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Factors Influencing the Adoption of Agroforestry Technologies in Maracha District, Uganda

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ABSTRACT

Agroforestry technologies have been extensively researched and introduced to smallholder farmers in Uganda. However, not many farmers have adopted these technologies. This study was conducted to assess underlying factors in creating awareness and adoption of agro-forestry technology practices in Maracha district in north west Uganda. A cross section survey was administered to 97 randomly selected households. Data were captured on the age, gender, marital status, educational level and years of farming experience, off farm activities, household size and farm size of the respondents. Other variables included farmers' awareness and involvement in agroforestry technologies, distance to the market, the agroforestry technologies adopted and other information relevant to the study. Data were analyzed using descriptive statistics, t-test and logistic regression analysis. Results showed that awareness of agroforestry technology was highly enabled by farmer's age ($P \leq 0.02$), level of education ($P \leq 0.04$), access to extension services ($P \leq 0.01$) and agroforestry experience ($P \leq 0.05$). Adoption of agroforestry technologies was significantly ($P \leq 0.01$) and positively influenced by access to extension services, age ($P \leq 0.05$), agro-forestry experience ($P \leq 0.01$), farm size ($P \leq 0.05$) and level of education ($P \leq 0.01$) and farming experience significantly ($P \leq 0.05$) but negatively influenced by distance to the nearest market. The prominent agroforestry technologies were woodlots, improved fallow and orchards while plantations attracted the least percentage of farmers. Extension services was the main motivator of awareness and adoption but built on farmers' early exposure to the technologies at school. This avenue of learning has a potential multiplication effect in a youthful Ugandan population, if agro-forestry intervention is emphasised in the lower school syllabi.

Keywords: Deforestation, Maracha, socio-economic factors, woodlots, Uganda

RÉSUMÉ

Les technologies agroforestières ont fait l'objet de recherches approfondies et ont été introduites auprès des petits exploitants agricoles en Ouganda. Cependant, peu d'agriculteurs ont adopté ces technologies. Cette étude a été menée pour évaluer les facteurs sous-jacents à la sensibilisation et à l'adoption des pratiques technologiques agroforestières dans le district de Maracha, au nord-ouest de l'Ouganda. Une enquête en

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coupe transversale a été administrée à 97 ménages sélectionnés au hasard. Les données ont été recueillies sur l'âge le sexe, l'état matrimonial, le niveau d'éducation et les années d'expérience agricole, les activités hors exploitation, la taille du ménage et la superficie de l'exploitation des répondants. D'autres variables comprenaient la sensibilisation des agriculteurs et leur implication dans les technologies agroforestières, la distance par rapport au marché, les technologies agroforestières adoptées et d'autres informations pertinentes pour l'étude. Les données ont été analysées à l'aide de statistiques descriptives, de tests t et d'une analyse de régression logistique. Les résultats ont montré que la sensibilisation à la technologie agroforestière était fortement favorisée par l'âge des agriculteurs (P≤0,02), le niveau d'éducation (P≤0,04), l'accès aux services de vulgarisation (P≤0,01) et l'expérience en agroforesterie (P≤0,05). L'adoption des technologies agroforestières a été significativement (P≤0,01) et positivement influencée par l'accès aux services de vulgarisation, l'âge (P≤0,05), l'expérience en agroforesterie (P≤0,01), la taille de l'exploitation (P≤0,05) et le niveau d'éducation (P≤0,01), tandis que l'expérience agricole a été significativement (P≤0,05) mais négativement influencée par la distance par rapport au marché le plus proche. Les technologies agroforestières les plus courantes étaient les bosquets, les jachères améliorées et les vergers, tandis que les plantations attiraient le moins grand pourcentage d'agriculteurs. Les services de vulgarisation étaient le principal moteur de la sensibilisation et de l'adoption, mais ils reposaient sur l'exposition précoce des agriculteurs aux technologies à l'école. Cette voie d'apprentissage a un effet multiplicateur potentiel dans une population ougandaise jeune, si l'intervention agroforestière est mise en avant dans les programmes scolaires du primaire.

