Household Resource Endowment and Determinants of Adoption of Drought Tolerant Maize Varieties: A Double-hurdle Approach

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Abstract

Existing literature suggests the influence of household wealth on farmer's technology adoption decisions. In 2007, this study was conducted to provide a clearer understanding of how differences in household wealth affect the way in which other variables influence adoption decisions. Using data from 369 households in Adama and Adami Tulu Jido Kombolcha districts of Ethiopia, the paper first stratified households into poorly and well-endowed categories based on wealth indices constructed using their productive assets by the principal components method. A double hurdle model was then specified and estimated for each wealth group to assess factors influencing the adoption and use intensity of improved varieties. The results suggest that factors influencing the adoption and use intensity of improved maize varieties among the 61% of the poorly endowed households differed from those observed for the well endowed households. The results, therefore, draw attention to the need to design wealth group specific interventions to improve the adoption and use intensity of improved maize varieties among farmers in the two and similar districts of Ethiopia.

Keywords: Wealth index, double-hurdle model, Ethiopia
JEL:

1. Introduction

Maize is an important cereal crop in Ethiopia as a source of food and cash. In terms of area coverage on a national basis, it is the second next to tef *(CSA, 2007*). It constitutes 20 % (1.69 million hectares) of the total area under cereals production in 2006/07 season. Annual production is more than 3.8 million tones, accounting for nearly 29 % of the total cereal production in the country. Average yields have also increased from 0.96t/ha in early 1960s to 2.23 t/ha in 2007, growing at an annual rate of 1.62 %. As much as 40% of the total maize cultivated area is drought prone regions (Mandefro, 2001), therefore, developing and deploying drought resistant varieties to increase productivity under drought conditions has a direct impact on the livelihood of households depending mainly on maize.

Since the inception of formal maize research in Ethiopia in 1952 (Tesfaye et al., 2001), about 30 maize varieties have been developed by the national research system but the extent of their adoption by farmers is not known. Existing literature (Adesina and Zinnah, 1993; Smale et al., 1994; Morris et al. 1999; Doss et al., 2003; and Moser and Barrett, 2005) suggest that access to credit has an impact on the adoption of improved technologies because it relaxes households' liquidity constraints (Bhalla, 1979) as well as boosts the their risk bearing ability (Hardaker *et al*., 1997). Among rural Ethiopian households as in many other developing countries, however, credit is hardly available for varied reasons (Lowenberg-DeBoer, *et al*., 1994). Consequently, households depend on their wealth (mainly productive assets) to chart a route out of poverty (Moser, 1998; Freeman *et al*, 2004; Ellis and Bahiigwa, 2003). The purpose of this study is to assess the level and factors affecting the adoption and intensity of use of improved maize varieties by different wealth groups in selected districts of Ethiopia. The results of this study would be important in designing research and policy interventions to improve the adoption and impacts of improved maize varieties in the country.

The rest of the paper is organized as follows. The next section presents the methodology used in data collection and analysis. This is followed by discussion on the estimated results. The last section presents some concluding remarks and policy implications of the results some concluding remarks and policy implications of the results.

2. **Materials and Methods**

2.1. Sampling and Data Collection

This study was conducted in Adami Tulu Jido Kombolcha (ATJK) and Adama districts of East Shewa zone in Ethiopia, in 2006/2007. Based on the relative proportions of maize in the two districts, a multistage random sampling technique was used to select sample of 196 and 173 sample households in 11 villages in ATJK and 9 in Adama districts, respectively. Interviews were conducted by trained enumerators using structured questionnaires with a response rate of 100%.

2.2. Data analysis

In this study, Principal Component Analysis (PCA) and Double-hurdle regression models were used to analyze the data. The PCA, as detailed in Filmer and Prichatt (2001), Zeller et al. (2005) and Langyintuo and Mungoma (2008), was used in computing wealth indices to categorize households according to their resource endowments, while the double hurdle model was used to analyze factors influencing the probability of adoption and intensity of use of the adopted varieties.

.The double-hurdle model is a parametric generalization of the Tobit model, in which two separate stochastic processes determine the decision to adopt and the level of adoption of the technology (Green, 2000). The double-hurdle model has an adoption (D) equation:

$$\left.\begin{array}{l} D_i = 1 \quad if \quad D_i^* > 0 \\ D_i = 0 \quad Otherwise \\ \\ D_i^* = \alpha^{'} Z_i + u_i \end{array}\right\} \qquad (1)$$

where D^* is a latent variable that takes the value 1 if the farmer adopts improved maize varieties and zero otherwise, Z is a vector of household characteristics and α is a vector of parameters. The level of adoption (Y) has an equation of the following:

$$Y_i = \begin{cases} Y_i^* = \beta^{'} X_i + v_i & if \quad Y_i^* > 0 \ \ and \ \ D_i^* > 0 \\ 0 & otherwise^{'} \end{cases} \qquad (2)$$

where Y_i is the observed answer to the proportion of area planted with improved maize varieties, X is a vector of the individual's characteristics and β is a vector of parameters.

The error terms, u_i and v_i are distributed as follows:

$$\left.\begin{array}{l} u_i \sim \mathrm{N}(0,1) \\ \mathrm{v_i} \sim \mathrm{N}(0,\sigma^2) \end{array}\right\} \qquad (3)$$

The log-likelihood function for the double-hurdle model is:

$$LogL = \sum_0 \ln\left[1 - \Phi\left(\alpha_i Z_i^1\right)\left(\frac{\beta X_i^{'}}{\sigma}\right)\right] + \sum \ln\left[\Phi\left(\alpha Z_i^{'}\right)\frac{1}{\sigma}\phi\left(\frac{Y_i - \beta X_i^{'}}{\sigma}\right)\right] \qquad (4)$$

Under the assumption of independency between the error terms v_i and u_i, the model (as originally proposed by Cragg, 1997) is equivalent to a combination of a truncated regression model and a univariate probit model. The Tobit model arises if $\lambda = \frac{\beta}{\sigma}$ and X = Z. A simple test for the double hurdle model against the Tobit model can be used. It can be shown that the Tobit log-likelihood is the sum of the log-likelihood of the truncated and the probit models. Therefore, one simply has to estimate the truncated regression model, the Tobit model and the probit model separately and use a likelihood ratio (LR) test. The LR-statistic can be computed using (Green, 2000) as:

$$\Gamma = -2\left[\ln L_T - \left(\ln L_p + \ln L_{TR}\right)\right] \sim \chi_k^2 \quad (5)$$

Where L_T = likelihood for the Tobit model; L_P=likelihood for the probit model; L_{TR}= likelihood for the truncated regression model; and k is the number of independent variables in the equations. If the test hypothesis is written as Ho: $\lambda = \frac{\beta}{\sigma}$ and $\lambda \neq \frac{\beta}{\sigma}$. Ho will be rejected on a pre-specified significance level, if $\Gamma \succ \chi_k^2$.

