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Gender Differences in the Adoption of Improved Maize Varieties: The Case of Smallholder Farmers in Mozambique

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Abstract: ***Maize is an important food and income-generating crop in Mozambique. Nevertheless, maize productivity remains low, which could be caused by the low adoption of improved maize varieties especially among smallholder farmers. Rural women play a crucial role in agricultural production but have no much control over resources, which obstructs them in adoption and productivity. Using data collected from 346 households, the study assessed the differences between male and female-headed households' level of adoption and the intensity of use of improved maize varieties (IMV) using Logit and Tobit models respectively. The study found no significant gender differences in the level of adoption, however, the level of adoption was higher for female-headed compared to male-headed households. Access to transport was found to be positive and statistically significant influencing the level of adoption of improved maize varieties. Female-headed households had lower access to transport. For the intensity of adoption, the dummy for gender was negative and statistically significant; implying that, the intensity of adoption was lower for male-headed compared to female-headed households. The study concludes that the level of adoption of improved maize varieties is not gender-sensitive, but the intensity of adoption is. The study recommended that the government should facilitate the construction of road infrastructures for ease transportation of inputs e.g. modern seed varieties and fertilizers and/or policies that favour the availability of stockiest (input shops) in the village to improve the accessibility of inputs to farmers. The Ministry of Agriculture should make policies, regulations, and programs that encourage food production and reliable output markets targeting both male and female to raise the intensity of adoption of IMV, food security and incomes in the households. Targeting male-headed households would raise the intensity of the use of improved maize varieties contributing to achieving high productivity, food security, and raise incomes in the households.***

Keywords: Gender, adoption, Improved Maize Varieties, Smallholder Farmers, Mozambique

1. Introduction

Agriculture production in Mozambique depends on the rain-fed condition and is predominantly subsistence farming, characterized by smallholders and low rates of technology adoption and productivity (World Bank, 2015; Benson *et al.*, 2012). The sector is dominated by smallholder farmers using family labour (99%), of whom cultivate small plots of land ranging between 0.5 to 1.5ha (World Bank, 2016). It is estimated that in Mozambique, female contributes 43 percent of all agricultural labor in the sector (Lidström, 2014). Gender disparities in productivity continue to exist in developing countries including Mozambique, ranging from 4-25 percent depending on crop and country (World Bank and One, 2014). The reasons behind gender gap persistence and low adoption are imbalanced access to key agricultural inputs such as land, labor, credit, fertilizer, and modern seed varieties where female make use of and own less modern agricultural inputs, for instance, improved maize varieties (Sheahan and Barret, 2014); low level of education (UNESCO, 2014) and that women tend to have limited information about improved technology compared to their male counterparts (Jost *et al.*, 2015; Tall *et al.*, 2014; Perez *et al.*, 2015). This deters efforts of attaining Sustainable Development Goals of fighting against poverty reduction and food insecurity and malnutrition or chronic undernutrition in the country. Evidence shows that closing the gender gap in technological adoption is fundamentally a vehicle to improved food and nutrition security, incomes, and poverty reduction in the household. To inform policy-makers and development practitioners aimed at empowering women and advancing their living standards through sustainable agricultural production to ensure food security and nutrition, and increased income, it is therefore imperative to assess the level and intensity of adoption of improved maize varieties (IMV) among male and female-headed households (MHH and FHH) in rural Mozambique.

Maize is an important crop for both food security and income generation to smallholder farmers in Mozambique; however, maize productivity remains low with an estimated yield of 1.1 tones/ha against an average potential yield of 4.9 tones/ha for Southern Africa Region (Marrule, 2014). The reasons for low maize productivity include low adoption of improved maize varieties; low levels of education; and the majority of food producers in Mozambique being women, most of whom cultivate small plots of land and having limited access to credit (Sheahan and Barret, 2014; Lidström, 2014; World Bank, 2015; MASA, 2015a). Moreover, high costs of improved maize seeds varieties, poor accessibility and lack of knowledge and low use of fertilizers, and pest

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and diseases affect maize production in Sub-Saharan Africa, including Mozambique (Lyimo, 2014).