Mots-clés: Déforestation, Maracha, facteurs socio-économiques, bosquets, Ouganda

Introduction

A forest is regarded as any vegetation type covering over 0.5 hectare and dominated by trees that grow above the height of 4 meters with at least 30 percent crown (UNEP, 2001). In Uganda, the 25 years after 1990 have recorded a decline in forest and woodland coverage from 30 to 10%, predicting the extinction of these resources in the country by the year 2040 (NEMA, 2016). The underlying factors of rampant deforestation include rapid population pressure and urbanization that come with demands for more space for settlement, low input agriculture that is compensated for by opening more land, expansion in monoculture plantations, as well reliance on wood for building material and fuel in form of charcoal and fire wood (NEMA, 2016). The extensive deforestation in rural setups is further accelerated by disruption of indigenous traditional land-use management practices. Efforts to improve agro-forestry technologies should consider integrating the compatible components of forestry and agricultural production system to be able to save the forests and arrest environment degradation. Consequently, the National Forest Authority of Uganda introduced the planting of trees and woodlots by individual land users, institutions and by community organizations. Target agro-forestry technologies have sought to increase land productivity and household income generation as well as environmental rehabilitation and diversification of agro-ecosystems. Incorporating fast growing tree species in agro-forestry provides a sustainable source of wood fuel (NEMA, 2015). The Uganda Forestry Policy (2001) recognizes the importance of development and sustainable management of farm forestry as it diversifies farm production and provides both subsistence and income

through products such as timber, fuel wood, herbal medicine and fodder (NEMA, 2015). Factors that hinder agroforestry technologies to reach the low resource farmers have been documented. Aboh and Akpabio (2008) observed poor linkages between research organization and extension. Furthermore, non-adoption by the farmers has been attributed to farmers' rationality on benefits in incomes and risks associated with new technologies under their socio-economic circumstance (Meijer *et al*., 2015). Therefore, in the uptake of any new technology, there lies a question of which socioeconomic factors may influence farmers' decision for the adoption (Meijer *et al.*, 2015; NFA, 2016). Given the dynamics in the economic, social and political aspects it is desirable to understand the current factors responsible for the adoption of agroforestry technologies by households. This study was undertaken with the objectives of profiling the households involved in agroforestry technologies, determining their level of awareness about agroforestry technologies and the socio-economic characteristics that influence the adoption of agroforestry technologies in Maracha District, Uganda.

Materials and Methods

Study Area. The study was conducted in Maracha District, located in West Nile (North West) region of Uganda. The district lies between longitude 30^0.56' 31" East and between latitude 3^0.15' 3 north of the Equator.

Data collection and analysis. A probabilistic and non-probabilistic sampling approach was adopted to select the study sample. The non-probabilistic approach used purposive sampling technique to select extension workers as key informants due to their technical knowledge on agro-forestry. Random sampling was then used to choose respondents from the category of farmers, and community leaders. Respondents were purposively selected that comprised farmers, extension workers, and local leaders. A sample of 99 respondents were selected according to Krejcie and Morgan (1970) sampling guide. These comprised of 80 farmers, seven extension workers and 19 local leaders.

