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Determinants of Adoption of Early Maturing Maize Varieties in Nzega District, Tabora Region

Donatha Raphael Dunda[1*], Damas Philip[2], Elimboto Muna[3]

[1]Department of Agricultural Economics and Agribusiness Sokoine University of Agriculture (SUA), P. O. Box 3007, Morogoro, Tanzania

[2]Department of Agricultural Economics and Agribusiness Sokoine University of Agriculture (SUA)
donatha.dunda[at]torita.or.tz

[3]Research Department, Tobacco Research Institute of Tanzania (Tabora)
elimboto.ibrahim[at]torita.or.tz

Abstract: ***Nzega is the districts located in semi-arid areas of Tanzania where drought is a limiting factor. In the district farmers are advised to use early maturing maize varieties (EMMV).*** **The adoption of EMMV in Nzega District is still low. Increase in use of EMMV is possible if factors which influence adoption are addressed. The study aims at identifying** ***challenges facing efforts of promotion adoption of EMMV. The paper identifies*** **determinants of adoption and level of adoption of** ***EMMV. The paper uses data collected from a total of 150 maize farmers consisting of adopters and non-adopters. Multistage random sampling technique was used to select maize farmers from 10 villages. Data were collected using a structured questionnaire. Cragg's double hurdle model was used in determining factors affecting adoption decision and the level of adoption. Results show that extension services, education level and size of the farm owned by the farmer, farmers income and distance to the nearest market were significant in affecting adoption decision and the level of adoption. Therefore, the adoption of EMMV can be attributed to institutional and socio-economic factors. The Government should put more effort in improving extension services, markets and provision of input subsidies for maize farmers.***

Keywords: Factor for adoption, early maturing maize varieties, Probit model, Gragg's, double hurdle

1. Introduction

Maize is a cereal crop which is produced on nearly 100 million hectares in developing countries, with almost 70% of the total maize production in the developing world coming from lower-and middle-income countries FAOSTAT (2012). In Sub-Saharan Africa maize is a staple food for more than 300 million people.

In Tanzania, maize is the major staple food. The crop is grown in almost every region in Tanzania mainland. On land basis, it occupies more than 80% of the land planted to cereals and is grown by over 80% of the farming community as food (Matata, 2011)

In recent years, rainfall patterns have become erratic and unpredictable. Erratic rainfall poses a big challenge for farmers growing maize because most of them practice rain-fed agriculture. On the other hand, high population growth demands for an increase in maize productivity. Therefore, there is a need to promote varieties like early maturing maize varieties which can do well in drought prone areas.

These varieties were introduced in the area during the 2000/2001 production season. But the adoption rate is still very low of about 35% only (Bucheyeki, 2012) currently, there is no research which has been done to determine the factors which have led to the low adoption rate for early maturing maize varieties in Nzega district.

2. Material and Methods

In this study data on factors which influence adoption of early maturing maize varieties were gathered from Nzega District in Tabora Region. The district receives low rainfall of around 650-850mm in the District drought and poor soil are limiting factors for agriculture development (Pauw, 1984) In the district, maize has a high risk of failure, as it requires higher rainfall. Due to this the government of Tanzania through Tumbi Research Institute in Tabora introduced early maturing maize varieties in the Nzega district.

Early maturing maize varieties are those varieties which can take two and a half to three month to mature and are recommended to be grown in short rain zones. These varieties are like kilima St, Kito St, Situka and TMV1. Due to the climatic condition of the district farmers are advised to grow early maturing maize varieties but the adoption rate of those varieties is low. (Bucheyeki, 2012) in his study found that the rate of adoption of improved varieties in Nzega District was 35%.

Cross-section research design was used. In this design data were collected at a single point in time. The study involves both primary and secondary data of farmers who grow maize, and specifically farmers who use early maturing maize varieties. Primary data were collected from farmers through direct interview. Secondary data were obtained from District Agricultural Office in Nzega, Tabora. Secondary data involve the potential yield of early maturing maize varieties. A total of 150 maize growers were used for this study. These farmers were obtained through multistage random sampling procedure. Samples of 150 farmers were obtained from the following procedure;

2.1 Sample Size and Sampling Procedure

Determination of sample size was done by estimating proportions of the population. That is determining the proportions of the population using and not using early maturing maize varieties. Desired sample size was determined by the following formula put forward by (Kothari, 2004).