3. Results and Discussions

3.1 Computing Wealth Indices by the PCA method

Households are endowed with different assets which are measured in different units. In order to simplify the categorization of households according to their wealth endowment, a PCA was run on 19 selected asset indicators which were perceived to be better indicators of wealth in their communities (Table 1). Nineteen components were extracted in the first stage of PCA but only eight were significant (based on the kieser Criterion of an eigen value greater than one). The eigen value is a measure of standard variance with a mean of zero and standard deviation of 1. Each standardized variable contributes at least the variance of 1 to the principal components extraction (Filmer and Pritchet, 2001). The first component was used in constructing the index because it explained 21% of the total variance in the 19 indicators and gave positive weight for all of them. The assigned weights were used to construct an overall standardized composite wealth index. Households were then ranked from highest to least composite wealth index. Accordingly, about 61% of the sample households were found to have negative wealth indices and categorized as poorly endowed while the remaining 39% of households with positive wealth indices were categorized as well endowed (Figure 1). With the sample index mean of 0, the mean index for poorly endowed households was -0.62 while that for the well endowed households was 0.96.

[Table 1 about here]

[Figure 1 about here]

The score from the PCA process divided by the corresponding standard deviation of each asset generates an impact indicator, which indicates the relative adjustment of the wealth index by acquiring the corresponding asset. Assets with top impact factors could be used in stratifying households in similar communities according to wealth but the number chosen is purely based on judgment. However, Langyintuo and Mungoma (2008) found out that three or four work very well. In this analysis, the four top assets with the largest impact factors are total cropped land, total farm size, mobile telephone, and draught animal.

3.2. Determinants of adoption of improved maize seed

3.2.1. Choice of variables for the empirical adoption model

The data reveal that 53% of the well endowed households have adopted improved maize varieties and planted them on 31% of their cultivated land. On the other hand, 47% of the poorly endowed households adopted IHYM varieties and 30% of their cropped land is covered with these varieties. About 50% of the whole sample farmers have adopted improved maize varieties and planted them on 29% of their cropped field.

The observed adoption choice of an agricultural technology is hypothesized to be the end result of socio-economic characteristics of farmers and a complex set of inter-technology preference comparisons made by farmers (Adesina and Forson, 1995). Several hypotheses can be derived on the decision factors that affect the probability and intensity of adoption of improved maize varieties (Table 2). In this study, the following hypotheses are used as a priori expectations:

- *Farmer's age* may negatively influence both the decision to adopt and extent of adoption of improved maize varieties. It is hypothesized that older farmers are more risk averse and less likely to be flexible than younger farmer counterparts and thus have a lesser likelihood of adopting new technologies.
- *Family size*, a proxy to labor availability, may influence the adoption of improved maize varieties positively as its availability reduces the labor constraints faced in maize production.
- *Education* augments one's ability to receive, decode and understand information relevant to making innovative decisions (Wozniak 1984). Thus, it is hypothesized that farmers with more education are more likely to be adopters than farmers with less education.

- The *availability of credit* may positively influence adoption of improved maize varieties by relaxing the binding capital constraints that farmers face through financing the variable costs associated with production of improved maize varieties.
- *Agricultural extension* may also enhance the efficiency of making adoption decisions. Based on the innovation-diffusion literature (Adesina and Forson 1995), it is hypothesized that extension visit is positively related to adoption by exposing farmers to new information and technical skills.
- The *availability of off-farm income* can affect the probability of adoption positively since it can increase the farmer's financial capacity to pay for improved inputs.
- *Seed cost*: since improved seeds are more expensive relative to local seeds, seed cost is hypothesized to be negatively influence the adoption of farmers.
- *Seed availability*: in order to make use of technologies, farmers should be able to get seeds either in the formal or informal distribution systems. Thus, seed availability is hypothesized to positively influence the adoption of IHYMVs.
- *Price* in the grain market has also a direct impact on the adoption behavior of farmers. If farmers perceive that there will be attractive price for the grain, the probability of adoption and proportion of maize area under the IHYM varieties will increase.
- *Tolerance*: if farmers perceive that a certain variety has better diseases, pests, and lodging tolerance, there will be higher probability for adoption of such varieties.
- Better *yield potential* and *storability*, early *maturity* and *tolerance to poor soil fertility conditions* are hypothesized to be positively related to the probability and use intensity of IHYM varieties. If farmers perceive that improved varieties have

larger seed and cob sizes and are more palatable than the local varieties, rate and intensity of adoption are expected to be higher.

[Table 2 about here]

3.2.2. Empirical Results and Discussion

Factors affecting the probability of adoption and use intensity of IHYM varieties are separately discussed in this section based on the results of the double hurdle model presented in Table 3. Only variables that are statistically significant in any of the models are presented.

[Table 3 about here]

Factors influencing the probability of adopting IHYM varieties

The empirical results indicate that gender of household heads, number of extension visit, perception of farmers about seed availability, field pest resistance and early maturity are statistically significant in influencing the probability of adoption of IHYM varieties for the whole sample and poorly endowed households. None of the explanatory variables are significantly affecting the probability of adopting IHYM varieties for the well endowed households. The influence of gender on probability of adoption is through its effect on control over resources in which female headed households have poor access and control over resources in general and have shortage of farm labor in particular.

Number of extension visits is significant in affecting the probability of adoption of IHYM varieties at 1% level for poorly endowed households and 10%

level for the whole sample. An interesting thing with the effect of extension contrast is the sign of the coefficients. Contrary to a priori expectation, extension visit is found to negatively affect the adoption of IHYM varieties. This is related to the involvement of extension workers into input credit provision and collection of the loan. The defaulting farmers usually avoid extension workers in order not to be asked about their debt and abandon the messages they deliver too. The effect of extension visit is not significant for the well endowed households probably because these are households that follow market price movement and adopt technologies irrespective of the effort made to disseminate the technologies through the extension system.

Seed availability significantly influences the probability of adoption of IHYM varieties at 1%level for the whole sample and 10% level for the poorly endowed households. This could be because maize seed is available either through the extension system or the cooperatives. Both sources are accessible to all members of the community on quota basis.

The perception of farmers on the early maturity of varieties significantly influences the probability of adoption only for poorly endowed households. Maize can be harvested green and consumed while other crops are at their early growth stage when households run out of their food reserve. This is the most important concern for households that are poorly endowed and have problem of food insecurity.

Factors influencing the intensity of use of IHYM varieties

The second hurdle of the model examined the adoption intensity of IHYM varieties as presented in the second section of Table 3 and the marginal effects in Table 4. The marginal effects are used to calculate percentage changes in the dependent variable when the exogenous variable shifts from zero to one for categorical variables and elasticities at the sample means for continuous variables.