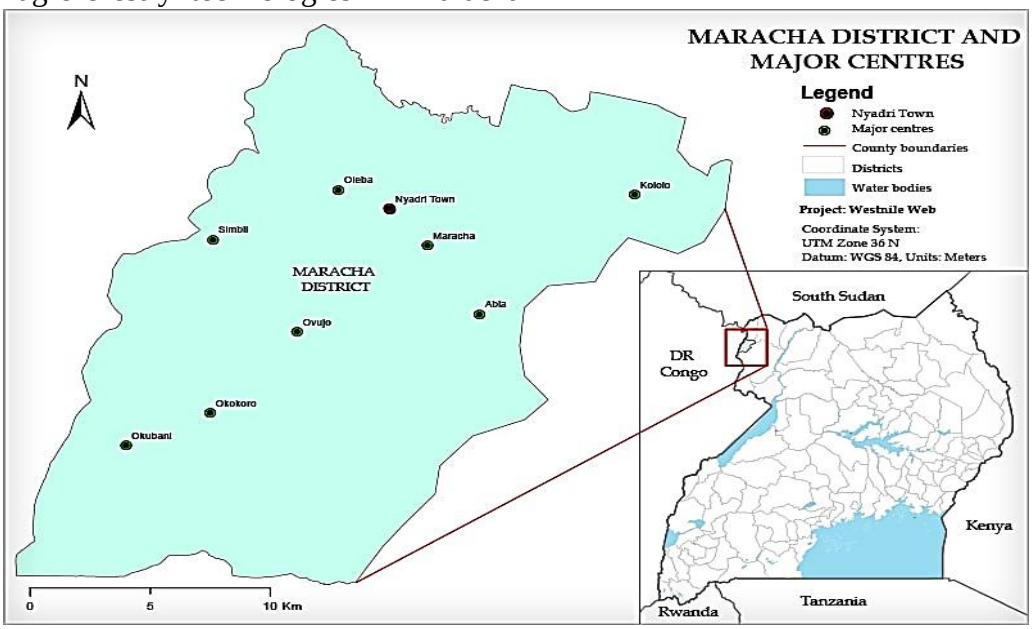

Figure 1. Map of the study area

A one-to-one survey questionnaire was administered to the farmers in an interview format. The extension workers and local leaders were subjected to a guided interview. SPSS statistical software was use to perform t test or chi square and STATA software for logistic regression analysis. A t-test was used to determine the correlation among variables and for determination of statistical differences. Results were summarized in form of frequency tables and graphs. Further analysis was done through logistic regression model to determine the effect of independent variables on awareness and adoption, where:

$Pi = E(Y=I\ \chi_i) = \beta_0 + \beta_i\chi_i\rho$……..... (i)

Where:
Y=1 indicates adoption,
Xi is a vector of independent variables,
β_0 is a constant,
β_i=1, 2…n are the coefficients of the independent variables to be estimated.

$L1 = Z(1) = \beta_0 + \beta_i\chi_I + \beta_2\chi_2 + \beta_3\chi_3$ ……+ $\beta_9\chi_9$ + U ……..(ii)

Where:
X1 = Gender; X2 = Marital status; X3 = Education level; X4 = Age; X5 = Farming experience; X6 = household size; X7 = Access to credit; X8 = Membership to famer group; X9 = Access to extension services; X10 = Distance to nearest market; X11= farm size; X12 = Agronomic experience; U = Constant.

Results

Farmer profile. Males (69%) doubled the female respondents (Table 1). Most of the farmers (85%) were between 20-40 years and majority (90%) of them farmers were married. More than half (69%) of the farmers had attained primary education, with only 5% having attained tertiary education. Most (96%) of the respondents reported having other sources of income. They also had an experience of less than 10 years in farming and 66% of them had 1-3 hectares of land, with very few (6%) exceeding 6 hectares. Almost half (54%) of the household size was 2-5 persons.

Table 1. Social economic characteristics of farmers

Variable	Frequency	Percentage	P value	Mean difference
Gender				
Male	67	69.1	0.000	4.691***
Female	30	30.9		
Age				
20 – 40	82	84.5	0.0102	3.124***
41 above	15	12.4		
Marital status				
Married	87	89.7	0.000	3.722***
Single	1	1.0		
Widowed	4	4.1		
Divorced	2	2.1		
Separated	3	3.1		
Education				
Primary	67	69.1	0.000	3.536***
Secondary	25	25.8		
Tertiary	5	5.2		

Off-farm activities				
No	4	4.2	0.000	3.196***
Yes	92	95.8		
Farm size				
1- 3	64	66.0	0.000	5.691***
3.1 – 6	30	30.9		
6.1 above	3	3.1		
Farming experience				
1 – 10	54	53.7	0.000	5.691***
11- 20	42	43.3		
21 and above	1	1.0		
Household size				
2 – 5	66	53.7	0.456	0.124
> 6	31	31.7		

*** Significant at 1%, ** at 5%, and * at 10%

Table 2. Institutional characteristics of farmers

Variable	Frequency	Percentage	P value	Mean difference
Distance to the nearest market				
0.5 – 3	75	77.3	0.000	2.356***
3.1 – 6	21	21.7		
6 above	1	1.0		
Extension services				
Access	25	25.8	0.000	4.742***
No access	72	74.2		
Credit				
Access	81	83.5	0.000	4.835***
No access	16	16.6		
Membership in a farmers' group				
Member	40	41.2	0.000	4.412***
Non- member	57	58.8		

*** Significant at 1%, ** at 5%, and * at 10%

Institutional characteristics

Most (75%) of the farmers had access to the market within the radius of three kilometres (Table 2). Majority (72%) of them lacked access to extension services. In terms of financial status, most (81%) of the farmers had accessed credit but 57% of them did not belong to any farmer group.