However, low maize productivity is not accepted as it causes persistent of poverty in the households, food insecurity and malnutrition, and the stunted growth of children. It is therefore of a vital to assess gender differences in the level and intensity of adoption of improved maize varieties (IMV), particularly for Mozambique for improving food and nutrition security, reduce poverty and raise employment and incomes through marketable surplus. The general objective of this study was to assess if there are gender differences between male and female-headed households (MHH and FHH) in the level and intensity of adoption of improved maize varieties (IMV) in rural Mozambique. Specifically, the study objectives were: (i) to assess the gender differences in the level of adoption of IMV between male and female-headed households and (ii) to assess the gender differences in the intensity of use of improved maize varieties (IMV) between male and female-headed households. The study is guided by these research questions: (i) are there differences between male and female-headed households on the level of adoption of IMV in rural Mozambique? (ii) are there differences in the intensity of adoption of IMV between male and female-headed households in rural Mozambique? The null hypothesis is that male and female-headed households have an equal level of adoption of IMVs and that intensity of use of IMV is the same for male and female-headed.

2. Theoretical Debate

Agricultural technology adoption and its dissemination often vary from place to place. According to CIMMIYT (1993), the variation in adoption is due to diverse factors such as agroecology, institutional and socio-economic factors. For example, socio-economic such as gender of a farmer, age, education, income, household size, farm size, and input use are among factor that tends to affect technology adoption. Likewise, institutional factors such as access to credit, transport, extension services, information, and membership of association (e.g. saving and credit, crop marketing group, inputs seed supply or crop), and network with traders.

2.1 Gender and Agriculture in Mozambique

Gender refers to the social roles that men and women take part in and the power relations between them, which usually have a profound effect on decision-making, resources allocation and utilization (e.g. technology adoption), which also has implication on productivity and food security in the households and welfare as well (Jacoby, 1992; Baumann, 2000; Welch *et al*. 2000; Husinga *et al.*,2001). In most countries, the living of rural communities and their well-being depends on agriculture production. For men and women in less developed countries, particularly Mozambique, agricultural production is vital for their living as it is the main source of food and income to rural communities. In Mozambique, the gender division of labour in the agriculture sector is highly uneven distributed within the sector. Men labour contribution to income-generating activities is relatively higher compared to that of women in the sector, whereas females contribute higher labour input than males (Arora, 2015), high labour-force and highest compared to the world average agricultural labour-force (FAO, et al, 2010).

In Manica, Sussundenga and Angonia where this study was conducted, women participate nearly in all agricultural activities, including land preparation, planting, weeding, harvesting, and tending livestock, the tasks performed by men in other regions (Marenya, Berresaw and Tostão, 2015). The division of labour in agricultural tasks in this region is not clear. Also, unequal participation in agricultural activities between male and female in Mozambique may reflect differences in productivity, and food and nutritional security in the households.

Furthermore, according to the National Statistical Institute, about 36 percent of households in Mozambique were headed by a female in 2011 (cited in Morgado and Salvucci, 2016), suggesting that there is a greater need to emphasize the adoption of IMV to increase food security in the households headed by men since in Mozambique, men tend to concentrate much on high paying cash crops production including cotton and tobacco (Heyer, 2006). This means that the benefits of adopting IMV in Mozambique and Sub Saharan Africa accrue mainly to households headed by women, who are food producers in the households. Also, in rural Africa including Mozambique, women do not have autonomy (power) in households headed by men and control over household's cash, and that large proportions of women do not have a say in how household income is spent (Köhlin *et al.*, 2011). Therefore, investing in improved maize technologies (e.g. high yielding varieties) i.e. increasing food security in the household, may not be the main concern in a male-headed household, who is not mainly responsible for feeding household members, and may not fully consider the cost of food insecurity in the household.