Where;
n= sample size, z = z score, p = proportion of the population, q = 1-p, e is the allowable error and, N is the population size. Kothari (2004) recommends p to take the value of 0.5, q= 1-0.5 = 0.5, N =1500 and N-1= 1499, z = 2.576 at 99% z score and e = 10%.

Therefore

$$n = \frac{z^2.p.q.N}{(N-1)(e)^2 + (z^2).p.q} \quad \text{.....(1)}$$

$$n = \frac{2.576^2 * 0.5 * 0.5 * 1500}{1499*0.1^2 + 2.576^2 * 0.5*0.5}$$

= 149.46 Approximately 150 farmers.

2.2 Analytical Framework and Model Specification

Data analysis involves descriptive statistics and regression model. Descriptive analyses such as frequency distribution tables, percentage, mean, standard deviation were used to analyze the respondent's socio-economic characteristics. In the regression, Gragg's Double Hurdle Model which consists of two stages has been used. The Probit model was used to determine the probability of adoption of early maturing maize varieties, the second stage of Gragg's model was a truncated regression which was used to determine factors affecting level of adoption, dprobit analysis was done in order to find the marginal effect for each independent variable.

2.3 Factors affecting adoption and level of adoption

Crag's double-hurdle model was used in finding factors affecting adoption and level of adoption as proposed by (Martínez, 2006) the method is because, according to (Cragg, 1971) a farmer faces two questions while deciding to adopt a certain technology. First is to decide whether to use the new technology and second is how much land to allocate to those improved varieties.

The most important underlying assumption under Cragg's double hurdle model is that the two decisions are made in two different stages but the first decision affect the second decision, in this case the error term are randomly distributed with mean 0 and standard deviation of δ^2.

$£_i \sim N(0, 1)$ and $\mu_i \sim N(0, \delta^2)$ where;
£ is the error term from the decision equation, μ is the error term from the second question (The truncated equation)

The relation of the two error term can be written as follows;

$$P = \frac{cov(£_i \mu_i)}{\sqrt{Var(£i)\ Var(\mu i)}}$$

Smith, (2003) assumes that the error term from decision one and two are randomly distributed and independently, this gives us the following expression;

$$\begin{pmatrix} £_i \\ \mu_i \end{pmatrix} \quad N \quad \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad \begin{pmatrix} 1 & 0 \\ 0 & \delta^2 \end{pmatrix}$$

Cragg's double-hurdle model, allows separate stochastic processes for the adoption decision and level of adoption. Also Cragg's double-hurdle model accommodates both non normality and heteroskedasticity of the error terms.

2.4 Model specification for factors affecting adoption

The first stage of Cragg's model is a Probit model which is used to analyze determinants of adoption of early maturing maize varieties. This model can be written as;

$yi = y^*$ if $y^* > 0$ ..... (2)
$yi = 0$ if $y^* \leq 0$ ..... (3)

$$yi^* = \beta_0 + \beta_1\chi_1 + \beta_2\chi_2 + \beta_3\chi_3 + \beta_4\chi_4 . + ...\beta_n\chi_n \quad \text{..... (4)}$$

yi* is the dependent variable describing the farm's decision to adopt the technology, taking numeric value of 1 for adopters, and 0 for non-adopters, xi is a vector of variables explaining whether a farmer adopts early maturing maize varieties and vi is the error term.

The hypothesized list of variables includes gender of the household head, age of the household head, education of the household head, farmer (years of formal schooling); farmer's access to credit facilities available in the locality (dummy, 1=farmers have access, and 0 otherwise). Detailed model with hypothesized variables is as follows:

$$\text{Adoption or } Y_i = \beta_{1AGE} + \beta_{2GEN} + \beta_{3EDU} + \beta_{4HHL} + \beta_{5HHDR} + \beta_{6LAND} + \beta_{7EXT} + \beta_{8CRED} + \beta_{9NL} + \beta 11FGR + \beta_{12INC} + \beta_{13DIM} \quad \text{..... (5)}$$

Where;
AGE = Age group of the household head (Two groups Young +middle aged= 0, Elders= 1). Young and middle those aged <40 years, elder >40 years

