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Gender Impacts on Adoption of New Technologies: Evidence from Uganda

Eftila Tanellari

Assistant Professor
College of Business and Economics
Radford University
Radford, VA 24142
Phone: (540) 831-5890
E-mail: etanellari@radford.edu

Genti Kostandini

Assistant Professor
Department of Agricultural & Applied Economics
University of Georgia - Griffin Campus
221 Stuckey Building
Griffin, GA 30223
Phone: (770) 228-7231
E-mail: gentik@uga.edu

Jackie Bonabana

Lecturer
Department of Agricultural Economics and Agribusiness
Makerere University
P.O. Box 7062
Phone: +256 414 531152
Email: jbonabana@agric.mak.ac.ug

Introduction

Peanut is an important food and cash crop within the agricultural sector of low-income countries in Africa. During 2007 peanut production ranked sixth in terms of the crops' value of agricultural production in Africa (FAOSTAT, 2010). Peanuts provide small-scale farmers with purchasing power, they are nutritious, and they promote value-added industries in low-income countries. In addition, peanuts are becoming more important as a great source of protein particularly for those households who cannot afford animal protein sources (Kassie *et al.*, 2011). In mid-1990's, the Peanut Collaborative Research Support Program (PCRSP) and other agricultural research programs started projects in Uganda, among other countries, to enhance peanut production through the introduction of improved peanut varieties and practices, better market access and improved processing technologies. In Uganda, peanuts are grown by both men and women who often manage their own peanut plots. However, little is known about gender differences in the adoption of technologies that enhance peanut productivity. Previous studies note that in general women tend to adopt improved technologies at a lower rate compared to men (Doss and Morris, 2001). This outcome may be due to time and resource constraints that women often face. Several PCRSP projects focus on gender differences in peanut production in an attempt to improve distribution of impacts within the household and enhance technology adoption.

Consequently, it is important to understand the factors that may results in different adoption rates in order to be able to build more effective strategies for technology dissemination. In addition, conventional gender models focus mainly in the gender of the head of the household. This approach does not reveal any information about the behavior of female farmers in male-headed households (Doss and Morris, 2001). Doss and Morris (2001) in their study about improved maize technology in Ghana, distinguish between the gender of the farmer and the gender of the head of the household in their study. They find that the gender variable does not have any explanatory power regarding the decision to adopt but the females living in female-headed households adopt at a lower rate than individuals in male-headed households. However, Doss and Morris (2001) did not have information on the household head gender and the analysis is conducted under the assumption that all males and all married female farmers live on a male-headed household. This approach may miscategorize married females with missing husbands as

living in male-headed households and unmarried females living with their parents as living in a female-headed household.

This paper investigates the different determinants that affect the use of improved peanut varieties among men and women in Eastern Uganda using data collected in 2011. The data includes both the gender of the farmer and the gender of the head of the household as well as detailed information on the individual that makes decisions on each groundnut plot and the use of peanut income from each plot. The analysis tries to explain some of the reasons regarding differences in adoption rates.

Previous adoption studies focus mostly on the gender of the head of the household. However this approach ignores the behavior of women that live in male-headed households. We distinguish between the gender of the farmer/respondent and the gender of the household head by examining the adoption behavior through two models. The first model focuses on the household as the unit of observation while the second model uses the individual farmer as the unit of observation.

The results of the study shed light on improved technology adoption with respect to gender differences. Furthermore, given the important role of women and the household dynamics in Uganda, research that addresses gender inequalities with regard to the use of improved technologies may provide valuable information that can be used towards improved food security and overall wellbeing of the household.

