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Factors Influencing Adoption of Improved Robusta Coffee Technologies in Uganda

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Abstract. This paper draws from a cross sectional survey of 252 coffee households and 8 key informants to examine the economic, farmer and institutional factors influencing adoption of improved Robusta coffee production technologies in Uganda. Data was subjected to descriptive and inferential statistical analysis. A logit model was estimated to ascertain the factors and their influence on adoption of improved coffee production technologies. Results revealed that access to credit, availability of off-farm income, level of education, labour availability and access to extension services significantly influenced adoption. Size of land holding, gender and age (of farmer) had no significant influence on adoption, suggesting that improved coffee technologies are mostly scale, gender and age neutral. It was concluded that coffee households' agricultural technology adoption decisions depend on their economic circumstances, farmer characteristic and institutional effectiveness.

Keywords: Economic factors, Farmer characteristics, Institutional factors.

INTRODUCTION

Over the last 20 years, coffee production in Uganda has stagnated at an average of 3 million bags per annum. Smallholder farmers dominate coffee production, with average coffee farm sizes estimated at 0.33ha per household (MoFPED, 2015). Estimated at an average of 369kg/ ha, input use is low when compared to the experimental yield of 3,500kg/ha. This is attributed to poor agronomic practices, inefficient research-extension-farmer linkages and incidence of Coffee Wilt Disease (CWD) which destroyed over 50% of the old coffee trees (MAAIF, 2013). The use of improved agricultural technologies has remained the major strategy to increase agricultural productivity (Nguthi, 2014). However, the contribution of these technologies can only be realized when the technology is widely used. Agricultural scientists have developed various farm technologies (e.g. the 6CWD resistant varieties). These were to help reverse the stagnant coffee productivity trends in Uganda. However, adoption of these technologies is low, hence the stagnation of productivity (UBOS, 2014). Therefore, there is a need to identify the factors influencing adoption of recommended coffee production technologies. This study was conducted to respond to this need.

MATERIALS AND METHODS

Area of Study

The study was conducted in the traditional Robusta coffee growing districts of the country.

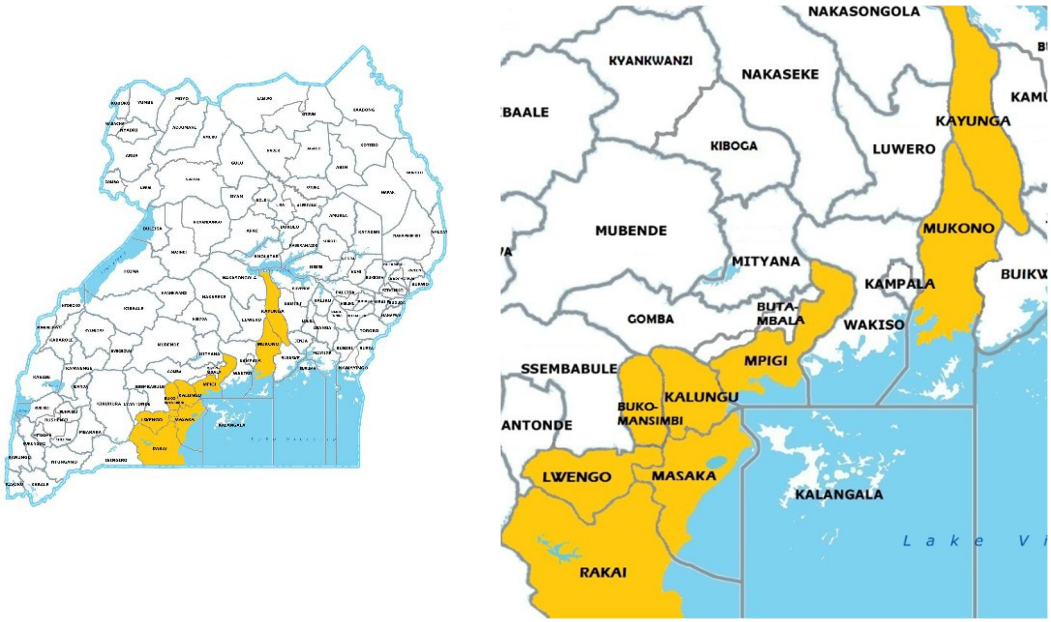

Figure 1. Map of Uganda Showing Districts where the Study was conducted.

