Understanding Low Rates of Technology Adoption by Women Farmers: A Case Study of the Determinants of Adoption of Improved Sorghum Varieties by Women Farmers in Mbeere District, Kenya

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ABSTRACT

The paper acknowledges the increasing recognition of women's contribution in agricultural and food production, both in terms of provision of labour and in the day-to-day management of farm households and farm activities. However, despite women's increased contribution in farming, not much is understood about their decisions on whether or not to adopt available agricultural technologies. Instead, majority of women farmers in Sub-Saharan Africa tend to be involved in subsistence farming with little use of improved technologies, which in turn translates into sub-optimal yields and low productivity. This paper identifies and analyses the factors that influence smallholder women farmers' decisions to adopt improved sorghum varieties in a marginal agricultural ecological zone in Kenya.

A total of 81 farm households of whom 41 were female managed in Mbeere District were interviewed with the aid of a structured questionnaire. The data on various institutional, infrastructural, farm/farmer characteristics as well as technology attributes was analysed using a logit regression model. The analysis revealed that non-yield attributes of improved varieties do affect the probability of adoption. Such attributes in the case of sorghum include taste, ease or difficulty of processing the grain and proneness to attack by birds. Since women play a major role in agricultural and food production in much of Sub-Saharan Africa, the implications of these results are that more and more women should be encouraged to participate in later stages of technology development and evaluation. This would ensure that their views with regard to other important attributes besides yield were incorporated, which in turn would make improved technologies more appealing to farmers.

KEY WORDS

Adoption, women, technology-specific attributes, sorghum, logit model.

1.0 INTRODUCTION

Recent studies have revealed that in much of Sub- Sahara Africa (SSA), women dominate the small farm sector and account for more than three-quarters of the food produced in the region. In Malawi, for example, it has been shown that between 50 and 70 percent of all the agricultural work is done by women and that 69 percent of all the farmers are women (Saito *et al*, 1990). Similarly, in Guinea and Burkina Faso, it has been noted that women perform 40 to 50 and about 49 percent of all the agricultural work, respectively. In addition, women are increasingly becoming the *de facto* and *de jure* managers of rural farms due to the rapidly changing economic and social circumstances. Most notable, among these factors is the growing population pressure, which has forced many men to migrate from farms in search of more remunerative activities in urban areas.

In Kenya, smallholder farmers make up the core of the agricultural sector and women especially, dominate much of farm activities. It has been estimated that at least 40 percent of the small holder farms in Kenya are managed by women, and that overall, women provide about 75 percent of the agricultural work force and form the bulk of food producers and marketers especially at the household level (World Bank, 1989).

Although women increasingly manage and carry out most of the agricultural activities, the majority of them are involved in subsistence farming characterised by low utilization of improved technologies. This is the case even in countries such as Kenya that have a long history of agricultural research, technology development and transfer. The use of subsistence technologies by women farmers translate into low productivity of the entire subsectors they dominate. A study by the World Bank in Kenya and Nigeria demonstrated that non-use of improved inputs and technology by women farmers resulted in a considerable (20%) loss in agricultural output (Saito, 1994). Currently, for most commodities in Kenya, smallholder farmers get less than 50 percent of the potential yields (MoALDM, 1996).

It is a widely recognized fact that improved technologies cannot increase productivity unless the farmers for whom they were intended use them. In Kenya therefore, where farming is predominately small scale and women increasingly manage and carry out most farm activities, it is crucial that the factors that hinder women's adoption of improved technologies are clearly understood and efforts made to alleviate them. Adoption studies carried out have tended to focus on high value commodities and major staples such as rice, dairy and maize. Maarse, (1995), examined adoption and impact of improved dairy in selected high potential districts in Kenya and revealed that farms operated by women performed poorly because most of them were ignored by extension in the delivery of messages on stall-feeding. Kenya Agricultural Research Institute (KARI) scientists through the Maize Data Base Project (MDBP) have done adoption of maize technologies extensively. These studies have shown that despite availability of maize technologies on shelf, adoption rates are rather low (Lynam and Hassan, 1998; Hassan *et al*, 1998). Less than 50 percent of smallholders apply the recommended levels of fertilizer and only about 15 percent use insecticide (Salasya and Hassan 1998). Furthermore, though decisions related to procurement and application of modern inputs on maize are often made by women, majority of them are constrained by such factors as lack of knowledge associated with the technology and capital (Saito, 1994; Salasya and Hassan, 1998).