Peanut Production and Gender Roles in Uganda

Peanuts are the second most important legume in Uganda. In 2008, Uganda produced 244,683 metric tons of peanuts and planted 345,232 hectares, mostly in the northern and eastern regions (Uganda Ministry of Agriculture, Animal Industry and Fisheries, 2011). These figures represent an increase of 75 percent in production and 38 percent in area planted from 2005. In Uganda, peanuts are grown by both men and women who often manage their own peanut plots. Men and women frequently engage in different production activities with women generally carrying out the most labor intensive tasks. Women farmers are mainly responsible for growing, managing and processing the peanut crop making it a woman's crop (Kaaya, Christie and Fuuna, 2007). In general, men and women have their separate plots but women have to carry out duties in their

husband's plot before they invest any time in their own plot. Women in Uganda generally have control over the production from their own plot which they mainly use for household consumption. Any additional produce is sold in the market to generate income that is used for household needs and expenses. The amount of time women spend on their peanut plot is limited by other obligations within the household such as cooking, cleaning and childcare. Time constraints as well as limited revenues and inputs restrict women from investing in new technologies or adopting new and improved varieties of peanuts (Kaaya, Christie and Fuuna, 2007).

Data

The data for the analysis was collected through surveys conducted in the Eastern Region in Uganda, the largest peanut growing region during August 2011. The participating villages were chosen from 20 districts. Two-stage sampling was used to identify the participating households. Stage one involved the selection of villages in each study area and stage two involved the selection of individual households to participate in the survey from each village. Participating villages were chosen using a 2 mile buffer access from the main road. A total of 40 villages were randomly identified, 20 from within the buffer and 20 villages outside the buffer. After the selection of villages was completed, the village leader was contacted to provide a list of all the groundnut growing farmers. In each village, 10 households from the list were selected to participate. The households to be interviewed were chosen using systematic sampling with a step-size approach determined by the total number of households in the village which was given consecutive numbers starting with one. The first household was randomly chosen by selecting a random number. The next household was selected using a step-size such that the required sample is selected by running through the entire list of households. For example, if the village had 80 households listed, the starting point (or the first household) was randomly picked and then every eighth household in the list was picked thereafter for a total of 10 households from that village. We interviewed all family members in each household that manage and cultivate their own field of groundnuts. The surveying process yielded 373 completed individual surveys.

The farmers were asked about peanut growing practices, acres planted, varieties used and information on help from extension services. Each member of the household that was involved in

peanut production was asked about the plots that they were responsible for. In addition, demographic information about each respondent was collected such as age, gender of respondent, gender of household head, education and household size. A summary of the variables used in the analysis and descriptive statistics are presented in Table 2.

In this analysis, the adoption of improved varieties refers to the intensity of adoption, defined in terms of the level of use of the technology (Doss and Morris, 2001). Farmers generally planted a mix of improved and local varieties of peanuts. However, farmers that plant improved varieties in a small portion of their peanut acres may do so to test the new variety and have not truly adopted it. We considered farmers to be adopters if they planted 50 percent or more of their peanut acres with improved varieties.

As shown in Table 2, 58 percent of respondents have adopted improved peanut varieties. About 52 percent of respondents live in the Teso region and 58 percent of them were male. On average the respondents were 44 years of age and had 6.4 years of schooling. The average size of the household was 8.3 people. The respondents reported that they lived an average of 6.05 kilometers from the nearest market, 6.34 kilometers from the nearest extension agent and 3.7 kilometers from the nearest major road. Farmers produced an average of 148 kilograms of peanuts in both the major and minor season the previous year and they contacted the extension office an average of 1.6 times a year for help. Male farmers had a higher adoption rate of improved varieties of 61.9 percent compared to female farmers at 52.2 percent (Table 1). Furthermore, male-headed households adopted new varieties at a rate of 58.7 percent compared to female-headed households at 56.1 percent.