GEN= Gender of the household head (1= Male, 0=female), EDU= Education of the household head (1 if secondary school and above, 0 otherwise) HHL= Family labour (Measured through using adult equivalent scale), HHDR= Household dependency ratio, FARMSIZE = (1= if large scale farmer > 5ha, 0 otherwise), EXT = Extension services (1=Yes, No=0), CRED =Access to credit (1= yes, 0= otherwise), NL =Number of livestock kept (Measured in Tropical livestock unit), INC =Income from other crop (Tshs), FGR = group or organization membership (1=yes, 0=no), DIM =Distance to the nearest market (km)

2.5 Model specification for factors affecting level of adoption

Second stage of Cragg's model was a truncated equation because it includes adopters only. This analysis was used to find factors affecting the level of adoption. The model in the second stage can be written as;

$$y_i^* = \beta x_i + \varepsilon_i, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$y^* = \beta_0+\beta_{1educ} +\beta_{2farmsize} +\beta_{3Ext} +\beta_{4Cred} +\beta_{5NL} +\beta_{6Inc} +\beta_{7Fgr} + \varepsilon_i \ldots\ldots\ldots\ldots\ldots (7)$$

yi* is the variable describing the level of adoption. The level of adoption is measured by using the ratio of quantity of land under early maturing maize varieties to total farm land for maize, xi is a vector of variables explaining level of adoption, these variables are education of the household head, access to credit, availability of extension services, land size owned by a farmer, and membership to any group and εi is the error term. Equations 5 and 7 are assumed to be independent, and the error terms are randomly and independently distributed, vi ~ N (0, 1) and εi ~ N $(0, \sigma^2)$)

2.6 Data Processing and Analysis

Survey data were coded and summarized in Statistical Package for Social Science software version 16 (SPSS), before being transferred to STATA 11 software for analysis. Descriptive statistics such as mean and standard deviation were computed. Econometric analysis was done in finding factors affecting adoption and factors affecting level of adoption using Cragg's double hurdle model.

3. Results and Discussion

3.1 Econometric Results

The results from the present study show that the coefficients for most of the variables hypothesized to influence the decision to adopt and the level of adoption for early maturing maize varieties have the expected signs. The Probit results show factors affecting adoption decision of early maturing maize varieties and the truncated regression analysis results show factors affecting the level of adoption.

3.2 Factors affecting adoption of early maturing maize varieties

The results in Table 2 show that nine factors have significant influence on farmers' decision to adopt early maturing maize varieties. These factors are gender of the household head, education level of the household, household labour, household dependency ratio, income from other crops, livestock unit owned, farm size, access to extension services and membership to any rural group or organization. The log likelihood for the fitted model is-49.35 and the χ^2 value of 92.5 indicates that all parameters are jointly significant at 5%, and Pseudo R^2 = 0.48. All variables were tested at three different levels of significance which are 1%, 5% and 10%. The results show that gender of the household head, education level of the household head, household dependency ratio, farm size, family labour, livestock unit, extension services, income from other crop and group affiliation were significant in influencing adoption of early maturing maize varieties.

Table 2: Prohibit regression results showing factors affecting adoption of early maturing maize varieties in Nzega Tabora

y_hat	Coef	Std err	Z	P>|z|
Gender of HHH	0.5741273***	0.1557283	3.69	0.005
Age of HHH (1if >40, 0 if <40)	-0.5377014	0.1642993	-3.27	0.001
Education (1if Secondary and above, 0 if primary and below)	0.5718046***	0.1910345	2.99	0.003
Family labour	0.4747075***	0.1560339	3.04	0.002
HH dependency ratio	0.8538828***	0.1890821	4.52	0.000
Farm size	0.8126428***	0.1998083	4.07	0.000
Income from other crop	0.4897618***	0.1580107	3.10	0.002
Livestock unit of the hh	0.4839161***	0.1558202	3.11	0.002
Group affiliation	0.2022994**	0.1688977	1.20	0.023
Access to extension	0.5061181***	0.1700476	2.98	0.003
Distance to the market	-0.0909082	0.1551252	-0.59	0.558
-Constant	-0.8688227	0.1740743	-4.99	0.000

* means significant at ***=1%, **= 5%, * = 10% level of significance
Log likelihood =-49.349383 Pseudo R2 = 0.4831
Number of observation = 150 Prob > chi2 = 0.0000
LR chi2 (12) = 92.26

The results in Table 2 show that age has a negative relationship with the decision to adopt early maturing maize varieties. This imply that younger farmers are more willing to adopt early maturing maize varieties than older farmers. These findings are similar to those found by (Langyintuo A. a., 2005) (Rahelizatovo, 2004) and; (Barham, 2004). Also family labour has a positive and significant influence on adoption. Increase in household labour increases the level of adoption of early maturing maize varieties (Feder, 1985). The results in Table 2 show that household dependency ratio has a positive and significant influence on the adoption of early maturing maize varieties. The reason behind is that big ratio means larger number of dependants within the household, this will motivate the household head to opt for early maturing varieties which have high yielding ability in order to fulfill the requirement of the family.

