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# Determinants of Wheat Varietal Replacement: The Case of Gedeb Hasasa Woreda, West Arsi Zone, Ethiopia

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**Abstract**
Varietal replacement is very low among small scale farmers in Ethiopia in general and in the study area in particular. In order to increase wheat varietal replacement rate it is important to know the factors that influenced farmers' decision. Thus, this study was carried out to determine factors affecting wheat varietal replacement in Gedeb Hasasa woreda. The study was conducted based on a sample size of 175 farmer respondents from four kebeles in Gedeb Hasasa woreda. Multi-stage sampling procedure was employed to select sample farmers and structured questionnaire was used for data collection. Descriptive statistics was used for analyzing quantitative data. Binary logit model was used to determine factors that influence wheat varietal replacement decision. The model results indicated that seed price, field day visit, access to new variety, farm size, maturity time, and disease resistance were significant determinant of wheat varietal replacement. Therefore, any effort in increasing wheat varietal replacement rate in the study area should consider at most the varietal attribute and institutional characteristics.
**Keywords:** Logit model, varietal replacement, wheat

## 1. INTRODUCTION

Wheat is one of the major cereal crop grown in Ethiopia. Ethiopia is the second largest wheat producing country in Africa next to South Africa. However, Ethiopia's wheat yields are much lower than those of most other African countries (Gashaw *et al*., 2014). According to Gashaw *et al*. (2014) low productivity is attributed to a number of factors including adoption of new agricultural technologies. As a result of the low productivity the country falls short of being self-sufficient in wheat production, and is currently a net importer of wheat grain.

A farmer's decision to change and adopted cultivar is called varietal replacement (Abdissa *et al*., 2001). Researchers suggested that when a variety fails to perform according to its characters the old variety needs to be replaced by a new one, which is suitable to grow in similar agro-ecological condition. Thus, Krishna *et al*. (2014) suggested the replacement of deteriorated older variety with a new improved variety to attain higher yield and to reduce the potential damage posed by newly emergent pests and diseases. Moreover, recently observed evolution of rust pathogens indicated that wheat varieties need to be replaced more frequently and regularly (FAO, 2008). Despite the increased effort of the research programs variety turnover remained low among farmers in the study area. According to the MoARD (2014) 66 bread wheat varieties released so far. Out of these 9 rust resistant bread wheat varieties were released since 2010. However, the most popular wheat variety grown in the study area is Kubsa (HAR-1685). Kubsa released in 1995 and is susceptible to disease called yellow rust. The study by Zewde *et al*. (2014) also indicated that though farmers in Ethiopia growing modern varieties of bread wheat, they are slow in changing to new varieties.

Increasing wheat productivity from a frequent variety replacement can become a reality once the factors that could encourage or prohibit varietal replacement are identified and understood. Hence, this study was conducted to analyze factors that determine wheat varietal replacement among wheat grower farmers in Gedeb Hasasa woreda.

## 2. RESEARCH METHODOLOGY

### 2.1. Description of the Study Area

The study area was Gedeb Hasasa woreda located in West Arsi zone of Ormoia regional state. The woreda divided in to two major climatic zones known to be Dega (35%) and woinadega (65%) with annual rainfall ranges between 600-700 mm. The topography is predominantly a flat land with an altitude varying from 2300 to 3200 meter above sea level. The mean minimum and maximum temperature of the woreda is 12°c and 27°c respectively. (WAO, 2014).

Main economic activities in the woreda are mixed farming, where crop production and livestock husbandry are practiced side by side. Although crops like maize, barley and teff are growing in the study area, Gedeb Hasasa is known for wheat production. Wheat is the major staple food for most of the households in the woreda, and the main source of income and employment as well. Because of its favorable agro-ecology and flat terrain for mechanized farming the study area was found hosting three large scale regional seed farms which was previously cultivated under the state farm.

### 2.2 Sampling Technique and Data Collection

A multi-stage sampling procedure was applied to identify farmers to be included in the survey. At the First Stage, Hassasa woreda was selected purposively for its potential of wheat production. At the second stage, kebeles were stratified depending on closeness and farness from Hasasa town. Then a total of four kebeles were selected randomly (two from far and two from closer to town). The size of the respondents from the four kebeles was decided based on probability proportional to the size method. The sample size was determined based on Green (1991) sample size determination formula. $N > 50 + 8P$ Where P is number of independent variables, and N is the sample size.

Primary and secondary, quantitative and qualitative data were used in the study. The primary data were collected from respondent household heads using pre-tested structured questionnaire. The interviews were conducted by trained data collectors. The survey was carried out from February to March, 2015.