Adoption Model

The adoption decision is modeled based on a random utility framework (Ali and Abdulai, 2010; Becerril and Abdulai, 2010). Farmers will choose to adopt improved varieties of peanuts if their utility from adopting (U_A) is greater than their utility if they do not adopt (U_N) such that their total utility (Y)_{*i*} is maximized as follows:

$$(1) \quad Y_i = U_A - U_N > 0$$

Since farmers' utility is unobservable, a binary indicator variable is utilized that equals unity if they use improved varieties of peanuts and a value of 0 otherwise. The decision to adopt is then expressed as a function of observables including gender, other farmer specific characteristics and farm specific variables.¹ The model is specified as follows:

$$(2) \quad Y_i = \beta X_i + u_i$$

where Y_i represents a binary outcome variable, β is a vector of parameters to be estimated, X_i is a vector of explanatory variables and u_i is the error term. Assuming that u_i is normally distributed, a probit approach can be used to model the probability of adoption:

$$(3) \quad Prob(Y_i) = \phi(\beta X_i / \sigma_u)$$

where $\phi(.)$ is the standard normal distribution function. The model will estimate the effect of X_i on the adoption decision.

To distinguish between the gender of the individual farmer and the gender of the head of the household, we estimate two probit models to look at the factors that influence the decision to adopt improved varieties. The first model focuses on the household as the unit of observation while the second model uses the individual farmer as the unit of observation. The estimators used to predict the probability of adoption include the Teso agro-ecological zone, distance to market (to account for market access), distance to extension agent, distance to nearest major road, the size of the household, whether farmers changed the peanut seed in the last 5 to 10 years, peanut production, number of visits to extension office and farmers socioeconomic characteristics. Generally, studies have found that infrastructure, land owned, education and the number of extension visits are positively associated with adoption (Doss and Morris, 2001; Simtowe *et al.* 2012). A number of studies that have focused on the gender of the head of household suggest that male-headed households are more likely to adopt new technologies compared to female-headed households (Doss and Morris, 2001; Kumar, 1994).

¹ This model considers farmers' adoption decisions at a point in time and ignores any dynamic effects that may be associated with the adoption decision.

Empirical Results

Results from the first probit model on the factors that influence households' decision to plant improved peanut varieties are summarized in Table 3. The analysis reveals that gender is a significant factor in the adoption of new peanut varieties with males being more likely to adopt. These findings are similar to Doss (2001) and indicate that women are adopting improved varieties at a lower rate than men. Location plays an important role in the adoption decision as well. Households that reside in the Teso region are more likely to use improved peanut varieties. This may be due to the fact that the Serere research station which produces and releases new peanut varieties, is located in the Teso region and is effectively distributing and informing farmers in its vicinity. The number of visits to the extension office for help and whether the farmers changed their peanut seed in the last 5 to 10 years are positively related to adoption. Several other variables in the model lack statistical significance in explaining adoption. The distance of the respondent's house to the nearest market, distance to the nearest major road and distance to the nearest extension office are not significant at conventional levels. In addition, the age of respondents and the size of the household lacked explanatory power. A somewhat surprising result is the negative relationship between adoption and education. As previously indicated, farmers residing in the Teso region are more likely to adopt due to the proximity to the Serere research station. However they are on average less educated than the non-Teso region which may explain the unexpected result.

In the second model, the gender of the head of the household is the focus of the analysis. The results indicate that in male-headed households there is no statistically significant difference on whether the respondent is a male or female farmer. However, the rate of adoption of new varieties for females in female-headed households is lower than respondents in male-headed households. This indicates that females in male-headed households may have more resources available to them compared to the females that reside in a female-headed household. Similar to the findings in Model 1, residing in the Teso region, number of visits to the extension office and having changed the seed in the last 5 to 10 years, all positively affect the probability to adopt. The marginal effects of Model 2 are presented in Table 4. The marginal effects measure the impact that changes to explanatory variables have on the probability of adopting new

technologies. For example, in Model 1, the probability that a farmer will adopt an improved variety increases by 0.465 if they move from another region to the Teso region (the Teso variable changes from 0 to 1). Similarly, in Model 2, the probability of adoption decreases by 0.171 if the respondent is a female in a female-headed household.