[Table 4 about here]

After adoption of the technologies, number of extension contacts is no longer significant in determining the area allocated to the variety. The influence of gender is significant at 10% level for the whole sample only because males have better access to land and have adopted an IHYM variety is willing to expand the area under the crop. Family size is found to significantly and negatively influence the intensity of adoption of improved maize varieties for the whole sample and well endowed households. If household size increases by one person, the area allocated to the variety decreases by 1.2%. On the other hand, age of household head is a positive and significant determinant of the intensity of adoption of IHYM varieties for the whole sample and poorly endowed group. If the age of a household increases by one year above the average age of the group (42 years), the area of improved maize variety increases by 1% for poorly endowed households. Similarly, livestock ownership (sometimes a proxy for wealth accumulation) is found to positively and significantly influencing the intensity of use of improved maize varieties for well endowed households. Each additional one TLU of livestock that a household owns increases the area allocated to improved maize varieties by 5% for well endowed households. Contrary to this, farm size is found to negatively and significantly influence the intensity of use of IHYM varieties for poorly endowed households. As farm size increases by one hectare (above 1.8 ha of the group), the area of improved maize varieties decreases by 14%. What this seems to suggest is that farmers with relatively smaller farms are more willing to adopt IHM varieties to increase total maize production. In contrast, those with larger fields can meet their total grain requirement without the IHYM varieties through area expansion.

With respect to technology specific factors, a perceived grain market price, pest resistance, early maturity, better performance under poor soil moisture condition and grain size are significant determinants of intensity of adoption of improved maize varieties. Perception of better grain market price of improved varieties increases the area allocated to the varieties by 16% for the well endowed households. On the other hand, the perception about early maturity is significant for the whole sample and the poor. If a poorly endowed household perceive that a given improved maize variety is early maturing relative to the local one, it increases the area of the improved variety by 29%. Perception of farmers about the resistance of an improved maize variety for pests and drought is found to be negatively influencing the intensity of use of the improved varieties. If a farmer perceives that an improved variety has better resistance to field pests, and drought, it reduces area allocated to the variety by 1% and 5%, respectively.

4. Conclusions and Implications

Using a PCA, a wealth index was constructed for the sample households. By stratifying into poorly- and well-endowed about the sample mean, 61% of the sample was observed poorly-endowed. A double-hurdle model was then used to assess the factors influencing their decisions to adopt IHYM varieties.

The results of this study suggest that factors influencing the adoption and use intensity of improved maize varieties are not the same for the two wealth categories. This implies the need to target households with different package of technologies based on their resource endowments. For instance the significant influence of gender, extension visit, seed availability, and early maturity only on the poorly-endowed households suggests the need to focus on the relatively poor households with varieties that are early maturing to ensure household food security. Seeds must also be made readily available within the vicinities of households as the poorly endowed are likely to be less willing to invest time in searching for seed far away art high cost of transaction.

The other aspect in which the results are interesting is that more years of experience in farming is associated with higher levels of adoption of improved maize varieties. In other words, older and more experienced farmers should be target with extension messages to enhance adoption. As a farmer learns more about the technology through own experience, the scale of adoption increases. Having experience after adoption decisions, therefore, makes farmers more efficient in carrying out the tasks necessary to expand the use intensity of the technology.

References

Adesina, A., Forson. J. B., 1995. Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, west Africa. Agricultural Economics 13. p. 1-9.

Adesina, A., Zinnah, M., 1993. Technology characteristics, farmers' perceptions and adoption decisions: a Tobit model application in Sierra Leone. Agricultural Economics 9, 297-311.

Bhalla, S.S., 1979. Farm and technical change in Indian agriculture. In Agrarian structure and productivity in developing countries. Editored by R Berry and W. Cline. Baltimore, John Hopkins University Press.

Central Statistical Agency (CSA). 2007. Report on Area and Production of Crops (Private Peasant Holdings, Meher Season). The Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey. Statistical Bulletin 388. Volume I, Addis Ababa

Cragg J. 1971. Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica*, 39. p. 829-844.

Doss, C., Mwangi, W., Verkuijl, H., De Groote, H. 2003. Adoption of maize and wheat technologies in East Africa: Synthesis of findings of 22 Case Studies. CIMMYT, Mexico, D.F.

Ellis, F., Bahiigwa, G., 2003. Livelihoods and rural poverty reduction in Uganda. World Development. 31 (6): 997-1013.

Filmer, D., Pritchett, L. H., 2001. Estimating wealth effects without expenditure data – or tears: An application to educational enrollments of India. Demography, Vol. 38, (1), 115-132.

Freeman, H.A., Ellis, F., Allison, E., 2004. Livelihoods and rural poverty reduction in Kenya. Development Policy Review, 22 (2): 147-171.

Greene. W., 2000. Econometric Analysis. Second edition. Macmillan, New York.

Hardaker, J.B., Huirne, R.B.M., Anderson, J.R., 1997. Coping with risk in agriculture. CAB International, Wallingford, Oxon, UK.

Langyintuo. A.S., Mungoma, C., 2008. The effect of household wealth on input market participation in southern Africa. (*Forthcoming, Food Policy*). Lowenberg-DeBoer, J., Abdoulaye, T., Kabore, D., 1994. The opportunity cost of capital for agriculture in the sahel: Case study evidence from Niger and Burkina Faso. Staff Paper. Department of agricultural Economics, Purdue University. West Lafayette, Indiana, USA.

Mandefro Negussie, Hussien Mohammed, Gelana Sebokssa, Gezahegn Bogale, Yosef Beyene, Hailemichael S., and Aderajew Addis. 2001. Maize Improvement for drought stressed areas of Ethiopia. in Enhancing the contribution of Maize to Food Security in Ethiopia: Proceedings of the Second National Maize Workshop of Ehiopia, Addis Ababa Ethiopia.

Morris, M.L., Tripp, R., Dankyi, A.A., 1999. Adoption and impact of improved maize production technologies. A case study of the Ghana Grains Development Project. Economics Program Paper 99-01. International Maize and Wheat Improvement Center (CIMMYT), Mexico. 38p.

Moser, C. and C. Barrett, 2005. The complex dynamics of smallholder technology adoption: The case of SRI in Madagascar. Cornell University Applied Economics and Management Working Paper: No. 2003-20.

Smale, M., Just, R.E., Leathers, H., 1994. Land allocation in HYV adoption models: an investigation of alternative models. American Journal of Agricultural Economics 76, 535-546.

Tesfaye Zegeye, Bedassa Tadesse, and Shiferaw Tesfaye. 2001: Adoption of High Yielding Maize Technologies in Major Maize Growing Regions of Ethiopia. Research Report No. 41. Ethiopia Agricultural Research Organization (EARO), Addis Ababa, Ethiopia.