The result presented in Table 2 show that farmer's affiliation to an organization influence adoption decisions. This is likely to be due to the fact that affiliation to any group or an organization is a social capital. Organization enables farmers to learn about agricultural technologies, share experiences and exchange ideas about agricultural technologies with other farmers (Sall, 2000)

Access to extension services has been found to influence adoption of early maturing maize varieties positively. This is because extension agent plays a very great role in the implementation and diffusion of innovation. Also (Abebaw, 2001) in the study of "Factors influencing adoption of high yielding maize varieties in Southwestern Ethiopia" found a positive influence of extension services and adoption of high yielding maize varieties.

The results show that gender of the household head (whether the head is male or female) influence adoption of early maturing maize varieties. The result in Table 2 show that male headed household are more likely to adopt early maturing maize varieties while female headed household has a negative influence. This is because according to the culture and norms of many societies women have less access to resources like land. Also Lopes (Lopes, 2010) in his study on adoption of improved maize and common Bean varieties in Mozambique found that the rate of adoption for female headed household is low because women have less access to external inputs, services, and information due to socio-cultural values.

The results in Table 2 show that, income from other crops has positive and significant influence on adoption of early maturing maize varieties. Income from other crops increases capital to the farmer which boosts adoption by enabling him/her to have the capacity to purchase technology and associated inputs which can be used in implementing the technology (Karanja, 2002)) and (Govereh, 2003).

The results in Table 2 show that, distance to the market draws a negatively result in adoption of early maturing maize varieties because these varieties have high yielding ability which enable the farmer to have surplus for selling. If the market where a farmer can sell those surplus is far this will have a negative influence in adopting high yielding varieties. This was also reported by (Sserunkuma, 2005) (Langyintuo A. a., 2008) and (Salasya, 2007) who found a negative correlation between distance to the nearest market and adoption of technology. It is generally perceived that the shorter the distance from the household to the nearest market, the higher the probability of adoption.

The results in Table 2 show that education level has a positive influence in adoption of early maturing maize varieties. This is because more educated household head are expected to understand new technologies in a shorter period of time and implement the technology than those with poor education (Paudel, 2008) (Kudi, 2011). The results in Table 2 show that, livestock has a positive influence to the adoption of early maturing maize varieties as it was expected. Livestock stand for wealth in most African societies. In general rich farmers are better placed in terms of risk bearing (Gregory, 2013).

The results in Table 3 show that farm land has a positive influence in adoption of early maturing maize varieties. This is because farmers with large pieces of land can afford to be more experimental because for them even a more relatively small percentage of their total land may be large enough to support land-intensive technology. This results are similar to those found by (Simtowe, 2007) ((Langyintuo A. a., 2008) This is because large scale farmer are good risk taker because they can devote a relatively small percentage of land to new technology while still having enough land for their traditional varieties.

Table 3: Maximum likelihood estimates of double hurdle models for adoption decision and level of adoption

Variable Name	Coefficient of 1st hurdle	Marginal Effect	Coefficient of 2nd hurdle
Gender of HHH	0.5741273	0.167464	2.270161
Age of HHH (1if >40, 0 if <40)	-0.5377014	-0.1568392	4.526882
Education (1if Secondary and above, 0 if primary and below)	0.5718046	0.1667866	0.041469**
Family labour	0.4747075	0.1384648	1.901119
HH dependency ratio	0.8538828	0.2490644	0.582329
Farm size	0.8126428	0.2370353	2.202941*
Income from other crop	0.4897618	0.1428559	0.8613107
Livestock unit of the hh	0.4839161	0.1411508	0.3525893
Group affiliation	0.2022994	0.0590076	0.7855627
Access to extension	0.5061181	0.1476268	2.281675**
Distance to the market	-0.0909082	-0.0265165	-0.37689
-Constant	-0.8688227		10.01998

R- Squared= 0.6292, *Adj R-Squared*= 0.5090

4.3 Determinants of the Level of Adoption

Three variables were found to have significant effects in explaining the level of adoption of early maturing maize varieties. These variables were education level of the household head, access to extension services and farm size.