The districts are Mukono, Kayunga, Lwengo, Bukomansimbi, Rakai, Mpigi, Masaka and Kalungu. These areas were purposively chosen because they account for more than 80% of Robusta coffee output in Uganda.

Sampling and Data Collection

The sample size and selection procedures were based on Krejcie and Morgan (1970) tables. A combination of purposive and simple random sampling procedures were used to select the low-level administrative units. Purposive sampling method was used to select one sub-counties in each district from where key informant respondents were selected. From each sub-county, two parishes were randomly chosen and in each of these, four villages were also randomly selected. In each village four small holder Robusta coffee farm households who own at least 200 coffee trees were randomly selected. This gave a total of 256 farmers for the study, however 4 questionnaires were proved invalid and this study considered responses from 252 coffee farmers of which 69 farmers (27%) were women. The key informants (KIs) were either the district coffee coordinator or sub-county extension officer from each district totalling to 8 KIs, making the total sample size for this study 260 respondents. The purpose of key informant interviews was to collect in-depth qualitative information from leaders and professionals who have first-hand knowledge about Robusta coffee production. The main data collection tool was a semi-structured questionnaire. The questionnaire was administered in a face-to-face interview, with farmers, mainly household heads as the respondents.

Study Design

The researcher presented the relationship between the variables under study based on the literature reviewed. The frame work examined the factors affecting adoption of agricultural technologies in coffee production as the independent variable and adoption and use of the agricultural

technologies as the dependent variable. The intervening variables were the government policies that include taxes on agricultural inputs and establishment of agricultural banks among others. The extraneous variables included, bad weather, thefts and insecurity. In the frame work, it was conceptualized that economic factors, farmers' characteristics and institutional factors may affect adoption of agricultural technologies. The economic factors were access to credit and off farm income. Farmers' characteristics were age, level of education, labour availability, farm size and gender of the farmer while institutional factors were extension contact and information access. The recommended agricultural technologies were biological innovation (new coffee varieties), chemical innovations (fertilizers and pesticides) and agronomic innovations (new management practices).

Data Analysis

Descriptive statistical analysis generated a general summary and features of the data. The features obtained included, frequencies, percentages, mean and standard deviation. Inferential statistical procedures were carried out that included ANOVA, T-test and Pearson correlation analysis for testing the relationships between variables and to test the hypotheses. One-Tail ANOVA was used test the influence of farmers' age and level of education on adoption of improved Robusta coffee technologies. Independent Samples T-test was used to test the influence of gender on adoption of improved Robusta coffee technologies and Pearson correlation method was used to test the relationship between economic factors and institutional factors with adoption of improved Robusta coffee technologies. The level of significance considered was 5%. The study further employed a logit model (probability model). The general model is a binary choice model involving estimation of the probability of adoption of a given practice (Y) as a function of a vector of explanatory variables (X), (Nkonya, et al, 2012). The implication for applying the logit model is because it was the best possible method to give quality output. The maximum likelihood method was used to estimate the parameters. The empirical model for the logit model estimation is specified thus:

$$Z_\iota = Log\frac{p_i}{1-p_i} = \alpha + \beta\chi_i + \mu_i$$

Where:

- $Log\frac{p_i}{1-p_i}$ are the log-odds in favour of farm households' decision to adopt modern agricultural production technologies;
- χ_i is the combined effect of χ explanatory variables that promote or prevent farmers' decision to adopt modern agricultural production technologies;
- α is the initial odds ratio (when other factors are constant);
- β is the un known coefficient of χ to be estimated in the model;
- μ_i is the error term;
- $\chi_1 \ldots \chi_i$ are factors that promote or prevent farm households' from adopting modern agricultural production technologies.