Considering the importance of maize to the food security and poverty reduction, it is grown by approximately 80 percent of the farming households, and the main source of income to many households in the country. Besides, it provides 22 percent of the total calories in the country (FAOSTAT, 2011). Taking note of the climate change which affects agriculture production, thus the adoption of maize high yielding varieties is emphasized to enhance food security.

2.2 Gender Differences in Agricultural Technology Adoption

Many studies have examined differences in agricultural technology adoption between males and females. Empirical evidence shows that differences in adoption between male and female farmers are because of unequal access to productive inputs (e.g. land, credit, education) and access to critical resources including extension services that are fundamental for agricultural productivity (Bisanda *et al* ., 1999; Doss and Morris, 2001; Ragasa *et al*., 2012). However, other empirical studies argue that it is not the ease of access to inputs but the tendency to utilize inputs that limit many women farmers in technology adoption (Peterman, Behrman and Quisumbing, 2010).

Recent studies of technology adoption illustrate those disparities in productivity between male and female is caused by the difference in resources and sometimes returns to those resources (Kilic *et al.*, 2013; Oseni *et al*., 2014; Aguilar *et al*., 2014). It is not that women are poorer farmers other than men just because of limited access to and control over resources which leads them to have low productivity (Croppenstedt *et al.*, 2013). The study by Herell and Krishnan (2007) found no productivity differences between male and female-headed households in Zimbabwe. The reason behind this is that the productivity gap between male and female farmers diminishes once there is equality in input use between them (Quisumbing, 1996).

It is, however, important to consider the gender gap in the level and intensity of adoption of improved maize varieties—as a gender gap in productivity and food security in male and female-headed households, which have received little attention, despite a large body of literature on the gender gap in technology adoption and productivity. Therefore, this paper contributes to the literature on technology adoption by assessing the effect of gender on both the level and intensity of adoption of IMV in rural Mozambique.

Given the gender division of labour in many African rural societies, women tend to have limited economic opportunities because they bear nearly all task in the household including taking care of children and other family members; tasks which men are likely not to do. For example, women spent a large amount of their time (about 85 to 90 percent) for household tasks such as searching for and collecting water and firewood and food preparation (Fontana and Natalia, 2008; Malmberg-Calvo, 1994). This increased labor and time demand on women and the need to stay at home to perform these tasks reduces the likelihood that they will participate in different income-earning opportunities in the global, including agricultural production. This has great implications on technology adoption as well as food security in households. Therefore, to realize the contribution of women in food security and poverty reduction, it is necessary to empower women in decision making in agriculture as well as closing the gender gap in the level and intensity in technology adoption.

3. METHODOLOGY

The study used cross-sectional data collected by the Adoption Pathways Project of the International Maize and Wheat Improvement Center (CIMMYT) in collaboration with the Faculty of Agronomy and Forestry Engineering of Eduardo Mondlane University in Mozambique. The survey-based on farm-household conducted in the year 2012/2013 season. The survey was the follow up of the SIMLESA Project, which traced the same households targeted by the Sustainable Intensification Maize and Legume Systems for Food Security in Eastern and Southern Africa (SIMLESA) Project. SIMLESA Project aimed at increasing farm-level food security and productivity in Eastern and Southern Africa, whereby farmers in northern-central Mozambique in three districts: Manica, Sussundenga, and Angonia (Fig.1) received training on different agricultural intensification practices including the use of improved maize varieties such as PAN 53, PAN 6777, R201, R301, and intercropping maize and legumes. Is after that intervention then, the Adoption Pathways project followed up and collected data on the same households by using household and individual plot level using a questionnaire.