Zeller, M., Sharma, M., Henry, C., Lapenu, C., 2006. An operational method for assessing the poverty outreach performance of development policies and projects: Results of case studies in Africa, Asia, and Latin America. World Development. Vol. 34, (3), 446-464.

Table 1: Total variance explained using principal components extraction method using standardized values of variables

Component	Initial Eigen values Total	% of Variance	Std. Dev.	Scoring factor	Impact factor
Human Capital					
Household labor capacity	3.920	20.634	0.161	0.134	0.835
Access to non family labor	0.000	0.000	0.501	0.072	0.144
Natural Capital					
Total farm size	0.421	2.215	0.146	0.208	1.426
Total cropped land	0.396	2.085	0.134	0.205	1.537
Physical capital					
Total TLU	2.112	11.113	0.160	0.145	0.911
Own draught animal	1.287	6.773	0.206	0.192	0.934
Own animal cart	1.130	5.945	0.208	0.141	0.678
Own bicycle	1.408	7.413	0.241	0.153	0.633

Own Television	1.245	6.552	0.154	0.060	0.386
Own wheel barrow	1.055	5.554	0.099	0.066	0.667
Own Radio	1.013	5.330	0.188	0.102	0.542
Own private water well	0.916	4.819	0.099	0.064	0.647
Own water bore hole	0.803	4.226	0.116	0.026	0.226
Own water pump	0.773	4.071	0.082	0.029	0.352
Own mobile phone	0.708	3.729	0.122	0.123	1.014
Financial capital					
Access to consumption credit	0.574	3.021	0.069	0.029	0.421
Access to production credit	0.667	3.512	0.069	0.029	0.421
Social capital					
Number of extension contact	0.528	2.778	0.111	0.048	0.434
Member of other associations	0.044	0.230	0.490	0.042	0.087

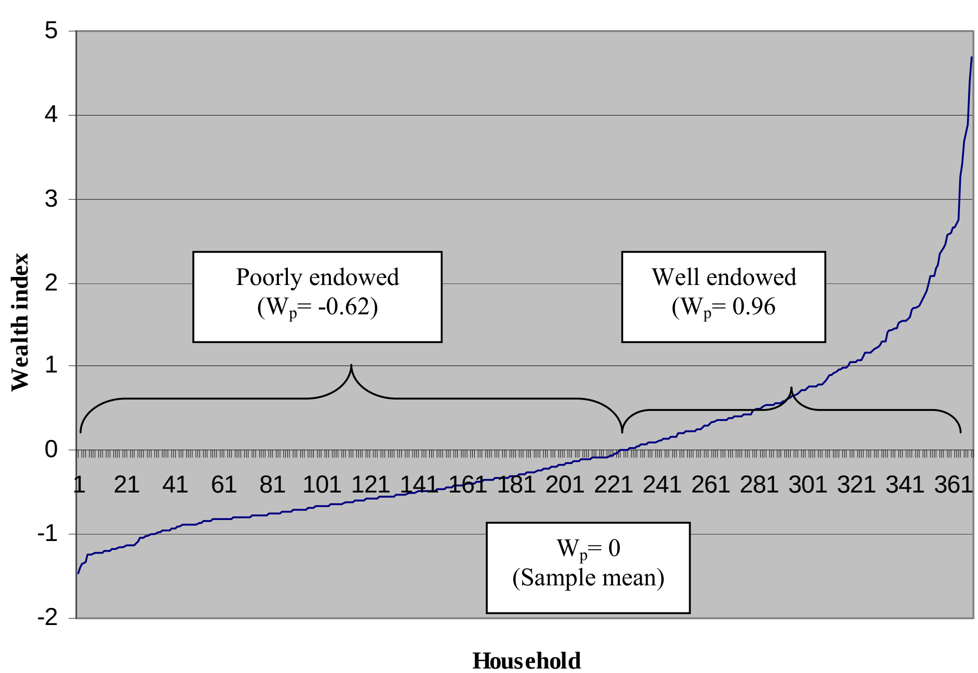


Figure 1: Distribution of households according to wealth groups

Table 2: Descriptive statistics of selected variables in the empirical model

Variables	Definition	poorly endowed		well endowed	
farm and farmer specific characteristics		*Mean*	*Std. dev*	*Mean*	*Std. dev*
Age	Age of household head in years	41.54	14.70	43.22	14.57
Gender	1 if household head is male and 0 other wise		0.26	0.97	0.16
Credit	1 if household has access to credit and 0 otherwise	44.00	19.60	37.00	25.5
Education	Education level of household head (ordered dummies 0= illiterate, 1= read and write, 2= grade 1-6, 3= grade 7-12, 4= above grade 12)				
Extension visit	number of contact with extension agents	1.08	1.92	1.63	2.59
Family size	Family size (number of people in the household)	5.20	2.71	8.90	4.39
TLU	Livestock ownership in Tropical Livestock Units (TLU)	2.70	2.51	10.67	8.30
Off farm income	1 if the household has access to off farm income and 0 otherwise	0.57	0.50	0.25	0.43
Farm size	Total farm size in ha	1.79	0.85	4.30	2.30
Technology specific attributes					
Seed cost	1 if farmer perceives the improved seed cheaper than the local one and 0 otherwise	0.15	0.36	0.14	0.35
Seed availability	1 if the farmer perceives improved seed more readily available than the local one and 0 otherwise	0.33	0.47	0.38	0.49
Grain market price	1 if the farmer perceives grain price is higher for local maize than the improved one in the market and 0 otherwise	0.22	0.42	0.19	0.40
Disease resistance	1 if improved maize varieties are perceived to more resistant to diseases than local one ad 0 otherwise	0.13	0.34	0.19	0.40
Pest resistance	1 if improved maize varieties are perceived to more resistant to field pests than local one ad 0 otherwise	0.13	0.34	0.19	0.39
Storability	1 if improved varieties are perceived more resistant to storage pests than the local one and 0 otherwise	0.12	0.32	0.14	0.35
Early maturity	1 if improved varieties are perceived early maturing than the improved one and 0 otherwise	0.69	0.46	0.68	0.47
Yield Potential	1 if improved varieties are perceived high yielding than the local one and 0 otherwise	0.38	0.49	0.54	0.50
Soil fertility	1 if improved variety is to perform better than the local in poor soil fertility condition and 0 otherwise	0.45	0.50	0.43	0.50
Drought tolerance	1 if improved variety is perceived more tolerant to drought condition than the local one and 0 otherwise	0.44	0.50	0.41	0.49
Lodging tolerance:	1 if improved variety is to be more tolerant to lodging than the local one and 0 otherwise	0.50	0.50	0.52	0.50
Cob size	1 if improved variety is to have larger cob size than the local one and 0 otherwise	0.28	0.45	0.52	0.50
Grain size	1 if improved variety is to have larger grain size than the local one and 0 otherwise	0.34	0.48	0.54	0.50
Palatability	1 if improved variety is perceived more palatable than the local one and 0 otherwise	0.50	0.50	0.60	0.49

