

# Linking Markets to Smallholder Agro-forestry Farmers as a Strategy for Poverty Alleviation in the Tropics

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Received: August 31, 2011 / Published: March 20, 2012.

**Abstract:** The objective of the study was to assess factors affecting market participation of agro-forestry smallholder farmers in Uganda. Primary data on household, farm and marketing characteristics were collected from 153 farming households using a semi-structured, pre-tested questionnaire. The determinants of market participation were assessed using the Probit model. Descriptive statistics showed that a combination of crop, livestock and tree products were marketed by farmers. The main products included maize, cassava and coffee (crops); firewood and poles (tree products); and birds and goats (livestock products). Results from the Probit model showed that farm size, household size, education level, access to credit and extension visits had positive and statistically significant effects on market participation of farmers in agro-forestry products' markets. Age of farmer had a negative and statistically significant effect on the participation. Emphasis on improving the quality and coverage of extension services, extending credit facilities to farmers and intensifying agro-forestry training among farmers are suggested as avenues to enhance participation of farmers in agro-forestry products' markets.

**Key words:** Agro-forestry, smallholder farmers, poverty alleviation, market participation, tropics.

## 1. Introduction

Agro-forestry 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 [1]. Cultivating trees in

combination with crops and livestock is an ancient practice. However, several factors have contributed to a rising interest in agro-forestry since the 1970s, including the deteriorating economic situation in many parts of the developing world, increased tropical deforestation, degradation and scarcity of land due to population pressure and the growing interest in farming systems, intercropping and the environment [2]. Brandle et al. [3], Clason [4] and Kurtz [5] argued that agro-forestry provides cost-effective alternatives

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that increase farm profits and protects the environment within rural settings. In such a scenario, agro-forestry practices that integrate tree, crop and animal components are emerging as part of an intensive land management approach focused on sustainable resource use and production within given economic, social and environmental settings [6, 7]. The ecological, economic and social benefits of agro-forestry are further documented [8-11]. With its potential to increase farm productivity and diversity, agro-forestry produces a range of products such as food, fuelwood, building materials, medicine and fodder. Properly conceived and practiced, agro-forestry can contribute to the sustained productivity of the natural resource base by enhancing soil fertility, controlling soil erosion, enhancing the microclimate of cropping and grazing lands and generally improving the environment. Agro-forestry has the potential to reduce poverty and can efficiently be used in poverty reduction strategies of the tropical East African countries. In forest-scarce African countries, agro-forestry has expanded greatly on small farms. In Kenya and Ethiopia, for example, agro-forestry farms account for most of the timber and pole production [12]. The Ugandan government's long-term plan for modernization of agriculture [13] also recognizes smallholder agro-forestry as a strategy for poverty alleviation and ecosystem protection in the country. In the plan for modernization of agriculture, poverty is defined as a situation when one or more persons fail to attain a level of well-being (usually material) that is deemed to constitute a reasonable minimum by the standards of the Ugandan society. However, linking markets to smallholder agro-forestry farmers still remains a big socio-economic development challenge in this part of the world.

Markets are of fundamental importance in the livelihood strategy of most rural households, rich and poor alike. Markets are where farmers, as producers, buy their inputs and sell their products; and where, as consumers, spend their income from the sale of crops

and non-agricultural activities, to buy their food requirements and other consumption goods. IFAD [14] argued that rural producers in many parts of the world cannot improve their living standards because of serious difficulties in accessing markets. Linking smallholder farmers to markets has become more important over time because of the long-term effects of liberalization of agricultural markets throughout the developing world [15]. Liberalization policies of elimination of commodity marketing boards, relaxation of price controls, privatization of state-owned companies and elimination of restrictions on agricultural production and marketing have increased competition and given farmers greater responsibility over their production and marketing decisions. While markets are critical to smallholder farmers, the factors that influence how markets operate, such as access to information and market institutions, have a powerful influence on market participation and earnings of smallholder farmers. Little attention has been given to marketing systems in the smallholders' rural livelihoods frameworks and their role in poverty alleviation. Thus, linking smallholder agro-forestry farmers to particular niche markets is critical to the success of agro-forestry innovations and economic prosperity of these poverty-ridden peasants in the tropics.