Data was gathered from 397 households using questionnaire instrument capturing individual and household level data were it collected socio-economic data (e.g. gender of household head, age, level of education, income, household size) and institutional factors (e.g. access to credit and extension services, communication and transport assets). The survey collected both quantitative (e.g. age and income) and qualitative (e.g. access to transport, information, extension services). Before analysis data were cross-checked where some observations were dropped because of missing some information, such as the area that household planted/cultivated IMV. At last, data from 346 households were analysed using STATA software, were mean for quantitative variables and percentage for qualitative variables were computed for the analysis to show the characteristics of the sampled households.

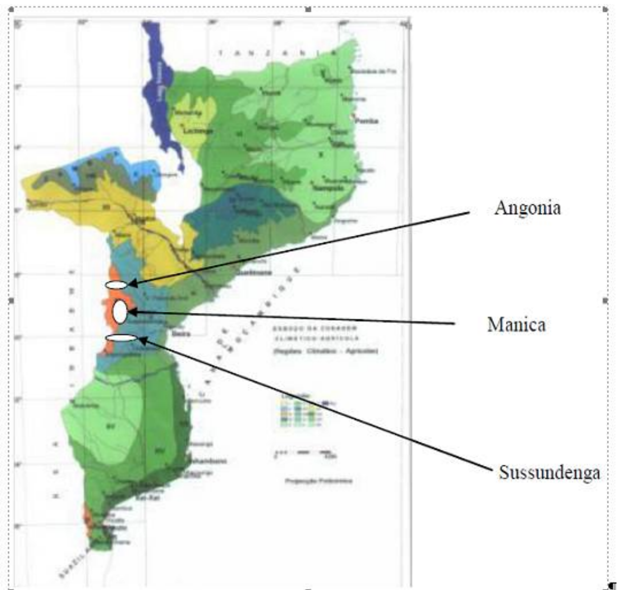

Figure 1: A map showing study area: Manica, Sussundenga and Angonia districts
Source: SIMLESA, 2010/14

3.1 Theoretical Framework and Model Choice

The choice of whether farmers to adopt or not to adopt any new technology are underlying economic theory based on the assumption that farmers are motivated by utility maximization (Rahm and Huffman, 1984; Shakya and Flinn, 1985). Farmers as rational producers decide whether or not to adopt novel technology depending on the utility that farmers expecting to derive from using the technology (Norris and Batie, 1987; Pryanishnikov and Katarina, 2003).

In this case, farmers as economic agents, decide to adopt or use IMV when perceiving that the utility or net gain from using the IMV is high compared to other maize varieties (for this case, local varieties). The perceived utility gain by farmers could be an increase in productivity or low cost. The assumption is that farmers behave consistently with utility maximization and that IMV adopted when the expected utility from adoption exceeds that of non-adoption.
Therefore, farmers' decision whether or not to adopt IMV technology can be considered as a binary choice. In other words, the decision to adopt or not to adopt can be described as a function of various factors such as the age of a farmer, income, education level, access to credit, etc. The utility

cannot directly be observed, but the actions of farmers as economic agents can be male or female-headed through their decision made. Farmer's decision whether or not to adopt IMV can be described as a linear random utility model, that is,

$$Y_i^* = X_i\beta_i + \pi_i \qquad (1)$$

Y_i^* is unobserved farmers utility, X is a vector of independent variables that determine differences in adoption of IMV, β is a vector of unknown parameters to be estimated, and π is a stochastic standard error normally distributed with zero mean. Farmers choose to adopt IMV when expected utility from adoption is greater than not adopting IMV. The observed adoption decision as a discrete random variable can be related to unobserved continuous benefits or utility that a farmer gains. In this case, the discrete dependent variable is taking the value of one if a farmer adopted IMV and zero otherwise. Mathematically, this means that a farmer will choose to adopt (Y_i =1)

$$if\ Y_i^* > 0, or\ not\ to\ adopt\ (Y_i = 0)\ if\ Y_i^* \leq 0.$$

Because of the nature of the dependent variable, several qualitative choice models (e.g. Logit and Probit) can be applied to estimate the model (Green, 2003). This study employed logit and Tobit to estimate the model of the level of adoption and intensity of improved maize varieties (IMV) between male and female-headed households, respectively. The reason to use the two models is that, in Logit mode, the value of the dependent variable is a dichotomous (0,1), one for adopters and zero for non-adopter; while in Tobit model, the dependent variable, the area that farmers planted IMV is continuous which censor above zero.

