Gender impacts on adoption of new technologies: the case of improved groundnut varieties in Uganda

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Abstract

Peanuts are a key crop in Uganda and are grown by both male and female farmers, although there is a strong inclination for resource-use decisions to be performed by specific genders. This paper identifies opportunities and participation by women and men in the decision to adopt improved peanut varieties in Uganda using a unique dataset from 20 leading peanut-growing districts in the country. The results indicate that there are gender differences in adopting improved varieties of peanuts. In addition, women in female-headed households are less likely to adopt improved varieties compared to women and men in male-headed households, suggesting that they may have less access to resources than women in male-headed households. The gender of the household head has implications for the adoption of improved technologies by women. Moreover, this imbalance in resource access and income-improving decision-making ability by women may have implications for the adoption of other technologies that could improve household welfare.

Key words: peanuts; gender; adoption; improved varieties; Uganda

1. Introduction

Groundnuts are an important food and cash crop within the agricultural sector of low-income countries in Africa. Groundnuts provide small-scale farmers with purchasing power, they are nutritious, and they promote value-added industries in low-income countries. In addition, groundnuts are becoming more important as a source of protein, particularly for those households that cannot afford animal protein sources (Kassie *et al*. 2011). In the mid-1990s, the Peanut Collaborative Research Support Programme (PCRSP), in collaboration with other agricultural research programmes, started projects in Uganda, among other countries, to enhance groundnut production through the introduction of improved groundnut varieties and practices, better market access, and improved processing technologies.

In Uganda, the legume is a source of protein, fat, carbohydrate and oil, providing important nutritional supplements to the diets of many Ugandans. Groundnuts are grown by both men and

women, who often manage their own groundnut plots. However, little is known about gender differences in the adoption of technologies that enhance groundnut productivity. Previous studies note that, in general, women tend to adopt improved technologies at a lower rate compared to men (Doss & Morris 2000; Doss 2001). This outcome may be due to the time and resource constraints that women often face. Several PCRSP projects focus on gender differences in groundnut production in an attempt to improve the distribution of impacts within the household and enhance technology adoption. Consequently, it is important to understand the factors that may result in different adoption rates in order to be able to build more effective strategies for technology dissemination.

Conventional gender models focus mainly on the gender of the head of the household. This approach does not reveal any information about the behaviour of female farmers in male-headed households (Doss & Morris 2000). In their study on improved maize technology in Ghana, Doss and Morris (2000) distinguish between the gender of the farmer and the gender of the head of the household. They find that the gender variable does not have any explanatory power regarding the decision to adopt, but that women living in female-headed households adopt at a lower rate than individuals in male-headed households. However, Doss and Morris (2000) did not have information on the gender of the household head and their analysis was conducted under the assumption that all males and all married female farmers live in a male-headed household. This may result in the incorrect categorisation of married women with missing husbands as living in male-headed households, and of unmarried women living with their parents as living in a female-headed household.

This article investigates the different determinants that affect the use of improved groundnut 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; detailed information on the individual who makes decisions on each groundnut plot; and information on the use of the groundnut income from each plot. The analysis explains some of the reasons regarding differences in adoption rates. Previous adoption studies focused mostly on the gender of the head of the household. However, this approach ignores the behaviour of women who live in male-headed households. We distinguish between the gender of the farmer/respondent and the gender of the household head by examining adoption behaviour 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 provide insights into 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 the overall wellbeing of the household.

2. Groundnut production and gender roles in Uganda

Groundnuts are the second most important legume in Uganda. In 2012, Uganda produced 295 000 metric tons of groundnuts and harvested 421 000 hectares, mostly in the northern and eastern regions (FAOSTAT 2012). These figures represent an increase of 31% in production and 87% in area harvested from 2005. In Uganda, groundnuts are grown by both men and women who often manage their own groundnut plots and manage and grow groundnuts in different ways (Kaaya *et al.* 2007). Generally, farm activities, from planting to harvesting and selling, are often carried out by both the men and the women in the household. However, there is a strong inclination for some activities to be dominated by a particular gender. Men and women frequently engage in different

production activities, with women generally carrying out the most labour-intensive tasks. For instance, land preparation, fertiliser application and chemical handling are mostly carried out by the men in the household. On the other hand, groundnut storage, groundnut processing, harvesting and weeding are predominantly 'female activities'. In general, men and women have their separate plots, but women have to carry out duties in their husbands' plots before they invest any time in their own plots. Women in Uganda generally have control over the production from their own plot, which they use primarily for household consumption. Any additional produce is sold in the market to generate income for household needs and expenses. The amount of time women spend on their groundnut plot is limited by other obligations within the household, such as cooking, cleaning and childcare, as well as duties on their husband's plots. Time constraints and limited revenues and inputs restrict women from investing in new technologies or adopting new and improved varieties of groundnuts (Kaaya *et al.* 2007).