Unlike maize, there is an apparent dearth in literature on adoption of crops suitable for dry areas such sorghum, millet and pulses. Few studies exist on technology transfer and adoption of grain sorghum and millet especially, Eastern Africa, probably because of research bias towards maize and other high value crops. However, given the increasing recognition of the importance of these crops to food security particularly in the dry marginal areas, more adoption studies focussing on these commodities will be invaluable. This paper identifies and evaluates the factors that influence smallholder women farmers' decisions on whether or not to adopt improved sorghum varieties in a marginal agricultural ecological zone in Kenya.

2.0 CONCEPTUAL CONSIDERATIONS AND THE ADOPTION MODEL

2.1 Conceptual Considerations in Adoption Studies

There are many factors that influence farmers' adoption behaviour. Among the factors commonly covered in adoption studies include:

i) The degree to which the technology is appropriate for the farmers' social and economic conditions (Byerlee *et al.*, 1982; CIMMYT, 1993; Kimenye 1998). This implies that beside the technology itself, the characteristics of the household, often reflecting access to resources, technology and information are important. Women farmers unlike men frequently lack access to both information and the technology inputs and this affects their adoption behaviour.

ii) The farmers' perception of the attributes of the technology such as taste, susceptibility to pests and ease of processing the product (Adesina and Zinnah, 1993). If an improved variety is perceived to be more prone to attack by pests such as birds, or to be more difficult to process (e.g. to thresh) the probability of its adoption may be significantly low.

iii) How the technology is supported by institutions and infrastructure such as, roads, co-operative societies, which provide credit and market the product, or *co-oporate groupings* (women's groups) could influence farmers' adoption behaviour (CIMMYT, 1993; Adesina and Zinnah, 1993). Sometimes technologies fail to be adopted because supportive infrastructure and institutions such as roads and markets are not well developed. Without good roads, farmers will be unable to reach the input and output markets.

iv) The effectiveness with which the technology is presented by the extension (Spring, 1985; CIMMYT, 1993). Farmers may fail to adopt an improved technology because they are either ignorant about it or they do not understand it or do not know how to use it.

2.2. Empirical Models Used in Adoption Studies

Various models exist in the literature, which are used to explain adoption decisions. The innovation-diffusion model, which is based on the pioneering work of Rodgers (1962), contends that access to information about a technology is the key factor that determines adoption. Thus, it puts greater emphasis on dissemination and communication mechanisms and that rational individuals will adopt an innovation once it has been communicated to them. Other models emphasize the role of economic constraints reflected in asymmetric distribution of factors of production such as land, capital and other institutional factors as major determinants of adoption and that the farmers' failure to adopt a technology could be strongly associated with lack of key production factors. Yet more recent and relatively less quantitatively developed models postulate that the farmers' perception of technology-specific attributes/characteristics such as, ease of threshing, taste of the product etc., could significantly influence the adoption behaviour. In a study on the adoption of improved rice varieties in Sierra Leone, for example, it was found that the farmers' perception of variety specific variables, including taste, ease of threshing, ease of cooking, yield and tillering capacity were positively and significantly related to the probability of adoption (Adesina and Zinnah, 1993; Adesina and Forson, 1995).

When analyzing adoption, one may be interested in either the effects of various factors on the probability of adoption or on both the probability and the rate (intensity) of adoption. The first type of analysis depicts a yes or no situation, which involves the use of qualitative dependent variable models, whereas, the second one is a case where the dependent variable has a censored distribution and adoption is analyzed using limited dependent variable models - censored distribution refers to cases where the dependent variable is only observed in some range. Although the values of the independent variables are observable for non-adopters, the researcher cannot observe how far or near from adopting the non-adopters are. The values of the dependent variable are therefore recorded as zeros for non-adopters even though there may be a difference in the points where different non-adopters are from adopting (Judge *et al*, 1988). The most commonly used limited dependent variable model is the tobit model. Examples of studies that have successfully used the tobit model include Adesina and Zinnah (1993) and Adesina and Forson (1995). However, since the purpose of the study reported in the present paper was to determine factors influencing only the probability of adoption, a qualitative dependent variable model was chosen for analysis rather than a limited dependent variable model.