3.2 Empirical Models

The logit model is a statistical probability model based on the distribution in which the dependent variable takes the value of 1 and 0, while the independent variable can be dummy, continuous or categorical. This can be presented in a simple equation as:

$$IMV_i = \beta_0 + \beta_i X_i + \epsilon_i \qquad (2)$$

where IMV represents the adoption of improved maize varieties which takes the value of 1 for the household that adopted improved maize varieties and 0 for non-adopters; X_i is a vector of explanatory variables that explain the differences in the level of adoption of improved maize varieties between male and female-headed households; ϵ_i is the error term which is independent and normally distributed random variable with zero of the mean.

Equation (2) above is a Linear Probability Model (LPM). Estimating using Linear Probability Model will lead to problems as the predicted value may fall out of the probability value, which ranges between 0 and 1. According to Gujarati (2004), to overcome the problem of the Linear Probability Model, the Logit model can be used. The Logit model was estimated using maximum likelihood estimation (MLE) procedures.

The logistic cumulative probability function for adopters of IMV is presented below:

$$P_i = \frac{e^z}{1 + e^z} \qquad (3)$$

where, P_i is the probability that the i^{th} farmer adopted improved maize technology and that P_i is a nonlinearly related to Z_i, the power of natural logarithm *e*, and *e* represents the base of the natural logarithm.

If P_i is the probability of adopting improved maize variety, then, $(1 - P_i)$ represents the probability of not adopting improved maize varieties, which can be expressed as:

$$1 - P_i = \frac{1}{1 + e^{Z_i}} \qquad (4)$$

By dividing equation (3) by equation (4), the following equation is obtained:

$$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i} \qquad (5)$$

Equation (5) represents the odds ratio in favour of the adoption of improved maize varieties.

In order to estimate the logit model, the dependent variable was transformed by taking the natural log of equation (4) which follows:

Therefore, for the i[th] observation (an individual farmer)

$$IMV_i = ln\left(\frac{P_i}{1 - P_i}\right) = Z_i = \beta_0 + \beta_i X_i + \ \ldots . + \beta_n X_n + \pi_i \qquad (6)$$

The relative effect of each explanatory variable (X_i) on the probability on the level of adoption of improved maize varieties is measured by differentiating with respect to X_i i.e. $\frac{\delta P_i}{\delta X_i}$, using quotient rule,

$$\frac{\delta P_i}{\delta X_i} = \left(\frac{e^{IMV_i}}{1 + e^{IMV_i}}\right)\left(\frac{IMV_i}{X_i}\right) \qquad (7)$$

where IMV_i is the log of the odds ratio, linear for both explanatory variables and parameters. The logistic distribution function defined in equation (6) is based on the logit model of Z_i ranging from $-\infty\ to + \infty$ and P_i is between 0 and 1, β_0 is the intercept, β_i's is a vector of unknown parameters to be estimated in the model, X_i's are explanatory variables for i^{th} farmer that influence gender differences in the level of technology adoption of improved maize varieties.

The Tobit model was used to determine the intensity of the adoption of improved maize varieties (IMV). The model was developed by James Tobin in 1958, and it is widely used in technology adoption studies. According to Maddala, (1992) and Johnston and Dinardo (1997), the basic Tobit model for discrete and continuous variables can be expressed as:

$$AR_i^* = X_i\beta_i + \epsilon_i \qquad (8)$$

$$AR_i = \begin{cases} 0\ if\ AR_i^* \leq 0 \\ AR_i\ if\ AR_i^* > 0 \end{cases}$$

where AR_i^* is a latent (unobserved) dependent variable, X_i is a vector of explanatory variables (Table 1), β is a vector of unknown parameters to be estimated, and ϵ_i is a disturbance term which follows a normal distribution with 0 mean and variance δ^2, $\epsilon_i \sim IN$ (0, δ^2). The model assumes that there is an underlying, stochastic index equal to $(X_i\beta + \epsilon_i)$ which is observed only when it is positive, and consequently qualifies as an observed, latent variable.