Table 3: Maximum likelihood estimate of the double hurdle model

Explanatory variables	Whole sample (n=369)	Poorly endowed (n=224)	Well endowed (n=145)
First hurdle: probability of adopting IHYIM varieties, dependent variable whether a farmer			
Gender	0.342 (0.124)*** [a]	0.398 (0.144)***	0.293 (0.290)
Extension visit	-0.022 (0.013)*	-0.057 (0.020)***	-0.004 (0.019)
Farm size	0.011 (0.022)	-0.135 (0.053)**	0.041 (0.026)
Seed availability	0.190 (0.071)***	0.198 (0.103)*	0.140 (0.102)
pest resistance	-0.253 (0.098)*	-0.326 (0.125)***	-0.050 (0.194)
Early maturity	0.208 (0.091)**	0.293 (0.115)**	0.259 (0.173)
Second hurdle: adoption intensity: dependent variable proportion of area under IHYM varieties			
Family size	-0.059 (0.024)**	0.010 (0.039)	-0.137
Age	0.010 (0.006)*	0.015 (0.008)*	0.017 (0.012)
Gender	0.556 (0.330)*	0.510 (0.387)	0.814 (0.735)
Livestock ownership (TLU)	0.018 (0.014)	-0.044 (0.043)	0.037 (0.021)*
Farm size	-0.035 (0.048)	-0.227 (0.121)*	-0.002 (0.070)
Seed availability	0.366 (0.190)*	0.413 (0.273)	0.336 (0.355)
Grain market price	0.247 (0.209)	0.292 (0.273)	0.888 (0.459)*
Pest resistance	0.206 (0.262)	0.110 (0.354)	0.902 (0.520)*
Early maturity	0.754 (0.216)***	0.944 (0.275)***	0.353 (0.461)
Drought tolerance	-0.479 (0.407)	0.442 (0.568)	-1.736 (0.789)**
Grain size	0.332 (0.262)	0.607 (0.347)*	0.317 (0.508)
Constant	-0.856 (0.455)*	-0.991 (0.578)*	-1.227 (0.981)
Censored observations	126	73	53
Log likelihood	-347.0819	-203.72	-112.3874
Wald $chi^2(24)$	238.82***	186.06***	157.95***

*Note: ***, **, and * significant at 1%, 5%, and 10% respectively.*

[a] Standard errors are in parentheses.

Table 4: Marginal effects of adoption intensity after double hurdle estimation

Explanatory variables	Whole Sample (n=369)	Poorly Endowed (n=224)	Well Endowed (n=145)
Family size	-0.013**	-0.008	-0.012***
Age	0.001*	0.001*	0.002
Gender	0.342*	0.398	0.293
Livestock ownership (TLU)	0.008	0.024	0.005*
Farm size	0.011	-0.135*	0.041

Seed availability	0.190*	0.198	0.140
Grain market price	0.065	0.031	0.157*
pest resistance	-0.253	-0.326	-0.050*
Early maturity	0.208***	0.293***	0.259
Drought tolerance	0.046	0.231	-0.007**
Grain size	-0.068	-0.031*	-0.204

*Note: ***, **, and * significant at 1%, 5%, and 10% respectively.*

Household Reso

Tole

Getachew Lege

[1]Texas Agricultural Experiment Station, Ethiopia

Introduction

Maize is an important cereal crop in Ethiopia as a source of f
sis, it is the second next to tef *(CSA, 2007*). It constitutes 20
production in 2006/07 season. Annual production is more tha
tal cereal production in the country. With respect to drought
under drought prone regions of the country (Mandefro, 2001)

source Endowment

lerant Maize Variet

gese[1], Augustine S. Langyint

opia Sanitary & Phytosanitary Standards and Livestock & Meat Ma

e of food and cash. In terms of area coverage on a national ba-
es 20 % (1.69 million hectares) of the total area under cereals
e than 3.8 million tones, accounting for nearly 29 % of the to-
ught tolerant maize, 40% of the total maize cultivated area is
2001). Thus, increasing the production of maize under drought

Dete

Table 1

nt and Determinant

eties: A Double-hur

ntuo[2] , Wilfred Mwangi[2], Mo

Marketing Program (SPS-LMM), [2] International Maize and Wheat

eterminants of Adoption of Improved

le 1: Maximum likelihood estimate of the double hurdle mode

	Whole sample	Poorly endowed	Well

nts of Adoption of I

urdle Approach

Moti Jaleta[3], Roberto La Rov

heat Improvement Center (CIMMYT), [3]International Livestock Res

ed Maize Varieties

nodel

Factors influencing the probability of adopt

Well endowed

- The empirical results indicate that gender of househo

Drought

overe[2]

k Research Institute (ILRI)

dopting IHYM varieties

ısehold heads, number of extension

under drought prone regions of the country (Mandefro, 2001) conditions has a direct impact on the livelihood of farm house consumption.

Since the inception of formal maize research in Ethiopia (19 national research system. The purpose of this study is to as maize varieties by different wealth groups and identify factor use (area coverage) of these varieties. The results of this stud policy interventions targeting the different categories of the co

Materials and Methods

Sampling and Data Collection

This study was conducted in Adami Tulu Jido Kombolcha (AT tricts of East Shewa zone in Ethiopia, in 2006/2007. Based on tions of maize in the two districts, a multistage random sam used to select sample of 196 and 173 sample households in and 9 in Adama districts, respectively.