3. Data

The data for the analysis was collected through surveys conducted in the Eastern Region of Uganda, the largest groundnut-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 from each village to participate in the survey. Participating villages were chosen using a two-mile buffer to 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, village leaders were contacted to provide a list of all the groundnut-growing farmers in their villages. 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, each of which was given a consecutive number 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 was selected by running through the entire list of households. For example, if 80 households were listed for the village, the starting point (or the first household) was randomly picked and then every eighth household on the list was picked thereafter for a total of 10 households from that village. We interviewed all family members in each household that managed and cultivated their own field of groundnuts. The surveying process yielded a total of 463 individual surveys, from which 373 surveys were complete and were included in the analyses.

Farmers were asked about groundnut-growing practices, acres planted, varieties grown and information on help from extension services. Each member of the household who was involved in groundnut production was asked about the plots for which they were responsible. In addition, demographic information was collected on each respondent, including age, gender of respondent, gender of household head, education and household size. A summary of the variables used in the analysis and descriptive statistics is presented in Table 1.

Table 1: Definition of variables and summary statistics

Variable	Description	Mean	Standard deviation
Improved varieties	1 if respondent planted 50% or more of the groundnut acres with improved varieties, 0 otherwise	0.578	0.494
Location	1 if respondent lives in the Teso sub-region, 0 otherwise	0.523	0.500
Male	1 if respondent is male, 0 otherwise	0.584	0.493
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 groundnut seeds	1 if respondent changed the groundnut seed in the last 5 to 10 years, 0 otherwise	0.466	0.499
Groundnut production	Total groundnut production in kg for both major and minor seasons	147.614	205.783
Extension contacts	Number of times farmers contacted extension for help	1.609	4.922

In this analysis, similar to what was found by Doss and Morris (2000), the adoption of improved varieties refers to the intensity of adoption, defined in terms of the level of use of the technology. Farmers generally planted a mix of improved and local varieties of groundnuts. However, farmers who planted improved varieties on a small portion of their groundnut acres may have done so to test the new variety and may not truly have adopted it. We considered farmers to be adopters if they planted 50% or more of their groundnut acres with improved varieties.

The summary statistics presented in Table 1 show that 58% of respondents had adopted improved groundnut varieties. About 52% of the respondents lived in the Teso sub-region[1] and 58% 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 about eight people. The respondents reported that they lived an average of 6.05 kilometres from the nearest market, 6.34 kilometres from the nearest extension agent and 3.7 kilometres from the nearest major road. Farmers produced an average of 148 kilograms of groundnuts in both the major and minor season in the year preceding the survey, 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, with 61.9%, compared to female farmers at 52.2% (Table 2). Furthermore, male-headed households adopted new varieties at a rate of 58.7% compared to female-headed households at 56.1%.

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[1] Surveyed districts in the Teso sub-region included Kumi, Amuria, Katakwi, Soroti, Kaberamaido, Bukedeya, Ngora, Serere and Palisa. Other districts covered were Manafwa, Sironko, Iganga, Busia, Tororo, Kapchorwa, Luuka, Budaka, Namutumba, Jinja and Mayuge.

Table 2: Adoption of improved varieties

	Gender of farmer		Gender of household head	
	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

4. Adoption model

The adoption decision in this study was modelled on a random utility framework (Ali & Abdulai 2010; Becerril & Abdulai 2010). Farmers will choose to adopt improved varieties of groundnuts 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 maximised as follows:

$$Y_i = U_A - U_N > 0 \tag{1}$$

Since farmers' utility is unobservable, a binary indicator variable was utilised that equals unity if they use improved varieties of groundnuts, and 0 otherwise. The decision to adopt is then expressed as a function of observables including gender, other farmer-specific characteristics and farm-specific variables.[2] The model is specified as follows:

$$Y_i = \boldsymbol{\beta X_i} + u_i \tag{2}$$

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:

$$Prob(Y_i) = \phi(\beta X_i / \sigma_u) \tag{3}$$

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 estimated two probit models to examine 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 location, 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 groundnut seed in the last five to 10 years, the level of groundnut production, number of visits to an extension office and the farmers' socioeconomic characteristics. Generally, previous studies have found that infrastructure, land owned, education and the number of extension visits are positively associated with adoption (Doss & Morris 2000; Simtowe *et al*. 2012). In addition, studies that have focused on the gender of the household head suggest that male-headed households are more likely to adopt new technologies compared to female-headed households (Kumar 1994; Doss & Morris 2000).