4. Results and Discussion

4.1 Descriptive Statistics Results

Table 1 shows the descriptive results in this study. The study found that 84% of the households were headed by males. The mean age of the household head was 48 and that, on average, a household was composed of 7 members. This signifies farmers were in productive age and there was the availability of labor supply for maize production in the households. About 78% of the household heads were literate, meaning that they are aware of the importance of adopting IMV.

Table 1: Descriptive statistics results of the explanatory variables used in this study

Variable	Percent	Mean
x_1= Gender of the head (1=male)	84%	
X_2= Age of the head (years)	N/A	48.18
X_3= Age square	N/A	2534.06
X_4= Education (1=literate)	79 %	N/A
X_5= Household size (Number of heads)	N/A	6.68
X_6= Income (MZM)	N/A	4599.11
X_7= Household input use (1=yes)	47%	N/A
X_8= Household access to credit (1=yes)	10%	N/A
X_9= Saving and credit association (1=yes)	10%	N/A
X_{10}= Member in crop marketing group (1=yes)	4%	N/A
X_{11}= Crop or input supply group (1=yes)	10%	N/A
X_{12}= Access to information (1=yes)	89%	N/A
X_{13}= Network with traders (1=yes)	73%	N/A
X_{14}= Access to transport (1=yes)	69%	N/A
X_{15}= Access to extension services (1=yes)	28%	N/A

Note: 30MZM was equivalent to 1$US

Only 28% of the household had access to extension services, which suggests limited access to information regarding IMV from extension officers. On the other hand, 10% of the household had access to credit. The main cause for low access to credit in Mozambique is due to time and distance barriers to access financial institutions such as banks considering that 70% of Mozambican live in rural areas while financial institutions are located in town (Sanford *et al.*, 2011; Sibanda, 2010). These findings imply that technology adoption programs may not be successful if farmers do not have access to credit which could help them to purchase inputs, for example, seed and fertilizer.

4.2 Econometric Results

Econometric results for both the Logit and Tobit model estimating the difference between male and female headed households in the level of adoption and intensity of improved maize varieties are presented in Table 2 and 3 below. Results from Logit model (Table 2) shows the Log-likelihood ratio of -232.65 and insignificant at 10% level, with Pseudo R^2 of 0.0246, respectively; which suggests low explanatory power of the model and implies that the variables included in the model explained about 2.46 percent male and female-headed households differences in the probability of adoption of IMV. The predicted probability in the level of adoption was 0.5448. Socioeconomic and demographic factors such as household size, age, education, and income were found non-significant to influence the level of adoption of IMV. Moreover, household income, age, access to credit and extension services, membership in saving and credit association, and crop marketing group were found positively influence the level of adoption of IMV, however insignificant. Age square, education, household size, input use, membership in seed or input supply group, and access to information were found to be negative and insignificant to influence the level of adoption of IMV.

The study found no statistical differences between MHH and FHH in the level of adoption of IMV. Female-headed households were likely more to adopt IMV compared to male-headed households. This shows that differences in the level of adoption between male and female headed may be caused by other factors and not the gender of the head. The study anticipated the gender of the head to have a significant effect on the level of adoption of IMV. However, it was found negative and non-significant with the level of adoption of IMV. The findings of this study concur with Doss and Morris (2001) who found the gender of the head to be insignificant in technology adoption in Ghana; however, other studies found significant gender differences between male and female headed in the adoption of improved maize seed and pigeon pea in Tanzania and Malawi, respectively (Bisanda, Mwangi and Verkuijl, 1999; Abate, Asfaw and Simtower, 2016). In the study of pigeon pea in Malawi (*ibid*), they found high adoption among female-headed households, older farmers, and those with access to credit. The results obtained in this study may reflect the effect of unobservable variables, not captured by the model, nonetheless, it does affect the intensity of adoption of IMV.