The results in the second stage of Cragg's model (second hurdle) in Table 3 show that access to extension services was statistically significant in explaining the level of adoption as it was expected, also (Tesfaye Z., 2001); (Habtemariam, 2004) in their study found similar results. Extension services enable farmers to get exposed and more familiar with new varieties. Extension services create awareness and build the necessary knowledge for using the innovation.

Results in Table 3 show that farm sizes have a significant influence in explaining the level of adoption of early maturing maize varieties. The reason behind is that large scale farmers have the ability to expand areas for the introduced varieties due to the available land. Also farmers with large land holdings are more likely to acquire credit which could help in buying inputs like fertilizer and pesticides. Positive influence of farm size to level of adoption was also explained by (Feder, 1985) who found that farm size may be a surrogate for other factors such as wealth, access to credit as well as access to information. Also (Rogers, 1995) point out that adopter categories and farm size are interrelated. Rogers (Rogers, 1995) explain that innovators and early adopters have higher social status as measured by variables such as income and wealth, have large farms, tends to be commercial farmers rather than subsistence farmers and are likely to have greater association with extension officers. Hence large farm size has a positive and significant influence on the level of adoption.

The results in Table 3 show that, education of the household head has a positive influence on the level of adoption of early maturing maize varieties because educated farmers are more capable than uneducated farmers in processing information, allocating inputs efficiently, and assessing the profitability of new technologies. Once the farmer has accessed the profitability of the technology and has knowledge on how to allocate input then the probability of increasing the level of adoption is higher than the farmer with low education. (Adegbola, 2007) in the study titled "The effect of information sources on technology adoptionn and modification decision" found positive relation between education level and the level of adoption of agriculture technology.

4. Conclusions and Recommendations

The main objective of the present study was to identify determinants of adoption of early maturing maize varieties in Nzega District. The major findings from the study were as follows;

The major factors which were found to influence adoption of early maturing maize varieties were extension services, markets access and farmers income. Based on these findings the following should be done;

Since agriculture extension influence adoption of innovations, there is a need to strengthen agriculture extension services in the villages, the focus should be more on training extension agent and also increasing extension agent capacity to reach farmers through provision of transport and housing.

Income in terms of livestock, farm size and other crops increases adoption by enabling famers to buy inputs like fertilizer and pesticides, therefore, the government should provide input subsidies to farmers in Nzega District.

Formal markets also influence adoption of early maturing maize varieties. The government should construct rural roads in order to make transport of product produced to the market possible.

References

[1] Abebaw, D. Belay, K. (2001). Factors influencing adoption of high yielding maize varieties in southwestern Ethiopia: An application of logit. *Quarterly Journal of International Agriculture* 40 (2): 149 – 167.

[2] Adegbola, P. and Gardebroek, P. (2007). The effect of Information sources on technology adoptionn and modification decision. *Journal of the International Association of Agricultural Economists* 37 (1): 55 – 65.

[3] Aristei, D. and Pieroni, L. (2008). A double-hurdle approach to modelling tobacco consumption in Italy. *Journal of Applied Economics* 40 (19): 2463 – 2476.

[4] Barham, B. L., Foltz, J. D., Jackson-Smith, D. and Moon, S. (2004). The dynamics of agricultural biotechnology adoption: Lessons from rBST (recombinant Bovine Somatotropin) use in Wisconsin, 1994-2001. *American Journal of Agricultural Economics* 86 (1): 61 – 72.

[5] Bucheyeki, T. L. (2012). Characterization and genetic analysis of maize germ plasm for resistance to Northern Corn Leaf Blight Disease in Tanzania. Thesis for Award of PhD Degree at University of KwaZulu-Natal, Pietermaritzburg, South Africa, 183pp.

[6] Cragg, J. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica*39: 829 – 844.

[7] FAOSTAT (2012). FAOSTAT Database. [http: //faostat. fao. org] site visited on 20/9/2013.