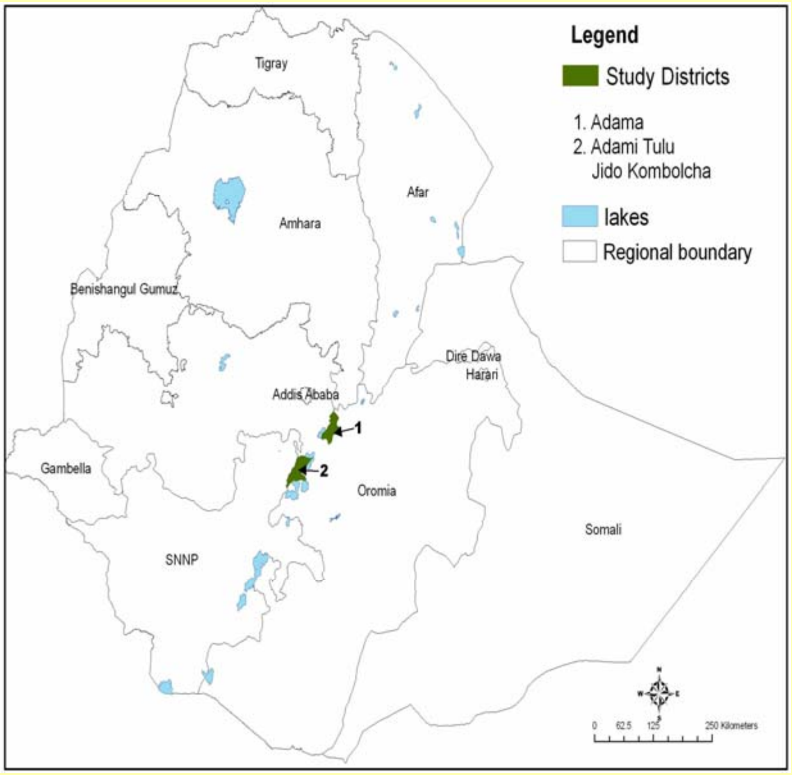
Data analysis

In this study, Principal Component Analysis (PCA) and Do data. The PCA, as detailed in Filmer and Prichatt (2001), Z

2001). Thus, increasing the production of maize under drought
households mainly depending on maize in their production and

(1952), about 30 maize varieties have been developed by the
to assess the level of adoption of improved drought tolerant
actors influencing their probability of adoption and intensity of
study could be used to indicate the research, development and
he community based on their resource endowment.

a (ATJK) and Adama dis-
ed on the relative propor-
sampling technique was
ls in 11 villages in ATJK



d Double-hurdle regression models were used to analyze the
), Zeller et al. (2005) and Langyintuo and Mungoma (2008),

Explana
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planatory variables	Whole sample (n=369)	Poorly endowed (n=224)	Well
rst hurdle: probability of adopting IHYIM varieties, dependent variable whether rmer adopted HYIM varieties or not			
ender	0.342 (0.124)*** [a]	0.398 (0.144)***	0.293 (0.
xtension visit	-0.022 (0.013)*	-0.057 (0.020)***	-0.004 (0
arm size	0.011 (0.022)	-0.135 (0.053)**	0.041 (0.
eed availability	0.190 (0.071)***	0.198 (0.103)*	0.140 (0.
est resistance	-0.253 (0.098)*	-0.326 (0.125)***	-0.050 (0
arly maturity	0.208 (0.091)**	0.293 (0.115)**	0.259 (0.
cond hurdle: adoption intensity: dependent variable proportion of area under I ties			
amily size	-0.059 (0.024)**	0.010 (0.039)	-0.137 (0
ge	0.010 (0.006)*	0.015 (0.008)*	0.017 (0.
ender	0.556 (0.330)*	0.510 (0.387)	0.814 (0.
ivestock ownership (TLU)	0.018 (0.014)	-0.044 (0.043)	0.037 (0.
arm size	-0.035 (0.048)	-0.227 (0.121)*	-0.002 (0
eed availability	0.366 (0.190)*	0.413 (0.273)	0.336 (0.
rain market price	0.247 (0.209)	0.292 (0.273)	0.888 (0.
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rought tolerance	-0.479 (0.407)	0.442 (0.568)	-1.736 (0
rain size	0.332 (0.262)	0.607 (0.347)*	0.317 (0.
onstant	-0.856 (0.455)*	-0.991 (0.578)*	-1.227 (0

Well endowed (n=145)
ether a
3 (0.290)
04 (0.019)
1 (0.026)
0 (0.102)
50 (0.194)
9 (0.173)
der IHYM va-
37 (0.040)***
7 (0.012)
4 (0.735)
7 (0.021)*
02 (0.070)
6 (0.355)
8 (0.459)*
2 (0.520)*
3 (0.461)
36 (0.789)**
7 (0.508)
27 (0.981)

- The empirical results indicate that gender of househo visit, perception of farmers about seed availability, field ity significantly influence the probability of adoption o sample and poorly endowed households.
- The influence of gender on probability of adoption is th resources in which female headed households have po sources in general and have shortage of farm labor in pa
- The non significant effect of extension visit for the wel due to the fact that well endowed households follow m gies irrespective of the effort made to disseminate the sion system.
- The negative effect of extension visit could be related workers into input credit provision and collection of lo ally avoid extension workers in order not to be asked a messages they deliver too.
- The influence of seed availability is not strong enough all members of the community on quota basis.

usehold heads, number of extension

field pest resistance and early matur-

ion of IHYM varieties for the whole

is through its effect on control over

ve poor access and control over re-

in particular.

e well endowed households could be

ow market price and adopt technolo-

the technologies through the exten-

ated to the involvement of extension

of loan. The defaulting farmers usu-

ked about their debt and abandon the

ugh since maize seed is available to

data. The PCA, as detailed in Filmer and Prichatt (2001), Z
was used in computing wealth indices to categorize househol
ble hurdle model was used to analyze factors influencing the
varieties.

The double-hurdle model is a parametric generalization of th
determine the decision to adopt and the level of adoption of
has an adoption (D) equation:

$$\left.\begin{array}{l} D_i = 1 \quad if \quad D_i^* > 0 \\ D_i = 0 \quad Otherwise \\ \\ D_i^* = \alpha' Z_i + u_i \end{array}\right\} \qquad (1)$$

where D^* is a latent variable that takes the value 1 if the farn
is a vector of household characteristics and α is a vector of pa
following:

$$Y_i = \begin{cases} Y_i^* = \beta' X_i + v_i & if \quad Y_i^* > 0 \quad and \quad D_i^* > 0 \\ 0 & otherwise \end{cases}, \qquad (2)$$

where Y_i is the observed answer to the proportion of area pla
dividual's characteristics and β is a vector of parameters.

The error terms, u_i and v_i are distributed as follows:

$$\left.\begin{array}{l} u_i \sim N(0,1) \\ v_i \sim N(0,\sigma^2) \end{array}\right\} \qquad (3)$$

The log-likelihood function for the double-hurdle model is:

$$LogL = \sum_0 \ln\left[1 - \Phi\left(\alpha_i Z_i^1\right)\left(\frac{\beta X_i'}{\sigma}\right)\right] + \sum \ln\left[\Phi\left(\alpha Z_i'\right)\frac{1}{\sigma}\phi\left(\frac{Y_i - \beta X_i'}{\sigma}\right)\right] \qquad (4)$$

), Zeller et al. (2005) and Langyintuo and Mungoma (2008), eholds according to their resource endowments, while the dou- the probability of adoption and intensity of use of the adopted

of the Tobit model, in which two separate stochastic processes on of the technology (Green, 2000). The double-hurdle model

farmer adopts improved maize varieties and zero otherwise, Z of parameters. The level of adoption (Y) has an equation of the

a planted with improved maize varieties, X is a vector of the in-

is:

Grain s	
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Log like	
Wald ch	

Facto

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- Perc alloca
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rain size	0.332 (0.262)	0.607 (0.347)*	0.317 (0.
onstant	-0.856 (0.455)*	-0.991 (0.578)*	-1.227 (0
nsored observations	126	73	
g likelihood	-347.0819	-203.72	-
ıld chi^2(24)	238.82***	186.06***	

ıctors influencing the intensity of use of IHYM varieti

As household size increases by one person, the area allocated to the var creases by 1.2%.