The $\chi_1 \ldots \chi_i$ are defined thus: χ_1 = Farm size in hectares; χ_2 = Has off-farm income generating activities, dummy (1 = Yes; 0 = No); χ_3 = Age of respondent in years; χ_4 = Maximum level of education in the household measured as years of formal schooling; χ_5 = Gender of respondent, dummy (1=Man; 0 = No); χ_6 = Access to credit, dummy (1 = Has access to credit; 0 = No); χ_7 = Access to extension services, dummy (1 = Has access to extension; 0 = Otherwise), and χ_8=labour availability.

Measurement of Variables

The categorical variables were measured using nominal and ordinal scale, with

numbers being assigned to each category only to identify similar objects within a category from elements in another category that are different. The nominal scale was used in the measurement of variables. To assess the effect of economic factors, farmers' characteristics and institutional factors on farmers' adoption of agricultural technologies, a 2-point measurement scale (with 1 = Yes and 0 = No) was used.

RESULTS

Farmers' Characteristics

This objective was set to determine whether farmers' gender, age, and level of education influence adoption of improved coffee technologies. Results show that there is a significant (p = 0.002) difference between male and female in adoption rates of recommended coffee technologies. Hence, gender of a farmer influenced adoption of improved coffee technologies. There was no significant difference (p=0.260) in adoption rate between the age groups. This therefore means that any farmer in any age group may adopt or may not adopt any recommended coffee production technologies. Results also show that there is no significant difference, (p=0.198) between farmers' level of education and adoption of recommended coffee technologies. The findings thus imply that any farmer irrespective of his/her education level may adopt or may not adopt improved coffee production technologies.

Economic Factors

The economic factors were access to credit and off-farm income. Analysis of Pearson correlation show that economic factors have a weak positive influence on adoption of coffee technologies (r= 0.147, p = 0.02). Farmers with money tend to adopt the improved coffee technologies much faster than those with limited resources.

Institutional Factors

Institutional factors were access to information through extension contact. Results reveal that, there is a positive relationship (Pearson correlation p= 0.250) between institutional factors and adoption of improved technologies in coffee production.

Logit model of factors influencing adoption of improved Robusta coffee technologies

The Logit model estimation (Table 1) gave a Pseudo R2 of 0.63, which implies that access to credit, extension services and off farm income, labour availability, size of farmer land holding, farmers' age, gender and level of education explain up to 63% total variation in adoption of improved Robusta coffee technologies.

Table 1. Model of factors influencing adoption of improved Robusta coffee technologies

Variable	Coefficient	Std. Err.	z	z P>|z|	[95% Conf. Interval]	
Farm size	.0824616	.0741431	1.11	0.266	-.0628563	.2277794
Age of farmer	-.0221283	.0168423	-1.31	0.189	-.0551386	.010882
Off farm income	2.276007	.9033791	2.52	0.012	.5054165	4.046598
Gender	-.2490521	.9669584	-0.26	0.797	-.46152	2.144256
Education level	3.09939	.42859	2.23	0.000	2.259369	3.93941
Extension services	1.173085	.542482	2.16	0.031	.1098404	2.236331
Access to credit	3.707817	.8501826	4.36	0.000	2.04149	5.374145
Labour availability	3.232288	.4399055	3.35	0.000	2.370089	4.094487
constant	6.857545	1.542221	4.45	0.000	3.834847	9.880244

Number of observations = 252; Wald chi2(10) = 202.98; Prob> chi2 = 0.0000

Log pseudo likelihood = -120.23183 Pseudo R2 = 0.6300

Hence only 37% is explained by factors not captured in this research. The Log-likelihood Ratio (LR) was also found to be significant at the 5% level of significance. This means that all the explanatory variables included in the model jointly influence farmers' probability of adopting improved coffee production technologies.

