits quickly to earn cash. They also use it as a food security. Okia *et al.* (2009) reported that scattered tree practices were common in the LVCZ because farmers usually retain rather than plant the trees and this makes mechanized farm operations difficult.

Knowledge and awareness of improved tree species: Table 4 shows that only 19 farmers (~8%) have received training in at least one aspect of agroforestry. Soil management is the aspect where most farmers (10) have received training followed by tree management. This lack of training implies that farmers continue to use only

Table 4: Level of training in various aspects of agroforestry by farmer in the Lake Victoria Crescent of Uganda

	Who trained provided the training?				
Area of training	NARO	Self help international	NAADS	Kalitas	Total (N = 229)
Tree management	4	4	3	1	9
Soil management	8	2	2	1	10
Crop-tree management	1	1	3	0	4
Improved fallows	1	0	0	0	1
Manure making	1	0	0	0	1
Mulching	1	2	1	0	4
Fodder bank management	1	2	0	0	3
Total	9	4	7	1	19

Table 5: Socio-economic determinates of adoption of planting patters of improves agro forestry tree species in the Lake Victoria Crescent Zone of Uganda

	Home garden			Scattered			Boundary		
Factors	B	SE	Sig.	B	SE	Sig.	B	SE	Sig.
Sex	21.592	20111.285	0.999	-21.484	9828.233	0.998	1.545	1.695	0.362
Age	0.557	0.354	0.115	-0.546	0.579	0.346	0.295	0.241	0.220
Marital status									
Married	-43.597	25750.474	0.999	-28.186	9250.102	0.998	0.999	2.031	0.623
Widowed	-20.879	20111.285	0.999	-22.934	9250.102	0.998	0.573	1.613	0.722
Separated	1.353	1.858	0.467	-23.061	18972.095	0.999	0.409	1.753	0.815
Education	0.474	0.336	0.158	0.745	0.721	0.301	0.188	0.240	0.434
Household size	-0.816	0.654	0.212	-1.358	1.026	0.186	0.269	0.395	0.496
Acreage	1.178	0.488	0.016**	0.568	0.613	0.355	-0.101	0.307	0.743
Tenure system									
Public	-0.538	1.220	0.659	6.553	2.085	0.002***	-0.656	0.837	0.433
Freehold	-1.205	1.373	0.380	5.355	2.038	0.009***	-0.050	0.905	0.956
Leasehold	-21.658	40192.970	1.000	17.872	40192.970	1.000	-23.085	40192.970	1.000
Income	-2.766	0.769	0.000***	1.494	0.944	0.113	0.567	0.336	0.092*
Techno	-3.908	1.327	0.003**	0.055	1.786	0.975	1.979	0.793	0.013**
Training	1.807	1.083	0.095*	0.881	1.201	0.463	0.449	0.608	0.460
Demos	1.673	0.947	0.077*	-1.019	1.283	0.427	-0.993	0.660	0.132

*, ** and *** means the variable is significant at 0.1, 0.05 and 0.001, respectively; home gardens: N = 96, LR χ^2 (11) = 68.69; Prob>χ^2 = 0.0000; Log likelihood = -31.862781, Pseudo R^2 = 0.5188; Scattered: N = 83, LR χ^2 (10) = 26.22, Prob>χ^2 = 0.0035, Log likelihood = -15.377167, Pseudo R^2 = 0.4602; Boundary: N = 96, LR χ^2 (11) = 23.50, Prob>χ^2 = 0.0150, Log likelihood = -53.768741, Pseudo R^2 = 0.1793

indigenous knowledge or the knowledge learned from neighbours to practice agroforestry. This knowledge may be limited as there have been tremendous developments in agroforestry that farmers may not be exposed to. The traditional practices of scattering tree on farm have long faced challenges of land shortage can no longer make significant contribution to desired benefits of agroforestry. Further farmer training and sensitization may be urgently required to improve farmers' access to adequate knowledge of potentially useful technologies.

The models estimating the determinants of adoption of agro forestry practices are shown in Table 5. The factors that significantly affect adoption home gardens include land size and level of income derived from agro forestry, land tenure, exposure to technology, training in any agroforestry technology and exposure presence demonstration sites in the area. For scattered trees only land tenure significantly affected adoption.

Mailo land was fixed at zero. Therefore, the impact reported is that of changing from mailo land to another type of tenure. The model indicates that changing from mailo land to private, Freehold and leasehold tenure reduces chances of adopting scattered trees by 0.5, 1.2 and 21.6 times, respectively. Farmers with larger land holdings have 1.2 more chances of adopting home gardens compared to those with smaller ones. However, chances of adopting home gardens are fewer if the farmers have higher income. This could be due to the high opportunity cost of the home gardens compared to other specialized income agro-enterprises that highly educated farmers focus on. For example, growing high value crops like tomatoes would be preferred to scattered trees on farm. Home gardens are also common among low-income groups because they are insurance means for food security and income diversification. Similarly, exposure to an improved technology also decreases the chances of adopting home gardens.

Kiptot *et al.* (2007) reported that farmers in areas with a long history of exposure to agroforestry research had higher adoption levels than those with recent history. However, other variables such as gender, age, household type, type of housing, education, farm size, adults working on the farm, livestock ownership and improved cows were not found to influence adoption of improved fallows. The findings support these findings because we found that exposure to a technology is the most important determinant of adoption among all agroforestry systems. Several other studies however, show the influence of these factors on adoption (Lapar and Pandey, 1999; Baidu-Forson, 1999; Doss, 2002; Naagula and Buyinza, 2009; Mazvimavi and Twomlow, 2009; Peterman *et al*., 2010). Important to note is that adoption is not a straightforward process. It is a continuous process and the categories are therefore only relevant at a specific point in time (Williamson, 1985; White, 2002). Farmers may oscillate between testing, adoption, discontinuation and re-adoption. Adoption is complex and influenced by many factors that do not lie solely within the household (Keil *et al*., 2005; Kiptot *et al*., 2007; Mazvimavi and Twomlow, 2009). These factors may include socio-economic, biophysical, institutional and even political ones (as in the case of farmers refusing to pay back credit). To classify farmers into two groups, adopters and non-adopters is often an oversimplification. It is not easy to classify farmers into various adoption categories, such as the four defined by Kiptot *et al*. (2007) as the boundaries are often blurred. Nevertheless, such classification provides a framework for understanding the perceptions of different categories of farmers. Seeing such differences may in turn improve understanding of the obstacles preventing initial adoption of a technology. There is a difference between the decision to discontinue a technology that one has tried and that of not adopting it at all. Similarly, discussions with farmers who discontinue the use of a technology may provide information on the features of the technology that proved unappealing to them under prevailing field conditions and bring out other issues that had not been anticipated at all, such as lack of benefits or inaccessibility to credit.

CONCLUSION

The study has revealed that the level of awareness of the various agro forestry technologies for livelihood improvement in the sampled districts is relatively low (~30%). Farmers acknowledge the usefulness of planting trees on farm for economic, environmental and even social benefits. Despite this interest in tree planting, several constraints such as land shortage, scarcity of planting material, inadequate knowledge and skills to establish and manage trees appropriately and high labour requirements for some technologies such as hedge-raw intercrops. There is generally high level of willingness to adopt these technologies if introduced. This will however, depend on socio-economic and environmental drivers.

RECOMMENDATIONS

Training and sensitization are highly recommended approaches for promoting adoption of technologies that the National agricultural Advisory services should include as an integral ingredient of the advisory role. Germplasm of candidate species is should be developed and availed to farmers possibly through local nursery operators that are periodically supervised by NARO and NAADS.

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