As the age of a household head increases by one year above the average he group (42 years), the area of improved maize variety increases by poorly endowed households.

Each additional one TLU of livestock that a household owns increases t allocated to improved maize varieties by 5% for well endowed househol

Perception of better grain market price of improved varieties increases t allocated to the varieties by 16% for the well endowed households.

f a poorly endowed household perceives that a given improved maize va early maturing relative to the local one, it increases the area of the impro

7 (0.508)
27 (0.981)
53
-112.3874
157.95***

all members of the community on quota basis.

- The Significant influence of perception about the early poorly endowed households is because maize can be while other crops are at their early growth stage when l

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ze variety is

nproved va-

Table 2: Marginal effects of adoption intensity afte

Explanatory variables	Whole Sample (n=369)	Poorly (n
Family size	-0.013**	-0.008
Age	0.001*	0.001*
Gender	0.342*	0.398
Livestock ownership (TLU)	0.008	0.024
Farm size	0.011	-0.135*
Seed availability	0.190*	0.198
Grain market price	0.065	0.031
pest resistance		

early maturity of maize varieties for

n be green harvested and consumed

hen households run out of their food

after double hurdle estimation

oorly Endowed (n=224)	Well Endowed (n=145)
.008	-0.012***
001*	0.002
398	0.293
024	0.005*
.135*	0.041
198	0.140
031	0.157*

$$LogL = \sum_{0} \ln\left[1 - \Phi\left(\alpha_i Z_i^1\right)\left(\frac{\beta X_i^{'}}{\sigma}\right)\right] + \sum \ln\left[\Phi\left(\alpha Z_i^{'}\right)\frac{1}{\sigma}\phi\left(\frac{Y_i - \beta X_i^{'}}{\sigma}\right)\right] \quad (4)$$

The LR-statistic can be computed using (Green, 2000):

$$\Gamma = -2\left[\ln L_T - \left(\ln L_p + \ln L_{TR}\right)\right] \sim \chi_k^2 \quad (5)$$

Where L_T = likelihood for the Tobit model; L_P=likelihood for

L_{TR}= likelihood for the truncated regression model; a

tions.

If the test hypothesis is written as Ho: $\lambda = \frac{\beta}{\sigma}$ and $\lambda \neq \frac{\beta}{\sigma}$. Ho will

Wealth Category of Households

Computing Wealth Indices by the PCA method

In order to simplify the categorization of households accor Analysis (PCA) was run on 19 selected asset indicators whic community. Nineteen components were extracted in the first kieser Criterion of an eigen value greater than one). The assig composite wealth index. Households were then ranked from h The mean index for poorly endowed households was -0.62 sample mean was 0.

About 61% of the sample households were found to hav

early

riety

- If a

d for the probit model;

pests,

lel; and k is the number of independent variables in the equa-

and 5

will be rejected on a pre-specified significance level, if $\Gamma \succ \chi_k^2$.

ds

•

according to their wealth endowment, a Principal Component which were perceived to be better indicators of wealth in their first stage of PCA but only eight were significant (based on the assigned weights were used to construct an overall standardized om highest to least composite wealth index.

).62 and that of well endowed households was 0.96 while the

have negative wealth indices and categorized as poorly en-

early maturing relative to the local one, it increases the area of the impro

riety by 29%.

f a farmer perceives that an improved variety has better resistance

pests, and drought, it reduces area allocated to the variety respectively,

and 5%.

Conclusions and Implications

- Using a Principal Component Analysis, a wealth index wa structed for the sample households. Accordingly, the index for about 61% of the sample households was below zero an households are categorized as poorly endowed. The rest are fied as well endowed households.
- The results of this study indicated that factors influencing the tion and use intensity of improved maize varieties are not th

nproved va-

nce to field

vely, by 1%

x was con-

ndex value

o and these

are classi-

g the adop-

ot the same

	0.065	0.031
pest resistance	-0.253	-0.326
Early maturity	0.208***	0.293**
Drought tolerance	0.046	0.231
Grain size	-0.068	-0.031*

-
- In this study, more years of experience in farming i
levels of improved maize varieties. This implies, fo
proved maize varieties, as the farmer's age and exp
creases by 1 year, the area of land allocated to maiz
1%.
- This suggests the need to focus on well experience
wider coverage with maize varieties. As a farmer le
nology through own experience, the scale of adopti
perience after adoption decisions, therefore, makes

031	0.157*
.326	-0.050*
293***	0.259
231	-0.007**
.031*	-0.204

ing is associated with higher
es, for the adopters of im-
experience in farming in-
maize varieties increases by

enced, aged farmers to ensure
ner learns more about the tech-
doption increases. Having ex-
akes farmers more efficient in