### 2.3 Analytical Method

The quantitative data were analyzed using descriptive statistics. To estimate the probability of wheat varietal replacement binary logistic regression (logit) model was used. The justification to use logit model was its simplicity of calculation and that its probability lies between 0 and 1 (Gujarati, 1995). The data processing was carried out using SPSS-20 software package.

#### 2.3.1 Empirical model

According to Gujarati (1995) the logistic distribution function is:

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon \quad (1)$$

Where, Ln is log, i is the $i^{th}$ observation in the sample, $P_i$ is the probability of wheat varietal replacement for the $i^{th}$ farmer given the explanatory variables $X_1, X_2 \ldots X_n$. $1\text{-}P_i$ indicates the probability of absence of varietal replacement. $\beta_0$ is the coefficient of intercept, $\beta_1, \beta_2 \ldots \beta_n$ are parameters to be estimated and $\varepsilon$ is error term.

#### 2.3.2 Model specification

Wheat varietal replacement as a function of a set of explanatory variables, the actual model specification would be:

Varietal Replacement = $\beta_0 + \beta_1(AGE) + \beta_2(FMEXP) + \beta_3(EDUC) + \beta_4(FRMSZ) + \beta_5(LIVOWN) + \beta_6(OFFACT) + \beta_7(SPRICE) + \beta_8(CREDIT) + \beta_9(DITOWN) + \beta_{10}(EXTCON) + \beta_{11}(VARAC) + \beta_{12}(FIDAY) + \beta_{13}(YIELD) + \beta_{14}(MATIME) + \beta_{15}(DISRES) + \varepsilon$

Where:

AGE = Age of the respondent in years.
FMEXP = Wheat farming experience of the respondent in years.
EDUC = 1 if the respondent attended formal education, 0 otherwise.
FRMSZ = Farm size of the respondent in hectares.
LIVOWN = Amount of livestock owned by the respondent in TLU.
OFFACT = 1 if the respondent engaged in off-farm activity, 0 otherwise.
SPRICE = 1 if the wheat seed price was affordable to the farmer, 0 otherwise.
CREDIT = 1 if the respondent received credit, 0 otherwise.
DITOWN = A distance from farmers home to the woreda town, measured in kilometer.
EXTCON = 1 if the respondent had contact with extension agent, 0 otherwise.
VARAC = 1 if the farmer had access to new varieties, 0 otherwise.
FIDAY = 1 if the respondent visited field day site, 0 otherwise.
YIELD = It is amount of product measured in quintals per hectare.
MATIME = 1 if the respondent perceives new varieties are early maturing, 0 otherwise.
DISRES = 1 if the respondent perceives new varieties have resistance to disease, 0 otherwise.

For the study, a variety replacer was defined as a farmer who grew improved new wheat varieties during the 2014 cropping season. A new wheat variety is a variety that has been used for less than 10 years from the year of release (Gamba *et al*., 2003).

## 3. RESULTS AND DISCUSSIONS

### 3.1 Socioeconomic Profile of Sample Farmers

A simple descriptive analysis was conducted to identify the socioeconomic conditions of the sample farmers. The results showed that 94.3% of the sampled farmers were male headed while only 5.7% were female headed. The mean age of sample household head was 44.75 years. It was found out that a high proportion of wheat growers attended formal education (64.6%). The sample wheat farmers had an average 22.67 years of farming experience. They had average farm sizes of 3.16 hectares, which is higher than the county average. According to

the survey result all the sample farmers owned livestock. The mean number of livestock for the sample respondents in Tropical Livestock Unit (TLU) was 9.32.

### 3.2 Wheat varieties grown in the study area

In the study woreda farmers are growing different wheat varieties. The wheat varieties that encountered during the survey are described in Table 1. In the 2014 production season, the wheat varieties found grown in the study area were Kubsa, Kekeba, Danda'a, madda walabu, Digelu and Pavon-76 (Table 1).

Table 1. Wheat varieties grown by sample farmers in 2014 production season

| Variety name | Frequency | Percentage | Year of release |
|---|---|---|---|
| Kubsa (HAR-1685) | 144 | 82.3 | 1995‡ |
| Kekeba (Picaflor) | 94 | 53.7 | 2010 |
| Dandea'a (Denphe) | 15 | 8.6 | 2010 |
| Digelu (HAR-3116) | 11 | 6.3 | 2005 |
| Madda walabu (HAR-1480) | 5 | 2.9 | 1999‡ |
| Pavon-76 | 4 | 2.3 | 1982‡ |

Note: ‡ = Old wheat varieties

Source: Field survey data and MoARD (2014)

According to the survey results 16% of the sample farmers grew new wheat variety alone. On the other hand 37.7% of them grew old wheat varieties. In the study area farmers tends to grow more than one wheat variety on their farms. As was noted, in the survey result, old varieties were found grown along with new released varieties. The results revealed that 46.3% of the sample farmers planted both new and old wheat varieties together. The most important reasons for growing more than one wheat varieties could be to spread risk and to identify the best performing what variety under their own conditions. This would enable farmers to choose varieties in terms of yield, disease resistance, marketability and early maturity among other aspects.