Farmers' characteristics and adoption of improved Robusta coffee production technologies

Farmers' age, level of education, gender, farm size and labour availability were considered. The findings revealed that there was no significant difference (p=0.797) between male and female farmers in adoption of improved coffee technologies. This means there is no gender-linked effect on adoption of improved coffee production technologies. As for the farmers' age, results also revealed no significant difference (p = 0.189) between farmers' age and adoption of improved technologies in coffee production. This also suggests that age differences have no effect on adoption of improved technologies in coffee production. Then farm size was found to have a positive but insignificant (p=0.266) effect on the adoption of improved coffee production technologies. However, farmers' level of education had a significant (p = 0.000) effect on adoption of improved technologies in coffee production and analysis further shows that a 3% increase in education level will increase adoption by 1% fold. Availability of labour also had a significant (p = 0.000) effect on adoption of improved coffee technologies and analysis shows that a 3% increase labour will increase adoption by 1% fold.

Economic factors and adoption of improved Robusta coffee production technologies

The economic factors considered in this study were access to credit and off-farm income. The results show that access to credit (p=0.000) and off-farm income (p=0.012) significantly affect adoption of improved technologies in coffee production. The analysis further showed that a 3% and 2% increase in access to credit and off-farm income respectively will increase adoption of improved Robusta coffee technologies by 1% fold.

Institutional factors and adoption of improved Robusta coffee production technologies

Institutional factors basically involve passing on information to farmers and it is from this information that farmers can adopt or reject the technology. This is mainly through farmer- extension linkage. From the study results, access to extension services was found to have a positive and statistically significant (p = 0.000) effect on adoption of improved coffee production technologies whereby a 1% increase in extension services will increase adoption by 1% fold.

DISCUSSION

Effect of farmers' characteristics on adoption of improved Robusta coffee production technologies

Though gender differences in coffee farmers favoured men to attend farm demonstration, farmers training sessions and extension services, findings revealed that there was no significant difference (p=0.797) between male and female farmers in adoption of improved coffee technologies. This means there is no gender-linked effect on adoption of improved coffee production technologies. These findings corroborate with earlier reports by Doss and Morris (2011), and Overfield and Fleming (2011) who reported insignificant effects of gender on adoption of improved maize in Papua New Guinea. However, the findings are not in

agreement with Kimenye (2014) in his study which revealed that women in Mbeera district, Kenya did not adopt new sorghum varieties because the taste was not good and processing of the grain was difficult.

As for the farmers' age, results also revealed no significant difference (p = 0.189) between farmers' age and adoption of improved technologies in coffee production. Similarly, (Adesina & Baidu-Ferson, 2015; Boahene *et al.*, 2013), reported in their studies that age does not affect adoption. On the other hand, McNamara *et al.*, (2011) found that age positively influenced adoption of integrated pest management practices on peanuts in Guinea. Although, Rogers (2015) reported that young farmers were found to be the first adapters of a technology than their older counterparts, it is also argued that with age, farmers gain more experience and acquaintance with new technologies and hence are expected to have higher ability to use new innovations more efficiently. However, since coffee is a cultural crop in the central region in Uganda, age differences may have no effect on adoption of improved coffee production technologies. Farmers in the traditional coffee growing areas have a cultural belief that they must grow coffees as it is the main source of income and a food security crop (Luzinda *et al.,* 2015)

Then farm size was found to have a positive but insignificant (p=0.266) effect on the adoption of improved coffee production technologies. This is because majority of farm households in the region operate on small scale with average farm sizes of 0.33ha yet literature shows that large scale farmers are more likely to adopt new technologies than small scale farmers. This presents a serious challenge to policy makers and implementers in promoting the adoption of improved coffee production technologies in the study area. The finding is not consistent with Caswell *et al.* (2011), McNamara *et al.*, (2012), Abara and Singh, (2013), Feder *et al,* (2015); who noted in their studies that the decision to adopt a new technology depends largely on the farm size. This means that if the technology requires large farm size like tractors, then there is low probability that the farmer will adopt it. In effect, technologies that are capital-intensive are only affordable by wealthier farmers and hence the adoption of such technologies is limited to larger farmers who have the wealth.