Table 2: Logit model results estimating the level of adoption of IMV between MHH and FHH

Variable	Coeff.	Std. error	*p*-Value	Marg. effect
Constant	-0.061	1.283	0.962	
Gender of the head (1=male)	-0.433	0.317	0.173	-0.105
Age of the household head	0.021	0.043	0.620	0.005
Age square	-0.0002	0.0004	0.571	-0.0001
Education (1=literate)	-0.188	0.282	0.503	-0.046
Household size	-0.026	0.033	0.430	-0.006
Income (MZM)	9.91e-06	0.0000	0.709	2.46e-06
Input use (1=yes)	-0.039	0.227	0.862	-0.010
Access to credit (1=yes)	0.220	0.382	0.565	0.054
Saving and credit association (1=yes)	0.148	0.375	0.693	0.036
Crop marketing group (1=yes)	0.106	0.571	0.853	0.026
Input Supply group (1=yes)	-0.138	0.366	0.706	-0.034
Access to information (1=yes)	-0.220	0.361	0.542	-0.054
Traders (1=yes)	0.293	0.249	0.239	0.073
Access to transport (1=yes)	0.437*	0.240	0.069*	0.109*
Access to extension (1=yes)	0.380	0.256	0.137	0.093

Number of observations=346;
Log likelihood=-232.65; LR Chi^2 (15)= 11.75; Prob>Chi^2= 0.6980;
Pseudo R^2=0.0246; predicted Prob. (adoption) = 0.5448

***, **, * denote statistical significant at 1%, 5% and 10% respectively.

On the other hand, household access to transport was found significant at the 10% level and positively influencing the level of adoption of IMV. A one-point increase in access to transport would increase the level of adoption of IMV by 10.9% to male-headed households. The sign of the coefficient for transport is consistent with the expected sign, meaning that access to transport has a positive impact on the level of adoption of IMV as it increases the likelihood of participation in both input and output markets. This finding conforms with Koru and Holden (2008) who found ownership of means of transport (e.g. bicycle) to be significant and positive influencing maize productivity in

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Uganda. Results show that the coefficient of access to transport was 0.437 (Table 2) while that of the marginal effect was 0.109 (Table 2). This means that the likelihood of adopting IMV was high among households who had access to means of transport, suggesting that male-headed households had better access to improved maize varieties and markets compared to female headed households.

4.3 Gender differences in the intensity of adoption of IMV between MHH and FHH

The Tobit model shows the Log-likelihood ratio of -275 insignificant at 10% level. It also reveals a Pseudo R^2 of 0.0215, which implies that the model was able to explain about 2.15 percent of the household decision on the intensity of the use of improved maize varieties. The predicted probability of intensity of use of improved maize varieties is 0.4851. This means that there is about 49% probability that farmers planted IMV in the study area. Comparing with the probability of adoption predicted by the Logit model, the intensity of use of IMV was lower. This indicates that farmers may adopt IMV but plant small area IMV.

Table 3: Tobit model results estimating the intensity of adoption of IMV between MHH and FHH