Trees are useful in livelihood and production strategies, especially among rural communities. Muok et al. [16] noted that growing trees on farms is a very important livelihood strategy in rural communities of sub-Saharan Africa. Agro-forestry, as a science and practice, has the potential to contribute to the improvement of rural livelihoods due to the capacity of its various forms to offer multiple alternatives and opportunities to smallholders to enhance farm production and income, while protecting the agricultural environment. While agro-forestry was identified as an important production and livelihood strategy in rural communities of sub-Saharan Africa [17], there is little consideration for the markets [18],

yet expanding market opportunities for smallholder farmers are critical to the success of agro-forestry innovations. A variety of agro-forestry technologies is finding enormous application in the East and Central African region. Such technologies are lifting many smallholder farmers out of poverty and mitigating declining agricultural productivity and the quality and quantity of natural resources. While thousands of smallholder farmers are adopting these technologies, the key challenge remains lack of access to markets. Most farmers have little access to market information concerning the demand and price of agro-forestry products, little knowledge of market specifications and weak linkages with market agents. As a result, they have little knowledge on how to assess the value of their products and where to market them. In addition, the review of existing literature and experiences from past agro-forestry initiatives reveals little information about the determinants of farmers' participation in agro-forestry markets in Uganda. For example, Byabashaija et al. [19] studied the traditional uses of indigenous tree species; Kiwuso et al. [20] identified the indigenous methods of controlling termites in Uganda's agro-forestry systems; Okullo et al. [21] described the local knowledge of Shea butter tree production; Okorio et al. [22] studied the potential of agro-forestry in improving livelihoods in Eastern and mid-Northern Uganda; and Katumba et al. [23] examined the domestication of medicinal tree species in the Lake Victoria shore region. These studies reveal no or limited information on the factors that influence farmers' participation in agro-forestry markets in Uganda. It is against this background that the study seeks to fill this gap.

The general objective of this study was to evaluate the factors affecting market participation of agro-forestry smallholder farmers. The specific objectives of the study were: (1) to compare the socio-economic characteristics of agro-forestry farmers participating and not participating in markets; (2) to characterize agro-forestry products marketed by

farmers; and (3) to analyze factors influencing farmers' participation in agro-forestry markets. The research hypotheses of this study were: (1) access to credit significantly affects farmers' participation in agro-forestry markets; and (2) membership to farmer organizations increases the probability of participating in agro-forestry markets.

## **2. Materials and Methods**

### *2.1 Description of the Study Area*

The survey was conducted in Busia District which is located in the south-eastern part of Uganda, north of Lake Victoria and west of the Republic of Kenya in the African tropics. It is approximately 196 km far from Kampala, the Capital city of the Republic of Uganda. The district which covers a total area of 743 sq. km accommodates a population of 243,298 people (117,564 males and 125,734 females) [24]. The district was selected because tree growing is the third major source of income for the majority of the farmers, after crops and livestock [25]. Therefore, agro-forestry has a great potential to improve farmers' livelihoods [22]. The district is predominantly rural, with 84% of the population living in rural areas and about 85% of this population survives on agriculture. The rural economy of the district is characterized by smallholder farmers who predominantly practice subsistence agriculture with the main crops grown being sorghum, millet, cotton, cassava, sweet potatoes, maize and beans.

### *2.2 Sample Size and Sampling Procedures*

Using purposive and simple random sampling techniques, cross-sectional data were collected from a total sample size of 153 farmers. Dabani and Bulumbi Sub-Counties in Busia District were purposively selected to represent high and low levels of adoption of agro-forestry technologies, respectively. This was followed by the purposive selection of Nangwe Parish from Dabani Sub-County and Bubango Parish from Bulumbi Sub-County where previous research and

dissemination activities by the government of Uganda, through the NARO (National Agricultural Research Organization), had taken place. From each parish, a list of farmers that was used as a sampling frame was generated with the help of the district agricultural extension officers. A simple random sampling technique was used to select 60 farmers from Nangwe parish and 93 farmers from Bubango parish to make a total sample size of 153 farmers for the study.