It is possible that the determinants of adoption might differ between farmers in female-headed households and male-headed households. Thus, we estimate two separate regressions, one for the adoption decision of female-headed households and one for the adoption decision of male-headed households. Results, presented in Table 5 (for female headed households) and Table 6 (for male headed households), show that households living in the Teso region are more likely to adopt. In addition, female-headed households are more likely to adopt if there are more people living in the household. This could be an indication of additional availability of labor, as improved varieties are generally more labor intensive. Furthermore, female-headed households that are large producers of peanuts are more likely to use improved varieties. The variables that affect the adoption decision for male-headed households are whether they reside in the Teso region (which are relatively more likely to adopt compared to those living in the Montane and the Banana-millet-cotton region) and whether they changed the peanut seed in the past 5 to 10 years.

Conclusion

Regarding peanut production in Eastern Uganda we find that female farmers are less likely to adopt than male farmers after controlling for the agro-ecological zone, distance to nearest market, distance to extension agent, distance to nearest major road, the size of the household, and whether farmers changed the peanut seed in the last 5 to 10 years, peanut production, number of visit to extension office and farmers socioeconomic characteristics. Furthermore, we find that females living in female-headed households are less likely to adopt new varieties than females or males living in male-headed households. Their decision to adopt is affected by the size of the household (available labor), whether they are large producers of groundnuts and whether they are located near the research station in the Teso region. Given that females play a vital role in the peanut production sector in Uganda, policies and interventions that target women specifically

may increase the adoption of new peanut varieties. For example, Kaaya, Christie and Fuuna, (2007) conducted training for female farmers in Uganda regarding peanut production practices and concluded that given women's gendered tasks in both men and women's peanut production and their role as gatekeepers of food quality for their household, women are positioned to play an important role in the adoption and use of new technology.

The analysis reveals that there are different dynamics between female and male-headed households when it comes to decision making with regard to peanut production. Research that examines these differences is useful for crafting better policy that enhance the adoption of new peanut varieties in order to reduce food insecurity and increase welfare. Clearly, the adoption of new technologies doesn't simply depend on the gender of farmer or household head. There may be other unobserved non-gender differences that may impact adoption such as access and quality of resources for women that are not part of this analysis and may be considered in future studies.

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Table 1 - Adoption of Improved Varieties

	Gender of Farmer		Gender of Head of Household	
	Male	Female	Male-Headed Households	Female-Headed Households
Adoption Rate				
Number of People	158	93	172	83
Percentage	61.9	52.2	58.7	56.1
Help from Extension				
Number of Visits (Mean)	1.75	1.44	1.74	1.37

Table 2 - Variable Definition and Summary Statistics

Variable	Description	Mean	Standard Deviation
Improved Varieties	1 if respondent planted 50 percent or more of the peanut acres with improved varieties, 0 otherwise	0.578	0.494
Teso Region	1 if respondent lives in the Teso region, 0 otherwise	0.523	0.500
Male	1 if respondent is male, 0 otherwise	0.584	0.493
Female	1 if respondent is a female farmers who lives in female-headed household, 0 otherwise	0.300	0.459
Female in Female-Headed Household	1 if respondent is a female farmer who lives in female-headed household, 0 otherwise	0.300	0.459
Female in Male-Headed Household	1 if respondent is a female farmer who lives in male-headed household, 0 otherwise	0.108	0.311
Age	Age of the respondent in years	44.051	13.758
Education	Number of years of schooling	6.398	3.962
Household Size	Number of people residing in the household	8.337	3.753
Distance to Market	Distance in km from respondent's house to nearest market	6.051	6.091
Distance to Extension	Distance in km from respondent's house to nearest extension agent	6.342	5.765
Distance to Major Road	Distance in km from respondent's house to nearest major road	3.712	4.572
Changed Peanut Seeds	1 if respondent changed the peanut seed in the last 5-10 years, 0 otherwise	0.466	0.499
Peanut Production	Total peanut production in kg for both major and minor seasons	147.614	205.783
Extension Contacts	Number of times farmer contacted extension for help	1.609	4.922