There are two types of qualitative dependent variable models popularly used in adoption studies, namely, the probit and the logit models. There are no major differences between the two models, except that the error term in the former assumes a normal distribution while in the latter it has a logistic distribution (Judge *et al*, 1988). Both models have been used successfully to investigate the probability of adoption. Among the studies that have used the logit model include, Adesina and Seidi (1995) and Saito (1994), while Jha *et al* (1991) used the probit model.

Adesina and Seidi (1995) used the logit model to study how farmers' perception about the characteristics of improved mangrove rice varieties affected adoption in Guinea-Bissau. They found that farmers' perception about yield performance of improved varieties, their ease of threshing and shortness of the crop cycle were significant determinants of adoption. In addition, contact with extension and access to non-farm income also significantly influenced adoption. Saito (1994) also used the logit model to determine the factors that influence adoption of improved maize varieties among men and women farmers in Kenya. The findings showed that contact with extension, the farmers' education level and access to credit were major determinants of adoption of improved maize varieties by both men and women farmers.

Jha *et al* (1991) on the other hand, used the probit model to study the adoption of fertilizer, animal traction and improved maize varieties in Zambia. The findings indicated that adoption was significantly influenced by extension, membership to cooperatives and infrastructure development.

In this paper, the logit model was used to determine the factors that influence the probability of adoption of improved sorghum variety in Mbeere District of Kenya. Specifically, the model was used to find out how farm size, gender, age, education, extension contact, yield, taste, ease of processing (threshing), proneness to attack by birds, condition of roads and membership to women groups affected the probability of adoption.

2.3. Theoretical Formulation of the Logit Model

The logit model is based on the cumulative probability function:

$$P_i=F(Z_i)=1/(1+e^{-z_i})= 1/(1+e^{-(a+bX_i)}) \quad \text{.......... } 1$$

Where, P_i represents the probability that an individual will make a certain choice, given knowledge of X_i.

Because it is similar to the cumulative normal function, but computationally more tractable, the logit function is often used as a replacement for the cumulative normal function. An equation to be estimated is obtained by rewriting Equation 1 as:

$$(1+e^{-z_i})P_i=1 \quad \text{.......... } 2$$

Then $$e^{-z_i}=(1-P_i)/P_i \quad \text{.......... } 3$$

And $$e^{z_i}=P_i/(1-P_i) \quad \text{.......... } 4$$

Taking logarithms of both sides yields,

$$Z_i= \log(P_i/1-P_i) \quad \text{.......... } 5$$

Thus, $$\log(P_i/1-P_i)=a+bX_i \quad \text{.......... } 6$$

Where, the X_i's represent the explanatory variables defined in Table 1.

Table 1: List of variables used in the logit model

Farm/farmer characteristics	Technology specific characteristics	Infrastructure and institutional variables
1. Farm size (in acres)	6. Yield (perceived higher than local: 1=yes; 0=no)	10. Distance to an all weather road (in km)
2. Gender (1= male; 0= female)	7. Prone to attack by birds (perceived less prone to attack than local: 1=yes; 0=no)	11. Member of a women's group (1=yes; 0=no)
3. Age (in years)	8. Ease of processing (perceived as easier to process than local: 1=yes; 0=no)	
4. Education (years of formal education)	9. Taste (perceived as better than local: 1=yes; 0=no)	
5. Extension contact (1= contact; 0= no contact)		

The data was collected from a random sample of 81 households from Mbeere District. Out of these households, 41 were female managed. The logit model was estimated using the Maximum-Likelihood Nonlinear estimation routine.

3.0 RESULTS AND DISCUSSION

Table 2 shows the numerical details of the determinants of adoption of improved sorghum variety (*serena*) by smallholder farmers in Mbeere District of Kenya. The results were, in general, consistent with a priori expectations about the role of education, extension service, and farmers' perception of the attributes of the improved varieties, infrastructural and institutional factors and membership to women groups. Table 2 for example, shows that the farmer's level of formal education and farm size significantly (at 5%) increased the farmers' probability of adopting the improved variety. Farmer's contact with extension as well as distance to an all weather road also positively affected the probability of adoption. Technology characteristics such as yield and ease of processing (threshing) positively affected the probability of adopting the improved sorghum variety at the 10 % level. This indicates that farmers found the improved variety (*serena*) not difficult to process and this increased the probability of adoption. This is true because, unlike *seredo* (another improved variety), *serena* is considered to be much easier to remove the husk. Other technology specific attributes such as taste and proneness to attack by birds also positively affected adoption.