Farmers' awareness on agroforestry technologies. Almost half (45%) of farmers were aware of agroforestry technologies, 39% of them having been sensitized about it. Only 33% of the farmers had practiced agro-forestry before sensitization after which only 39% of them had practiced the technologies. In terms of knowledge dissemination, 39% of the respondents attributed agro-forestry popularity in the area agricultural to workshops. Such trainings had exposed 44% of the farmers to different technologies. Other farmers (48%) had

learn agro-forestry from school in agriculture class while (40 %) had acquired it from neighbours and demonstration farms. In terms of agriculture productivity, 40% strongly agreed that agro-forestry improved productivity on their farms. Other farmers (39%) were not sure about agro-forestry while 37% of them did not appreciate the value of the technology.

Table 3. Farmers' awareness on agroforestry technologies

Agroforestry attributes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mode
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	
I am fully aware of agroforestry	0 (0.0)	6 (6.2)	24 (24.7)	44(45.4)	23 (23.7)	4
I know the use of agro-forestry.	1 (1.0)	13 (13.4)	38 (39.2)	38(39.2)	7 (7.2)	3
I have been sensitized on agro-forestry.	2 (2.1)	5 (5.2)	31 (32.0)	38(39.12)	21 (21.7)	4
My knowledge enabled me to practice agro-forestry.	0 (0.0)	3 (3.1)	18 (18.6)	45 (46.4)	31 (32.0)	4
Because I am aware I can encourage other farmers to do agro-forestry.	1 (1.0)	6 (6.2)	21 (21.7)	36 (37.1)	33 (34.0)	4
Awareness taught me the value of agro-forestry.	1 (1.0)	7 (7.2)	36 (37.1)	28 (28.9)	25 (25.8)	3
I practiced agro-forestry before sensitization.	1 (1.0)	5 (5.2)	29 (29.9)	30 (30.9)	32 (33.0)	5
Agro-forestry has gained popularity in my area because of agricultural workshops.	2 (2.06)	8 (8.33)	16 (167)	37 (38.5)	33 (34.4)	4
Awareness taught me the different types of agro-forestry.	0 (0.0)	9 (9.5)	16 (16.8)	42 (44.2)	28 (29.5)	4
I learned agro-forestry from school in agriculture class.	0 (0.00)	5 (5.15)	21 (21.7)	47 (48.5)	24 (24.7)	4
I learned agro-forestry from neighbours and demonstration farms.	0 (0.00)	6 (6.19)	37 (38.5)	39(40.2)	15 (15.4)	4
I acquired agro-forestry knowledge	0 (0.00)	23(23.71)	30 (30.9)	21 (21.7)	23 (23.7)	3

from seminars and workshops.						
Knowing agro-forestry motivated me to practice it.	2 (2.06)	5 (5.15)	39 (40.2)	32 (33.0)	18 (18.6)	3
Agro-forestry makes my farm productive.	0 (0.00)	0 (0.00)	21 (217)	37 (38.1)	39 (40.2)	5

Table 4. Factors influencing awareness of farmers about agroforestry technologies

Variable	Coefficient	Std. Err.	P>z
Sex	0.050	0.527	0.925
Marital status	0.040	0.274	0.885
Education	0.196	0.289	0.037**
Age	0.000	0.045	0.018**
Farming experience	0.044	0.067	0.513
House hold size	0.432	0.194	0.026*
Credit	0.420	0.671	0.531
Membership in a farmer group	1.037	0.551	0.060
Extension	0.926	0.655	0.007***
Market distance	0.200	0.184	0.277
Farm size	0.025	0.222	0.912
Agroforestry experience	0.086	0.119	0.049**
Constant	0.666	1.475	0.002***

*** significant at 1%, ** at 5% and * at 10%); N = 248; LR chi2 (8) = 34.21; Prob > chi2 = 0.0000; Log likelihood = -62.418947; Pseudo R2 = 0.3460

Factors influencing awareness of farmers about agroforestry technologies. From the logistic regression analysis, awareness of agroforestry technology was highly enabled by farmer's level of education (P≤0.04), age (P≤0.02), access to extension services (P≤0.01) and agroforestry experience (P≤0.05) (Tables 4 and 5).

Level of adoption of different Agro forestry technologies. Results showed high adoption of Agro forestry technologies in the study area. Out of the respondents, 79% had adopted agroforestry and practic more than one technology. Comparison of adoption revealed a significant difference (P≤0.01) between the adopters and non-adopter and farmers adopted the technologies at varied levels (Figure 2). Woodlot planting was highly (96 %) practiced, followed by wind breaks (90%), improved fallow (71%), orchards and shelter belts at 68% while plantations was the least adopted (32%). In addition, farmers were found to be practicing more than one form of agro forestry technology resulting in high overall adoption of the technologies.