The use of recently released wheat varieties like Kekeba and Danda'a was very low despite their resistance to diseases. It was reported grown by 53.7% and 8.6% of the sample farmers respectively (Table 1). Nevertheless, Kubsa, an old wheat variety, was the most frequently grown variety by the sample farmers (82.3%) despite its susceptibility to yellow rust. This could be an indication of low awareness among farmers or a specific variety attribute preference by farmers in the study area.

### 3.3 Wheat variety attributes preference by farmers

Farmers do have different reasons in their wheat variety preference. The survey result indicated that high yield, early maturity, disease resistance and marketability were the four important characteristics that the sample farmers look for in a variety. In order of ranking, high yield mentioned by 49.7% of the sample farmers, followed by disease resistance 38.9%, early maturity 6.9% and marketability 4.6%. Majority of the sample farmers preferred for high yield as prime driver in their wheat variety selection. This is usually to increase production and profit. The study also showed that disease resistance was in fact the most important attributes in variety preference. This was logical decision given that, wheat disease is a major threat for wheat production in the country in general and in the study area in particular. From the economic point of view, wheat variety having diseases resistant is important to cuts down cost of production.

### 3.4 Determinants of wheat varietal replacement: logit model results

Prior to regression multi-collinearity test and remedy measure was taken. A Pearson product-moment correlation analysis was used to test for multi-collinearity. Pearson correlation coefficients can only take on values from -1 to +1. According to Pallant (2013) a correlation coefficient ranges from -0.7 to +0.7 is considered as acceptable. He also suggested omitting one of the variables if the correlation coefficient value is out of the acceptable range. Examination of correlation matrix indicated the presence of multi-collinearity. Farming experience was found highly correlated with age of household head ($r = 0.820$, $p < 0.001$). Therefore, farming experience was eliminated from the model.

Goodness of fit statistics was used to determine whether the model adequately describes the data. The Hosmer-Lemeshow statistic result ($\chi^2 = 9.213$, $df = 8$, $P = 0.325$), indicated that the model adequately fitted the data. The Omnibus tests of model coefficients was statistically significant ($\chi^2 = 133.984$, $df = 14$, $p < 0.001$), indicating that predictors as a set reliably predicted the dependent variable well. The model overall correct prediction of the likelihood of wheat seed replacement was 86.3% (Table 2).

Results from the logit model used to examine the factors affecting wheat varietal replacement are presented in Table 2. From the total fifteen variables that hypothesized to influence varietal replacement fourteen variables were interred in the model. One variable was omitted due to multi-collinearity. The model result revealed that farm size, seed price, access to new variety, field day visit, maturity time, and disease resistance were found to contribute to wheat varietal replacement decision at significant level.

All the variables that showed significant effect on varietal replacement were found in conformity with the prior expectations of the study. Variables that influenced varietal replacement significantly are discussed below.

**Farm size**

Farm size of the respondents had the expected positive sign and was significant at 5%. The logit model result indicated that, the odds in favor of wheat varietal replacement increased by a factor of 1.932 as the farm size increased by one unit (Table 2). The result implies that wheat farmers with larger farm size are 93% more likely to use new wheat variety than farmers with small land holding. The possible explanation is that, farmers with large farm size might grow new varieties along with old ones either to evaluate varietal traits or to spread risk of crop failure. The result was in line with the finding of (Bedru and Dagne, 2014; Kafle, 2010; Motuma *et al*., 2010).