Farmers' level of education had a significant (p = 0.000) effect on adoption of improved technologies in coffee production. Similarly, other researchers (Chaves & Riley, 2014; Strauss *et al.*, 2011), reported that farmers with more formal education tend to adopt agricultural technologies more than farmers with less formal education. Vaiene *et al.*, (2009) in their study on determinants of agricultural technology adoption in Mozambique also reported that educated farmers were in a better position to process information and search for appropriate technologies than uneducated farmers. Therefore, in the case of farmers' adoption of improved Robusta coffee technologies in Uganda, a 3% increase in education level will increase adoption by 1% fold.

Labour availability had a significant (p = 0.000) effect on adoption of improved technologies in coffee production. According to Baide (2015), farmers may find labour incompatibility as an issue to consider when thinking about changing to sustainable agricultural practices. This is due to complexity of sustainable agricultural practices. North West Area Foundation, (2014) found that increased labour demands represent a substantial barrier to adoption for many conventional farmers while for farmers who had already adopted sustainable practices, labour concerns ceased. The labour requirement for coffee production is not well

documented however analysis in this study showed that a 3% increase in labour used for coffee production will increase adoption by 1% fold.

Effect of economic factors on adoption of improved Robusta coffee production technologies

The results show that access to credit (p=0.000) and off-farm income (p=0.012) significantly affect adoption of improved technologies in coffee production. Lubwama, (2015), reported that access to credit increased the probability of adopting a technology. This is consistent with the view that high poverty levels among farmers and lack of access to credit make it almost impossible for them to afford technologies (Bonabona, 2012). The fact that most improved technologies are capital intensive, it becomes difficult for many farmers, especially those in rural areas where poverty is endemic to acquire and utilize them without assistance in the form of supply of affordable credit and other financial services. Feder, *et al.*, (2015) also reported that constrained access to credit among farmers was one of the main reasons why technology failed to diffuse. Therefore, results from this study conclude that a 3% and 2% increase in access to credit and off-farm income respectively will increase adoption by 1% fold.

Effect of institutional factors on adoption of improved Robusta coffee production technologies

Institutional factors basically involve passing on information to farmers on whether to adopt or reject the technology. This is mainly through farmer- extension linkage. From the study results, access to extension services was found to have a positive and statistically significant (p = 0.000) effect on adoption of improved coffee production technologies. Agricultural extension is considered as a type of informal adult education that is intended to enhance farmers' knowledge in certain areas and enables them to benefit from available agricultural technologies and improved practices (Nguthi, 2014). In this way, the extensions service supplements the deficiency in the farmers' formal or informal education, lack of knowledge about technology availability, benefits and effective use of the technology. Manale *et al.*, (2009) also assert that access to information on new technologies is crucial as it creates awareness and attitudes towards technology adoption. Therefore results from this study conclude that a 1% increase in extension services will increase adoption by 1% fold.

Conclusion and Recommendations

This paper concludes that access to credit, availability of off-farm income and labour, farmers' level of education and access to extension services positively influence adoption of improved coffee technologies in Uganda. The study therefore recommends the following probable measures.

- Formation of farmer groups or cooperatives through which Robusta coffee farmers can easily access low interest agricultural credit facilities, participate in exchange farmer training visits, coffee seminars and workshops which in turn increases their informal education levels
- Increased research- farmer- extension interface for technology promotion and outreach. This will ensure farmers have access to extension services, and the extension agents are able to inform coffee farmers on sources of improved recommended varieties from research, inputs and technical advice on better utilization of improved Robusta coffee production technologies.
- Formation of coffee farmer field schools across the coffee growing

regions. Here farmers will learn the different improved Robusta coffee production technologies in a group and in turn train their fellow farmers thus a higher multiplier and diffusion effect.

- Agricultural researchers to develop labour saving technologies which will increase availability of cheap labour, reducing production costs thereby increasing returns from the coffee enterprise.

However, adoption may succeed regardless of farmer's scale of operation, age and sex.

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