[8] Feder, G., Just, R. E. and Zilberman, D. (1985). Adoption of agricultural innovations in developing countries*:* A survey. The University of Chicago. *Economic Development and Cultural Change* 33: 255 – 297.

[9] Govereh, J. and Jayne, T. S. (2003). Cash cropping and food crop productivity: synergies or trade-offs? *The Journal of International Association of Agricultural Economics* 28 (1): 39–50.

[10] Gregory, T. and Sewando, P. (2013). Determinants of the probability of adopting quality protein maize technology in Tanzania: A logistic regression analysis. *International Journal of Development and Sustainability* 2 (2): 1 – 18.

[11] Habtemariam, A. (2004). The comparative influence of intervening variables in the adoption behavior of maize and dairy farmers in Shashemene and DebreZeit, Ethiopia. Thesis for Award of PhD Degree at, University of Pretoria, South Africa, 201pp

[12] Karanja, M. A. (2002). Liberalisation and smallholder agricultural development: a case study of coffee farms in Kenya. Thesis for Award PhD Degree at Wageningen University, The Netherlands, 203pp

[13] Kothari, C. R. (2004). *Research Methodology Methods and Techniques*. (3rd Ed.), New Age Publisher, New Delhi, India.401pp.

[14] Kudi, T., Bolaji, M., Akinola, M. and Nasa'l, D. H. (2011). Analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria. *International Journal of Peace and Development Studies* 1 (3): 8 – 12.

[15] Langyintuo, A. and Mekuria, M. (2008). Assessing the influence of neighborhood effects on the adoption of improved agricultural technologies in developing agriculture. *African Journal of Agricultural and Resource Economics* 2 (2): 151 – 169.

[16] Langyintuo, A. S. and Mulugetta, M. (2005). *Modelling Agricultural Technology Adoption Using the Software STATA*. International Maize and Wheat Improvement Center, Harare, Zimbabwe.29pp

[17] Martínez, E. R. (2006). A Box-Cox double-hurdle model of wildlife valuation: the citizen'sperspective. *Journal of Ecological Economy* 58 (1): 192 – 208.

[18] Matata, P. Z., Gama, B. M., Mbwaga, A., Mpanda, M. and Byamungu, D. A. (2011). Effect of Sesbaniasesban fallows on Striga infestation and maize yield in Tabora Region of Western Tanzania. *Journal of Soil Science and Environmental Management* 2 (10): 311–317.

[19] Paudel, P. and Matsuoka, A. (2008). Factors influencing improved maize varieties in Nepal: A case

study of Chitwan district. *Australian Journal of Basic and Applied Sciences* 2 (4): 823 – 834.

[20] Pauw, D. (1984). *Soils, Physiography and Agro Ecological Zones of Tanzania.* Ministry of Agriculture and Cooperative, Dar es Salaam, Tanzania.158pp

[21] Rahelizatovo, N. C. and Gillespie, J. M. (2004). The adoption of best-management practices by louisiana dairy producers. *Journal of Agriculture and Applied Economics*36: 229 – 240

[22] Salasya, B., Mwangi, W., Mwabu, D. and Diallo, A. (2007). Factors influencing adoption of stress-tolerant maize hybrid (WH 502) in western Kenya. *African Journal of Agricultural Research* 2 (10): 544 – 551.

[23] Sall, S., Norman, D. and Featherstone, A. M. (2000). Quantitative assessment of improved rice varieties adoption in Senegal: Farmers' perspective. *Journal of Agricultural Systems* 66 (2): 129 – 144.

[24] Simtowe, F., Mduma, J., Phiri, A., Thomas, A. and Zeller, M. (2007). Can Risk-aversion Towards Fertilizer Explain part of the Non-adoption Puzzle for Hybrid Maize? Empirical Evidence from Malawi. *Journal of Applied Sciences* 6 (7): 1490 – 1498.

[25] Sserunkuma, D. (2005). The adoption and impact of improved maize and land management technologies in Uganda. *Journal of Agricultural and Development Economics* 2: 67 – 84.

[26] Tesfaye Z., Bedassa, T. and Shiferaw, T. (2001). Determinants of adoption of improved maize technologies in major growing Region of Ethiopia. *Second National Maize Workshop*, Ethiopia.12 – 16 November 2001. pp.125 – 136.

[27] Wooldridge, J. W. (2002). *Econometric Analysis of Cross Section and Panel Data.* MIT Press, Cambridge.741pp.