### 2.3 Data Collection

Both primary and secondary data were collected during the study. A semi-structured, pre-tested questionnaire was used to capture primary data from selected farmers at their respective farms using direct interviews. Primary data included farmer's age, gender, marital status, main occupation and farming experience. It also included household size, number of household members involved and not involved in farming, farm ownership, farm size, education level of household head, education level of spouse, membership to farmers' organizations, access to credit facilities, access to agro-forestry output markets, main agro-forestry production objective, contact with extension personnel, distance to trading centre, distance to district capital, types and prices of agro-forestry products. Secondary data included reviewing of previous research findings on the marketing of agro-forestry products among smallholder farmers.

### 2.4 Analytical Procedures

#### 2.4.1 Probit Model

In order to analyze factors influencing farmers' participation in agro-forestry products' markets, the Probit model was used. A probit model is a specification for an ordinal or a binary response model which employs a probit function. The regression analysis involves a categorical dependent variable, usually 1 and 0, using a cumulative normal distribution function. The probit function is the

inverse CDF (Cumulative Distribution Function) or quantile function associated with the standard normal distribution. The probit model is estimated using standard maximum likelihood procedures and such an estimation is called a probit regression. The probability that a household participates in a given activity is a function of the independent (exogenous) variables and is estimated using the Probit model because of the advantage, it has over many other models in that the probabilities are bounded between 0 and 1 [26]. At the same time, it compels the error terms to be homoscedastic for the reason that the forms of probability functions depend on the distribution of the difference between the error terms associated with one particular type and another. The Probit model indicates that the observable dependent variable,  $y_i$ , is determined as follows, given the latent (unobservable) random variable  $y_i^*$  [27].

$$\begin{aligned} y_i &= 1 \text{ if } y_i^* > 0 \\ y_i &= 0 \text{ if } y_i^* < 0 \end{aligned} \quad (1)$$

Given that  $y_i^* = \beta X_i^* + u_i^*$ , then the probability that  $y_i = 1$  is given as

$$P_i = \text{Prob} [u_i^* > -\beta X_i] = F(\beta X_i) \quad (2)$$

where,  $F(\beta X_i)$  is the cumulative density function (cdf).

The probit model is then derived by letting  $F(\cdot)$  be the cdf of a standard normal random variable. The observed probit used to estimate the agro-forestry products market participation function is specified as

$$y_i = \beta X_i + e_i; i = 1, \dots, n \quad (3)$$

where,  $y_i$  is the dependent variable which takes a value of 1 if the household participates in agro-forestry products markets and value of 0 if the household does not.  $\beta$  is a vector of parameters to be estimated.  $X$  is a vector of explanatory variables hypothesized to influence the probability of households participating in agro-forestry products markets.  $e$  is the random disturbance term.

#### 2.4.2 Model Specification

The Probit model was estimated as,

$$y_i = \beta X_i + e_i; i = 1, \dots, n \quad (4)$$

where,

$y_i$  = Probability of market participation (1 = if the farmer participated, 0 otherwise)

X is a vector of explanatory variables that include

$X_1$  = Age (Years)

$X_2$  = Sex of the farmer (1 = Male, 0 = Female)

$X_3$  = Education level (Years of formal schooling)

$X_4$  = Household size (Number)

$X_5$  = Farm size (Hectares)

$X_6$  = Market distance from farm (Km)

$X_7$  = Group membership (1 = Member, 0 = Otherwise)

$X_8$  = Extension visits (Number of visits)

$X_9$  = Access to credit (1 = Yes, 0 = Otherwise)

E = Error term

$\beta$  = A vector of parameter estimates to be computed

#### 2.4.3 Data Analysis

Primary data were entered in SPSS (Statistical Package for Social Scientists) and analyzed using Stata. Descriptive statistics in the form of percentages, means and standard deviations were generated to identify socio-economic characteristics of farmers and types of agro-forestry products sold. Comparison of socio-economic characteristics was made using chi-square and *t*-test statistics for categorical and continuous variables, respectively. To analyze the factors influencing farmers' participation in agro-forestry markets, the Probit model was used.

### 3. Results and Discussion

#### 3.1 Socio-economic Characteristics of Market Participants and Non-participants

Table 1 presents descriptive statistics of continuous variables of agro-forestry farmers participating and not participating in marketing their produce in Busia District out of 153 farmers surveyed, only 50 farmers participated in the marketing of agro-forestry products. Agro-forestry farmers who did not participate in marketing were on average older (43 years) than those who participated and the difference was significant at 5% level of significance ( $\alpha = 0.05$ ). The mean household size of market participants was

comparatively larger (with 8 members) as compared to non-participants (with 6 members). The significant relationship between household size and market participation implies that farmers with a higher number of household members were more likely to participate in agro-forestry markets compared to those with fewer members.