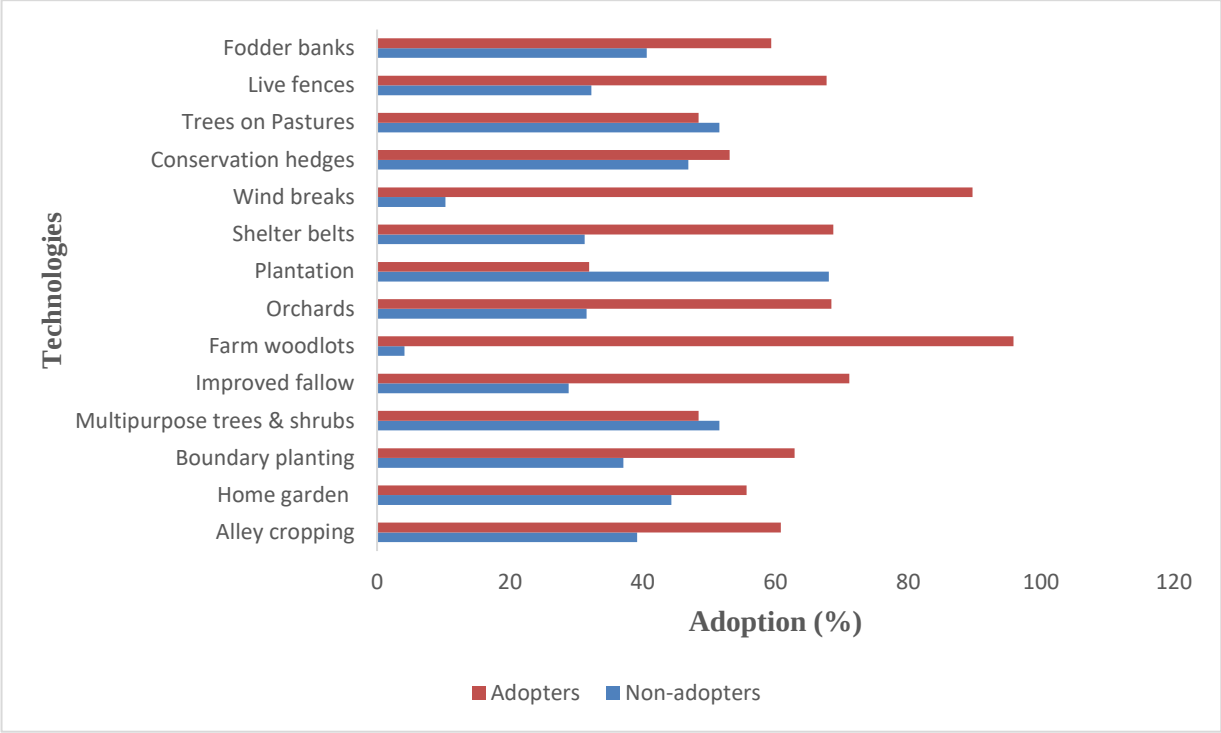

Figure 2. Proportion of farmers practicing different Agro forestry technologies

Table 5. Logistic regression model of factors influencing adoption of agroforestry technologies

Variables	Coefficient	Std. Err.	P>z
Gender	0.596	0.882	0.499
Marital status	0.235	0.420	0.576
Education	0.046	0.430	0.013**
Age	0.165	0.104	0.013**
Farming experience	-0.165	0.116	0.054**
Household size	0.048	0.298	0.873
Extension	1.561	0.964	0.015**
Membership in a farmer group	0.104	1.504	0.945
Credit	0.420	0.671	0.531
Distance to the nearest market	-0.311	0.344	0.037**
Farm size	0.200	0.481	0.038**
Agroforestry experience	1.369	0.385	0.000***
Constant	3.368	2.915	0.048**

*** Significant at 1%, ** at 5%, * at 10%; Prob > F = 0.0000; Log pseudo likelihood = 41.857875; Pseudo R^2 = -0.8380

Factors influencing adoption of agroforestry technologies. From the logistic regression analysis, adoption of agroforestry technology was significantly (P≤0.01) and positively influenced by access to extension services, age (P≤0.05), agro-forestry experience (P≤0.01), farm size (P≤0.05) and level of education (P≤0.01). Conversely, distance to the nearest market and farming experience significantly (P≤0.05) and negatively influenced adoption of agroforestry technologies