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

5. Empirical results

The results from the first probit model on the factors that influence households' decision to plant improved groundnut varieties are summarised in Table 3. The analysis reveals that gender is a significant factor in the adoption of new groundnut varieties, with males being more likely to adopt. These findings are similar to those of Doss (2001) and indicate that women are adopting improved varieties at a lower rate than men. Location also plays an important role in the adoption decision. Households in the Teso sub-region were more likely to use improved groundnut varieties. This may be due to the fact that the Serere research station, which produces and releases new groundnut varieties, is located in the Teso sub-region and is effectively distributing improved varieties and informing farmers in its vicinity.[3] The number of visits to the extension office for help and whether the farmers changed their groundnut seed in the last 5 to 10 years are positively related to adoption.

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 groundnut 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

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 the respondents and the size of the household lacked explanatory power. A somewhat surprising result was the negative relationship between adoption and education. As indicated previously, farmers residing in the Teso sub-region are more likely to adopt due to the proximity to the Serere research station. However, they are on average less educated than farmers in the non-Teso sub-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 was no statistically significant difference in whether the respondent was a male or female farmer. However, the probability of adoption of new varieties by women in female-headed households was lower than for women in male-headed households. This may suggest that women in male-headed households may have more resources available to them compared to the women who reside in female-headed households. Similar to the findings in Model 1, residing in the Teso sub-region, number of visits to the extension office and having changed the seed in the last five to 10 years all positively affected the probability to adopt. The

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[3] The improved groundnut varieties included more than 10 different SERENUT lines that were released after the year 2000. These varieties are resistant to groundnut rosette virus, one of the most limiting biotic stresses of groundnuts in the region (Okello *et al*. 2010).

marginal effects of Model 2 are presented in Table 4. The marginal effects measure the impact that changes in explanatory variables have on the probability of adopting new technologies. For example, in Model 1 the probability that farmers will adopt an improved variety increases by 0.465 if they are in the Teso sub-region districts (the location variable changes from 0 to 1). Similarly, in Model 2 the probability of adoption decreases by 0.171 if the respondent is a woman in a female-headed household.

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 groundnut seeds	0.414***	0.155	0.161
Groundnut 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

It is possible that the determinants of adoption might differ between farmers in female-headed households and male-headed households. Thus we estimated two separate regressions, one for the adoption decision of female-headed households and one for the adoption decision of male-headed households. The results, presented in Table 5 (for female-headed households) and Table 6 (for male-headed households), show that households living in the Teso sub-region are more likely to adopt irrespective of the gender of the household head. 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 the availability of additional labor, as improved varieties are generally more labour intensive. Furthermore, female-headed households that are large producers of groundnuts 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 sub-region (residents of the Teso sub-region are relatively more likely to adopt compared to those living in the Montane and the Banana-millet-cotton region) and whether they changed the groundnut seed in the past five to 10 years.

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
Groundnut 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
Groundnut 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

6. Conclusion

This study examines groundnut production in Eastern Uganda with a specific focus on gender, adoption and use. We found that female farmers were less likely to adopt than male farmers. Furthermore, we found that women living in female-headed households were less likely to adopt new varieties than women or men living in male-headed households. Their decision to adopt is affected by the size of the household (available labour), whether they are large producers of groundnuts, and whether they are located near the research station in the Teso region. Given that women play a vital role in the groundnut production sector in Uganda (Kaaya *et al*. 2007), policies and interventions that target women specifically may increase the adoption of groundnut technologies such as improved groundnut varieties. The analysis reveals that there are different dynamics between female- and male-headed households when it comes to decision making with regard to groundnut production. It identifies participation by both women and men and can be used as a tool to understand how a society is organised, as well as the dynamics within a given non-homogenous farming community. This is because female and male farmers play different roles in technology adoption. Research that examines these differences is useful for crafting better policy that enhances the adoption of new groundnut varieties in order to reduce food insecurity and increase welfare. Clearly, the adoption of new technologies does not simply depend on the gender

of the farmer or household head. There may be other, unobserved non-gender differences that may have an impact on adoption, such as access to and quality of resources for women and asset ownership, which were not part of this analysis and may be considered in future studies.

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