The average number of household members actively involved in farming was higher (4 members) for farmers who participated in marketing. This means that households with a big number of members actively involved in farming were more likely to participate in agro-forestry markets because of abundant labor supply provided by such members. On the other hand, households with fewer numbers of members involved in farming are less likely to participate in agro-forestry markets because of labor shortages, leading to low output in absolute terms. Market participants held comparatively larger farms (3 ha) compared to non-participants (2 ha). In addition, the education level of household heads in terms of years of formal schooling was higher for market participants (6 years) compared to 3 years for non-participants. The significant relationship between the level of education and market participation implies that educated farmers participate more than the less or non-educated ones. This is because education enhances the ability to derive, decode and evaluate useful information [28].

Results indicate that general farming experience in terms of years was not significantly different across the two groups of farmers. On the other hand, experience in agro-forestry practices was significantly different. Farmers who participated in agro-forestry markets had more experience (of 4 years) in practicing agro-forestry compared to their counterparts. Results further indicated that the market distance between market participants and non-participants was not significant. On average, the two groups of farmers had an average market distance of 8 km. In terms of extension services, farmers who participated in

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**Table 1** Descriptive statistics of continuous variables of agro-forestry farmers participating and not participating in marketing.

Variable (mean)	Market participants (n = 50)	Non-participants (n = 103)	t-value	$\rho$ -value
Age (years)	36 (11)	43 (12)	3.339	0.001
Household size (number)	8 (4)	6 (3)	-2.494	0.014
Household members involved in farming (number)	4 (3)	3 (2)	-2.979	0.003
Household members not involved in farming (number)	4 (3)	4 (2)	0.164	0.870
Education level of household head (years)	6 (4)	3 (4)	-3.458	0.000
Distance to trading centre (km)	8 (6)	8 (6)	0.218	0.828
Farm size (ha)	3 (3)	2 (2)	-3.243	0.002
General farming experience (years)	12 (10)	11 (10)	-0.525	0.600
Agro-forestry experience (years)	4 (3)	2 (3)	-3.546	0.000
Extension visits (number)	2 (2)	1 (1)	-4.951	0.000

agro-forestry markets received more extension visits (2) per month on average as compared to those who did not participate (1). This indicates that the more visits by the extension agents to the farmers, the more aware they become of the better agro-forestry marketing practices, hence participation in marketing.

Table 2 presents descriptive statistics of categorical variables of agro-forestry farmers participating and not participating in the marketing of agro-forestry products in Busia District. The results indicate that there were more male than female farmers participating (78%) and not participating (83.5%) in marketing of agro-forestry products in Busia District. This is because men tend to have better access to land, labor and other resources than women [29]. Farming was the major occupation for both farmers who participated and those who did not participate in agro-forestry markets. A large percentage of farmers (70%) who participated in agro-forestry markets belonged to farmer groups compared to their counterparts. There is a significant difference ( $P = 0.001$ ) in participation in agro-forestry markets between farmers belonging or not belonging to farmer groups. Farmer groups are centers where market information can be accessed by farmers, thus enhancing participation in markets. Similarly, in terms of access to extension services, farmers who participated in agro-forestry markets had more access to extension services compared to non-market participants. There is a significant difference ( $P = 0.001$ ) in participation in

**Table 2** Descriptive statistics of categorical variables of agroforestry farmers participating and not participating in marketing.

Variable (%)	Market participants (n = 50)	Non-participants (n = 103)	$\chi^2$ -value	$\rho$ -value
Sex				
Male	78.0	83.5	0.680	0.410
Female	22.0	16.5		
Major occupation				
Farming	96.0	94.2	0.226	0.634
Non-farming	4.0	5.8		
Group membership				
Yes	70.0	40.8	11.499	0.001
No	30.0	59.2		
Access to credit				
Yes	14.0	12.6	0.056	0.812
No	86.0	87.4		
Access to extension				
Yes	52.0	24.3	11.646	0.001
No	48.0	75.7		

agro-forestry markets between farmers having access to extension or not. Contacts with extension agents expose farmers to information, which stimulates market participation. Results further indicate low percentages for both categories of farmers in terms of access to credit.