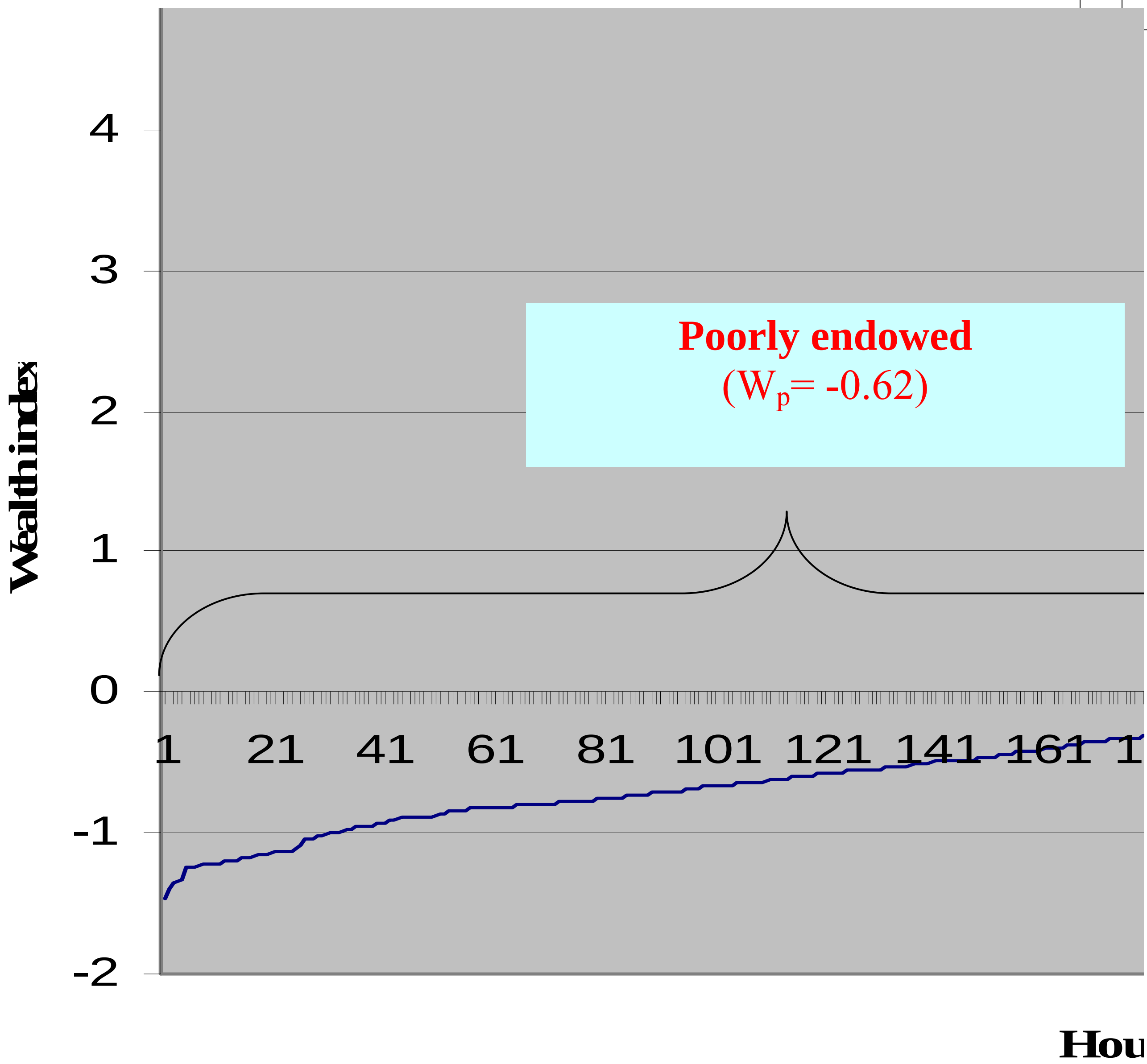
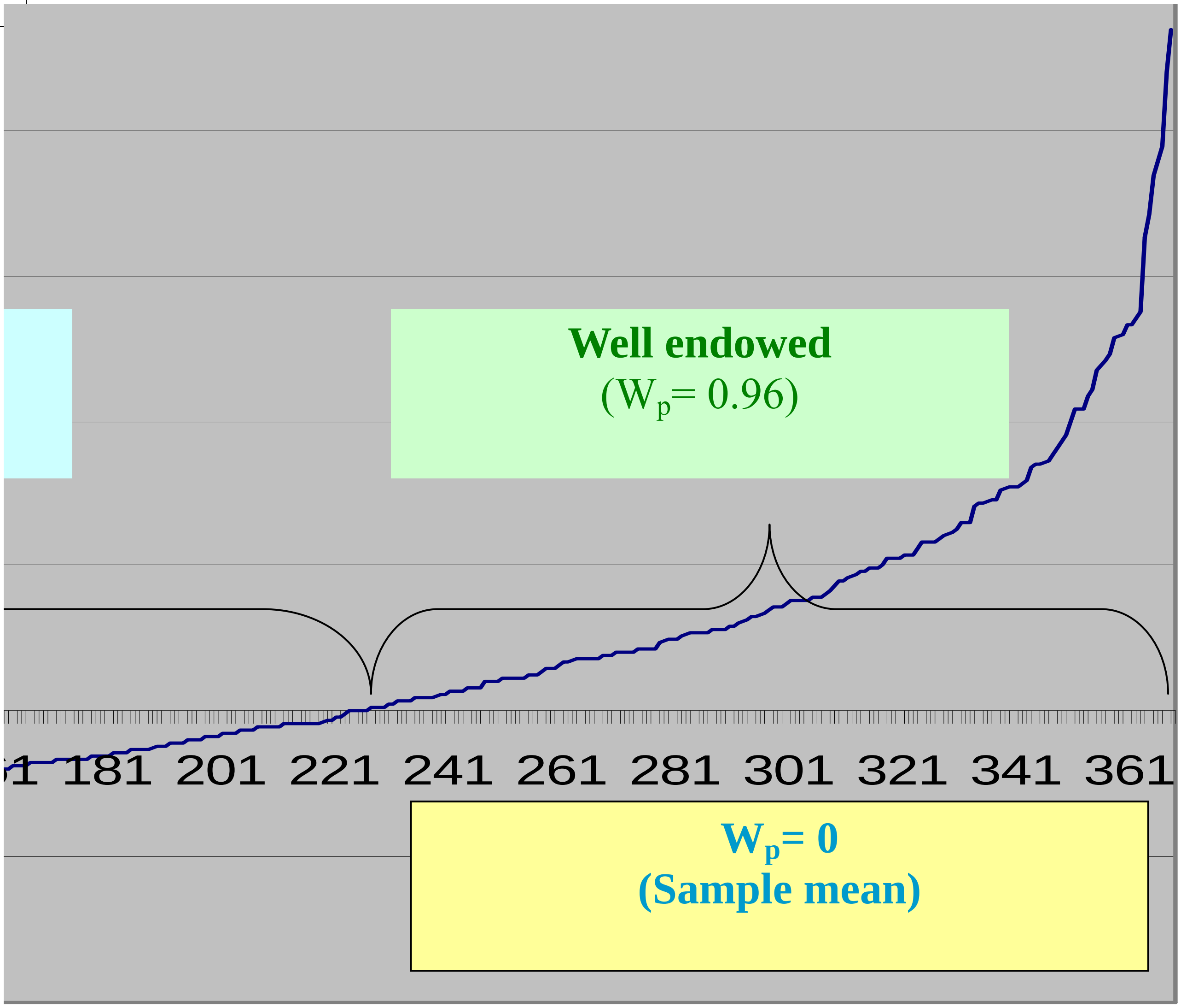


Figure 1: Distribution of households



Household

lds according to wealth groups

tion and use intensity of improved maize varieties are not th for the two wealth categories implying the need to targeting with different package of technologies. For instance the sign influence of gender, extension visit, seed availability, and ear turity only on the poorly endowed households suggests the n focus on poor and women headed households, the need fo maturing varieties to ensure household food security for th the need to avail improved seeds at affordable price to the p order to ensure maximum rate of adoption by the poorly en households.

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d early ma-
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perience after adoption decisions, therefore, makes
carrying out the tasks necessary to expand the use ir

akes farmers more efficient in
se intensity of the technology