Discussion

Awareness and adoption are two major steps in uptake of agricultural technologies farmer to improve their livelihoods but the two are influenced by intrinsic and extrinsic factors (Meijer *et al.,* 2015). Extension services was the most effective in creating awareness of agro-forestry technologies. This was followed by education, experience and age of the farmers. Though the majority of the farmers were of the basic primary school, they had an opportunity to be introduced to agroforestry. Education, experience and age are exposure factors and might have provided a good platform that enabled the performance of the extension services on agroforestry technologies. Shiferaw *et al*. (2009) observed that education enhances the analytical and problem-solving skills of farmers. In addition, education enhances a locative ability of decision makers by enabling them to think critically and use information sources efficiently. According to Shiferaw *et al*. (2014), educated farmers are also more capable of sourcing information, and more efficient in evaluating and interpreting information about new agricultural technologies.

The same factor that created awareness were equally important in promoting adoption. According to Abdulai and Huffman (2005), an enlightened farmer is able to access different technologies and make more accurate adoption decisions. Therefore, a dominantly young generation of farmers who are below 40 years was a significant driver to technology uptake. Younger people are more likely to adopt agroforestry technologies than old people (Haji *et al*., 2018). This age group is also believed to have longer planning horizons and therefore take risks relative to older folks. In addition, management of some of the agroforestry technologies are labour demanding in the initial stages thereby not favouring the category of old farmers. However, the number of years that the farmer had been practicing agroforestry positively and significantly influenced adoption of agroforestry technologies. Farmers that had been practicing agroforestry were more aware of different types of agroforestry technologies, possibly due to better contacts with agroforestry extension projects and extension workers or from personal experience as well as through learning from other farmers (Mercer *et al*., 2005).

The range of agro-forestry technologies were adopted at difference level. This difference can partly be attributed to the diversity of products expected from a technology. The most preferenced technologies such as woodlots and wind are alternative source of wood fuel while orchards are a supplement food and these technologies could supplement house hold incomes as well. In contrast the least adopted plantation, could be due to its demand for land yet the majority of the households had less than three acres of land. According to Emana *et al.* (2012), farmers with larger pieces of land are more likely to adopt improved technologies compared to counterparts with small land since they can afford to apportion part of their fields to try out the improved technology. Limitation of land could partly explain the low attitude to adopting agro-forestry by farmers with long experience in farming.

Successful technology adoption depends on favourable convergence of technical, economic, institutional and policy factors (Meijer *et al.,* 2015). Participation of farmers in training, demonstration, field day and other extensions services created a platform for acquisition of the relevant agricultural production information. Development experts have emphasized agricultural extension and rural education as crucial in achieving agricultural development, poverty reduction, and food security (Ginéa and Yang, 2009). Both awareness and adoption of agro-forestry technologies in the study area was not

significantly influenced by farmers association on groups. Farmers were not also relying to agri-financial benefits but instead had none agricultural activities that supported their livelihood. Maracha border districts Democratic Republic of Congo where locals involve in cross border trade as alternative source of income (Titeca and de Herdt, 2010).

Distance from the nearest market negatively and significantly ($P \leq 0.05$) influenced adoption of agroforestry among farmers. Marketing information such as prices, demand and supply as well as expectations will strengthen a farmer's decision on agroforestry technologies when there is security of marketing possibilities. Distant markets come with high transport costs of farm inputs and produce. Having a good access to the main highway ensures good access to the market centres where farmers sell their farm products (Paudel and Thapa, 2004). And specifically, good road network is critical for bulk farm produce.

Conclusions

Socio-economic factors that influence adoption of agroforestry technologies were access to information, literacy level, age, and experience of the farmer which were the most significant factors in creating awareness and promoting adoption of agro-forest technologies. Farmer's experience, access to markets and availability of land were additional contribution factors to adoption, especially of the technologies with multiple applications. The impact of extension services built on farmer's early exposure to some of the technologies at school. The rate of deforestation in Uganda is as rapid as its population growth and the majority of Ugandans are the youth. This calls for inclusion of agro-forestry in the lower school syllabi.

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Statement of No-Conflict of Interest

The authors declare that they have no competing interests.

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