Table 3 - MODEL 1: Determinants of Adoption Decision (Focusing on Gender of Individual Farmers)

Variable	Coefficient	Standard Error	Marginal Effects
Teso Region	1.269***	0.169	0.465
Male	0.369**	0.157	0.144
Age	-0.000	0.006	-0.000
Education	-0.035*	0.019	-0.014
Household Size	0.002	0.021	0.001
Distance to Market	-0.006	0.015	-0.002
Distance to Extension	-0.017	0.014	-0.007
Distance to Major Road	0.017	0.020	0.007
Changed Peanut Seeds	0.418***	0.153	0.162
Extension Contacts	0.028*	0.016	0.011
Constant	-0.577*	0.348	
Log Likelihood	-202.766		
Chi Square	106.59		
Prob. Chi Square	0.000		
N	373		

* Significance at the 0.10 level

** Significance at the 0.05 level

*** Significance at the 0.01 level

Table 4 - MODEL 2: Determinants of Adoption Decision (Focusing on Gender of Household Head)

Variable	Coefficient	Standard Error	Marginal Effects
Teso Region	1.307***	0.174	0.476
Female in Female-Headed Household	-0.433**	0.179	-0.171
Female in Male-Headed Household	-0.246	0.226	-0.097
Age	-0.001	0.006	0.000
Education	-0.037*	0.020	-0.014
Household Size	-0.002	0.021	-0.001
Distance to Market	-0.007	0.015	-0.003
Distance to Extension	-0.017	0.014	-0.007
Distance to Major Road	0.017	0.020	0.007
Changed Peanut Seeds	0.414***	0.155	0.161
Peanut Production	0.000	0.000	0.000
Extension Contacts	0.028*	0.016	0.011
Constant	-0.248	0.387	
Log Likelihood	-202.303		
Chi Square	107.51		
Prob. Chi Square	0.000		
N	373		

* Significance at the 0.10 level

** Significance at the 0.05 level

*** Significance at the 0.01 level

Table 5 - Determinants of Adoption for Female-Headed Households

Variable	Coefficient	Standard Error	Marginal Effects
Teso Region	1.589***	0.349	0.573
Age	-0.006	0.013	-0.002
Education	-0.077*	0.046	-0.031
Household Size	0.096**	0.047	0.038
Distance to Market	0.055	0.050	0.022
Distance to Extension	-0.007	0.022	-0.003
Distance to Major Road	0.010	0.039	0.004
Changed Seeds	-0.000	0.317	-0.000
Peanut Production	0.001**	0.001	0.001
Extension Contacts	0.030	0.030	0.012
Constant	-1.345	0.833	
Log Likelihood	-49.960		
Chi Square	44.22		
Prob. Chi Square	0.000		
N	104		

* Significance at the 0.10 level

** Significance at the 0.05 level

*** Significance at the 0.01 level

Table 6 - Determinants of Adoption for Male-Headed Households

Variable	Coefficient	Standard Error	Marginal Effects
Teso Region	1.216***	0.210	0.440
Age	0.003	0.006	0.001
Education	-0.019	0.022	-0.007
Household Size	-0.029	0.025	-0.011
Distance to Market	-0.008	0.016	-0.003
Distance to Extension	-0.018	0.018	-0.007
Distance to Major Road	0.009	0.025	0.003
Changed Seeds	0.612***	0.186	0.230
Peanut Production	-0.000	0.000	-0.000
Extension Contacts	0.032	0.022	0.012
Constant	-0.230	0.424	
Log Likelihood	-144.718		
Chi Square	77.20		
Prob. Chi Square	0.000		
N	269		

* Significance at the 0.10 level

** Significance at the 0.05 level

*** Significance at the 0.01 level