### 3.2 Types of Agro-forestry Products Marketed by Farmers

Agro-forestry farming systems produce a wide variety of crop, livestock and tree products. Table 3 shows that the most commonly sold crop products by

**Table 3 Crop products.**

Crop output sold	Frequency* (n = 49)	Percentage (%)
Maize	14	28.6
Cassava	11	22.4
Coffee	10	20.4
Beans	4	8.2
Millet	3	6.1
Bananas	2	4.1
Groundnuts	2	4.1
Sweet potatoes	2	4.1
Cotton	1	2.0

\*Multiple responses.

agro-forestry farmers in Busia District are Maize (28.6%), Cassava (22.4%) and Coffee (20.4%).

Apart from crops sold, agro-forestry farmers also market a wide variety of trees and tree products. Table 4 indicates that farmers mostly sell firewood (19%) which is got from various agro-forestry tree species, including *Eucalyptus species*, *Markharmia lutea*, *Artocapus heterophylus*, *Milicia excelsa*, *Calliandra calothyrsus* and *Sesbania sesban*. This means that firewood is a major source of fuel for households in Busia District. This finding is in line with the Busia District State of Environment Report [25]. It is from the same tree species that farmers obtain poles (11.9%) for sale. Fruits from tree species such as *Persea americana* (19%), *Artocapus heterophylus* (16.7%) and *Mangifera indicia* (1.2%) are also sold by farmers. *Makharmia lutea* (9.5%), *Maesopsis eminii* (3.6%), *Eucalyptus species* (3.6%) and *Makharmia spp* (3.6%) are sold as seedlings to other farmers.

Agro-forestry systems in Busia District are integrated with livestock, particularly goats, birds, cattle and sheep. Table 5 indicates that goats and birds (34.4%) are the most commonly sold livestock by agro-forestry farmers. These were followed by pigs (15.6%), cattle (9.4%) and sheep (3.1%). Results further indicate that milk (3.1%) was the only livestock product sold by farmers.

### 3.3 Factors Influencing Farmers' Participation in Agro-forestry Markets

The results of the Probit model of the determinants of market participation are presented in Table 6. Out

**Table 4 Trees and their products.**

Trees and tree products	Frequency* (n = 84)	Percentage (%)
Firewood	16	19.0
Ovacado ( <i>Persea americana</i> )	16	19.0
Jackfruit ( <i>Artocapus heterophylus</i> )	14	16.7
Poles	10	11.9
Musambya ( <i>Markharmia lutea</i> )	8	9.5
Musizi ( <i>Maesopsis eminii</i> )	3	3.6
Kalitunsi ( <i>Eucalyptus species</i> )	3	3.6
Omusolya ( <i>Makharmia spp</i> )	3	3.6
Mangoes ( <i>Mangifera indica</i> )	1	1.2

\*Multiple responses.

**Table 5 Livestock and livestock products.**

Livestock and livestock products	Frequency* (n = 32)	Percentage (%)
Goats	11	34.4
Birds	11	34.4
Pigs	5	15.6
Cattle	3	9.4
Sheep	1	3.1
Milk	1	3.1

\*Multiple responses.

**Table 6 Probit model estimates of the determinants of market participation.**

Variable	dy/dx	t-value	P-value
Sex	-0.056	-0.47	0.641
Age	-0.019	-4.28	0.000***
Household size	0.026	1.85	0.065*
Formal education	0.021	2.09	0.037**
Market distance	-0.000	-0.01	0.989
Farm size	0.046	2.19	0.029**
Group membership	0.126	1.41	0.159
Access to credit	0.236	1.71	0.088*
Extension visits	0.103	3.21	0.001***

\*, \*\*, \*\*\* Significant at 10%, 5% and 1%, respectively.

of the nine variables included in the model, six were significant in influencing farmers' participation in agro-forestry markets. These were age, household size, education level, farm size, access to credit and number of extension visits. Sex of the farmer, market distance and group membership did not significantly influence participation of farmers in agro-forestry markets at 5% level of significance ( $\alpha = 0.05$ ). The marginal effects are indicated as dy/dx. These imply, for instance, that households who have had access to credit have a

23.60% higher chance of participating in agro-forestry products' markets than those who have no access to formal credit. An increase in age by one year of the household head reduces the probability of participating in agro-forestry products' markets by 1.90%. An increase in the household size by one person increases the probability of participating in agro-forestry product markets by 2.60%.