However, for women farmers, the effect of extension service and formal education on adoption of the improved sorghum variety though positive, were not significant. Instead, the results show that the attributes of the variety, particularly the ease with which the grain is processed, had a stronger influence on women farmers' adoption decisions. The ease with which a sorghum variety could be processed significantly increased the probability of women farmers' adopting the variety. Threshing, pounding and grinding sorghum are tedious chores and improved varieties are reputed to be more difficult to thresh, pound and grind than the local ones. The *serena* variety, unlike *seredo*, is said to be much easier to thresh and pound. The farmers' perception that the variety was less prone to attack by birds was an important determinant of adoption. Farmers claim that the grain of local sorghum varieties is not as soft as that of most improved varieties and cannot be easily detached from the ears and therefore are less preferred by birds. Varieties that are less prone to attack by birds do not require much labour to scare away the birds.

Table 2: Probability of Adopting Improved Sorghum Variety (*serena*): Mbeere District

Variable	ALL FARMERS (sample size = 81)				Woman Managed Farms (sample size = 41)			
	Coefficient	Standard error	Wald statistic	Significance	Coefficient	Standard error	Wald statistic	Significance
Constant	-3.7172	2.0123	3.4125	0.0647*	-3.3760	3.8490	0.7694	0.3804
Farm size	0.2260	0.0941	5.7735	0.0163**	0.1564	0.1639	0.9105	0.3400
Gender	-0.2335	0.7793	0.0898	0.7645				
Age	-0.0737	0.0908	0.6594	0.4168	-0.0326	0.7780	0.0018	0.9666
Education	0.0793	0.0335	5.5913	0.0180**	0.3162	2.5152	0.0158	0.8999
Extension contact	0.7432	0.9813	0.5736	0.4488	0.0619	1.3437	0.0021	0.9632
Yield	2.5574	1.1743	4.7425	0.0294*	-8.0646	44.0077	0.0336	0.8546
Prone to bird attack	1.1145	0.9720	1.3148	0.2157	0.[illegible]564	0.1287	1.4783	0.2240
Ease of processing	2.0751	0.9062	5.2432	0.0220*	1.0458	0.3245	3.4228	0.0645*
Taste	1.3149	0.9359	1.9740	0.1600	-0.1809	1.0372	0.0304	0.8616
Distance to all weather road	-0.0969	0.0474	4.1865	0.0407*	-0.0892	0.0672	1.7599	0.1846
Member to women group	0.4405	0.5878	0.5616	0.4536	0.4022	0.7773	0.2677	0.6049
% correctly predicted		81				78		

* Significant at 10 percent; **Significant at 5 percent

As postulated, the probability of farmers' adoption of improved varieties is negatively affected by the poor condition of roads, possibly because it makes it difficult for farmers to get to the markets. Furthermore, the results showed that being a member of a women's group increased the women's chances of adopting improved technology. One of the advantages of being a member of a women group is the increased chance of getting agricultural information, including new technologies.

4.0 CONCLUSIONS

The paper has demonstrated that non-yield characteristics of an improved variety do affect adoption. Factors such as farmers' perception of whether the improved sorghum was equal or superior to local varieties in terms of such as attributes as ease of processing of the grain, taste and proneness to attack by birds were important determinants of adoption. This means that no matter how technically appealing or feasible the improved technologies appear to researchers, they cannot increase farm productivity unless they are also appealing to the farmers, particularly women who are the ones who carry out most of the farm activities. For this reason, later stages of technology development and evaluation should be made more participatory and involve both men and women farmers. This would ensure that farmers' views about such non-yield attributes are also taken into account before the technologies are disseminated to the communities. In this way, farmers would find improved agricultural technologies such as improved and new varieties more appealing and this would enhance utilization.

Other factors found to enhance technology adoption by women farmers included membership to women groups and contact with extension. Women groups act as important sources of information on technologies and of external inputs such as improved seed and could therefore serve as effective extension contact points.

ACKNOWLEDGEMENT

I am grateful to the International Development Research Centre (IDRC) for the financial support, and to the Ministry of Agriculture, Embu and Mbeere Districts who provided logistical support.

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