Variable	Coeff.	Std. error	*p*-Value	Marg. effect
Constant	0.230	0.383	0.548	
Gender of the head (1=male)	-0.178*	0.091	0.050*	-0.077*
Age of the household head	0.001	0.013	0.959	0.0003
Age square	-0.0000	0.0001	0.874	-7.72e-06
Education (1=literate)	-0.037	0.083	0.660	-0.015
Household size	-0.011	0.010	0.259	-0.005
Income (MZM)	5.44e-07	7.79e-06	0.944	2.21e-07
Input use (1=yes)	-0.038	0.068	0.579	-0.015
Access to credit (1=yes)	0.149	0.110	0.177	0.065
Saving and credit Association (1=yes)	0.014	0.110	0.895	0.006
Crop marketing group (1=yes)	-0.057	0.163	0.729	-0.022
Input Supply group (1=yes)	-0.062	0.109	0.571	-0.025
Access to information (1=yes)	-0.008	0.104	0.937	-0.003
Traders (1=yes)	0.083	0.075	0.270	0.033
Access to transport (1=yes)	0.106	0.072	0.144	0.042
Access to extension (1=yes)	0.098	0.074	0.184	0.041
Number of observations=346;				
Log likelihood=-232.65	Log likelihood=-275.65;		LR Chi Square (15)= 12.13;	
Pseudo R^2=0.0215	Predicted Prob. (intensity) =0.4851			

***, **, * denote statistical significant at 1%, 5% and 10% respectively.

Gender of the household head was found significant and negatively influencing the intensity of use of improved maize varieties. Male headed households had lower intensity (planted IMV in a less area) compared to female headed households, and that being a male-headed household could reduce the intensity of adoption of IMV by 7.7 percent. Interestingly, we found no difference between male and female headed households in the level of adoption, but differences in the intensity of adoption. Results suggest that estimating only the level of adoption based on a *yes* or *no* dummy variable can be misleading. The result of this study is inconsistent with the findings of Arega (2009); Nkegbe and Shankar (2014) and Awotide *et al*. (2014) who found the gender of the household head to be insignificant with the intensity of adoption. The reason for the intensity of adoption of IMV to be higher for female headed households in comparison to male-headed households is because in Mozambique, women are likely to engage more or specialize in food production while male tend to cultivate cash crops such as cotton, tobacco, and sugarcane (FAO *et al* ., 2010). Another reason could be the focus on food insecurity by female-headed in their households. This is because males tend to cultivate cash crops, which may have more cash to purchase food compared to females in the time of trouble.

Factors such as income and age influenced positively the intensity of adoption of IMV but insignificant. On the contrary, education level and household size negatively influenced the intensity of adoption of IMV. Institutional factors such as access to credit and extension services, membership in saving and credit association, access to transport and traders, were found insignificant but positively influencing the intensity of use of IMV.

5. Conclusions and Recommendations

The study assessed gender differences in the *level* of adoption and the *intensity* of adoption of improved maize varieties between male and female headed households in rural Mozambique, using Logit and Tobit models, respectively. Logit estimates show that there were no statistically significant differences in the level of adoption of improved maize varieties (IMV) between male and female headed households; however, female headed households were as likely to adopt IMV compared to their counterpart male-headed households. A significant difference between male and female headed households is observed in access to transport, which was found to be significant at the 10% level and positively influenced the level of adoption of IMV. On the other hand, Tobit estimates show a significant difference in the intensity of use of IMV between male and female headed households. The intensity of use of IMV was higher for female headed households compared to male-headed households. This suggests that female headed households would be better off in food security compared to male-headed households. Based on the findings, the study concluded that the level of adoption of IMV is not gender-sensitive, but the intensity of adoption is.

Based on the findings, the study recommends the following:

- Given that access to transport enhanced the level of adoption and that male-headed households had high access to transport, public policies and investment in public goods such as road infrastructures would lead to improved access to price information and inputs such as improved maize varieties and fertilizers contribute to famers' level of adoption.
- Given that gender had effects on the intensity of adoption, the government should put forward policies targeting male-headed households that urge food production and reliable input-output markets. This would help to raise the intensity of use of improved maize varieties and productivity to male-headed households, consequently, contributing to achieving increased incomes and food and nutrition security in their households.
- The government should empower women to enable them to have access to key agricultural resources such as land, seeds, credit, and irrigation equipment as men to improve the level of adoption and labor productivity in maize production.

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