Age was significant at 1% and the sign is consistent with the expectation that it influences market participation negatively. Results indicate that an increase in farmer's age by one year would reduce the probability of participating in agro-forestry markets by 1.9%, given that all other factors are held constant. This implies that as a farmer grows older, agro-forestry becomes a way of life rather than a business. These results tally with those of Randela et al. [30] who reported that younger farmers were progressive, more receptive to new ideas and understood the benefits of agricultural commercialization compared to older farmers. Young farmers have been recognized globally as savers of environmental resources [31-34].

Household size was significant at 10%, with a positive coefficient, implying that farmers with large numbers of people in the household were more likely to participate in agro-forestry markets. Results indicate that as the number of active people in the household increases by one person, there will be an increase of 2.6% in the probability of participating in agro-forestry markets. This could be due to the availability of labor supply for farming activities associated with large family sizes. In the study area, the average number of household size participating in the marketing of agroforestry products was comparatively higher than that of non-market participants (Table 1). Household size has been reported to encourage market participation by other scholars as well [35-37].

The positive and significant coefficient on the education level of the farmer implies that educated

farmers were more likely to participate in the marketing of agro-forestry products markets because education improves farmer's ability to understand and interpret information. When all other factors are held constant, an increase in the formal education of the farmer by one year increases their probability of participating in agro-forestry products markets by 2.1%, holding all other factors constant. Similarly, Otieno et al. [38] reported that the intensity of market participation significantly increased by the household head's education level and access to formal market information channels.

Farm size is a characteristic of the farm which has continued to receive attention from agricultural researchers [39]. Farm size was hypothesized to influence market participation positively as the larger the farm, the higher the probability of participating in agro-forestry markets. Results indicate that an increase in farm size by 1 hectare increases the probability of participating in agro-forestry products markets by 4.6%. Boughton et al. [40] and Randela et al. [30] also reported positive and significant relationships between farm size and market participation.

Results indicate that access to credit has a positive and significant influence on the probability of participating in agro-forestry products markets. Households who have had access to credit have a 23.60% higher chance of participating in agro-forestry product markets than those who have no access to formal credit. A positive and significant effect of access to credit was also reported by Randela et al. [30]. There is a positive and significant relationship between the degree of extension contact and participation in agro-forestry products markets at 1% level of significance. When all other factors are held constant, an additional extension visit increases the probability of market participation by 10.3%. Farmers' interaction with extension officers improves their access to information and marketing skills. Thus, the more extension visits to the farmers, the more likely they would sell their produce [32-36, 41].

#### 4. Conclusions

This study revealed that only a few agro-forestry farmers participate in the marketing of their agro-forestry products. A combination of crop, livestock and tree products is sold by farmers. Main crop produces sold are Maize, Cassava and Coffee. Most rural agro-forestry farmers in the district sell firewood, in addition to fruits from *Persea americana*, *Artocarpus heterophyllus* and *Mangifera indica*. *Markhamia lutea*, *Maesopsis eminii*, *Eucalyptus species* and *Makhamia spp.* are sold as trees to other farmers. In terms of livestock, farmers mostly sell live goats and birds. Socio-economic factors that affect farmers' participation in agro-forestry markets include age, household size, education level, farm size, access to credit and number of extension visits. Policies aimed at improving the quality and coverage of these variables are likely to increase participation of farmers in agro-forestry markets so as to improve their livelihoods.

#### Acknowledgments

The authors sincerely acknowledge the generous financial support received from the National Agricultural Research Organization (NARO) of the government of Uganda that led to a successful implementation of field activities. Authors thank the farmers in Busia District of Uganda for actively participating in this study. Authors also appreciate the support of the College of Agricultural and Environmental Sciences, Makerere University, more especially the Principal Professor Sam Kyamanywa. Authors are grateful to Professor Victor Ochwoh, Makerere University, for the encouragement to carry out fieldwork for this investigation and Mr. Albert Muhumuza, the IT administrator at the College, for his tireless efforts assisting us, and Special thanks to Ms Ndibaisa Peruth Akiiki for the moral support.

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