Table 2. Logit model result for factors influencing varietal replacement

| Predictors | B | Wald | Sig. | Exp(B) |
|---|---|---|---|---|
| Age | 0.018 | 0.397 | 0.529 | 1.018 |
| Formal education | 0.076 | 0.012 | 0.911 | 1.079 |
| Farm size | 0.659 | 5.062 | 0.024** | 1.932 |
| Livestock ownership | 0.033 | 0.205 | 0.650 | 1.034 |
| Off-farm activity | 0.510 | 0.716 | 0.398 | 1.666 |
| Seed price | 2.043 | 11.150 | 0.001*** | 7.711 |
| Access to credit | 0.284 | 0.240 | 0.624 | 1.328 |
| Distance to town | 0.061 | 2.086 | 0.149 | 1.063 |
| Extension contact | -1.165 | 1.887 | 0.169 | 0.312 |
| Access to new variety | 3.202 | 17.403 | 0.000*** | 24.591 |
| Field day visit | 2.065 | 11.572 | 0.001*** | 7.883 |
| Yield | -0.068 | 2.316 | 0.128 | 0.934 |
| Maturity time | 2.139 | 5.515 | 0.019** | 8.495 |
| Disease resistance | 1.904 | 5.454 | 0.020** | 6.715 |
| Constant | -7.511 | 10.067 | 0.002 | 0.001 |
| | | $\chi^2$ | P | |
| Goodness of fit test | | | | |
| Hosmer & Lemeshow | | 9.213 | 0.325 | |
| Omnibus Model chi-square test | | 133.984 | 0.000*** | |
| Overall Prediction percentage = 86.3% | | | | |

Note: ** = Significant at 5%, *** = Significant at 1%

Source: Field survey result

**Seed price**

According to the logit model analysis result seed price had significant influence on wheat varietal replacement at 1% significant level. The odds in favor of wheat varietal replacement increased by a factor of 7.711 when the seed price was affordable than it was unaffordable (Table 2). This implies that new wheat variety utilization by farmers increased when the seed price was reasonable and affordable. The result was consistent with the findings reported by Khanal and Maharjan (2013) which found seed price as significant determinant in the adoption of improved rice varieties. Also Langyintuo and Mulugeta, (2008) reported that seed price influence adoption of improved maize variety significantly.

**Access to new variety**

As observed in the logit model result in Table 2, access to new variety had positive and significant influence on varietal replacement in the study area. The likelihood of varietal replacement would increase by a factor of 24.591 for farmers that had access to new variety than they did not access to new variety. This finding compares with Awotide *et al.* (2012) that found access to seed to have a positive and significant relationship with adoption of improved rice variety in Nigeria.

**Field day visit**

The model result indicates that participation in wheat variety demonstration field day had a positive significant effect on farmers' varietal replacement practice. Participation on wheat variety demonstration field day increased the likelihood of wheat variety replacement by a factor of 7.883 (Table 2). This indicated, farmers who had an opportunity to attend wheat variety demonstration field day were much more convinced with the characteristic of the new wheat varieties. Thus, field day is a good means of promoting as well as presenting new wheat varieties at farmers disposal. The result was consistent with the study of Yemane (2014) which found out that field day participation had significant effect on the adoption of improved upland rice variety.

**Maturity Time**

As anticipated, maturity time found affecting wheat varietal replacement positive and significantly at 5% level

(Table 2). The odds of varietal replacement compared to non replacement are increased by a factor of 8.495 if a wheat variety has short maturity time. The result reveled that wheat variety with early maturity trait increased the likelihood of its selection by wheat grower farmers. Shortage of rainfall especially on some parts of the study woreda could be the possible reason for farmers to prefer short maturing varieties. Moreover the price for the early harvested grain is usually attractive compared to late harvested grain. The result compares well with Salasya *et al*. (2007) reported that maturity time has significant influence on the adoption of stress-tolerant maize hybrid in Kenya. The result, however, in contrast with the finding of Timu *et al*. (2012) that reported early maturity has no effect on adoption of improved sorghum varieties in India.

**Disease resistance**

Disease resistance had also a positive and significant influence on the probability of varietal replacement at 5% significant level (Table 2). The odds in favor of varietal replacement would increased by a factor of 6.715, if a wheat variety had disease resistance trait than it did not. The result revealed that new wheat varieties with disease resistance attribute were more likely used by farmers. This could be due to the recurrent wheat disease infestation in the study area, which usually forced the farmers to incur additional cost for disease control. This result is in line with the finding of Timu *et al*. (2012).

## 4. CONCLUSION AND RECOMMENDATIONS

This study has shown that wheat varietal replacement decision was significantly influenced by farm size, seed price, access to new variety, field day visit, maturity time, and disease resistance.

Since access to new variety and seed price were influencing factors in sustaining varietal replacement, efforts should be geared toward delivering new wheat varieties at affordable price. Furthermore, seed of new varieties would better if available in smaller packets with reasonable price so that farmers can test and multiply their own seed.

The study has also revealed that field day visit influencing varietal replacement. This implies that for every newly released variety a promotion campaign through demonstration field day needs to be carried out so that to increase awareness of the farmers about new wheat varieties inherent characteristics and performance.

It was found that farmers have their own new variety preference criteria. Therefore, researchers may need to focus on developing wheat varieties that meet farmers' preferences. In this regards greater consideration of participatory approaches to wheat variety improvement is crucial. Expanding Participatory Variety Selection and Participatory Plant Breeding approaches in the country in general and in the study area in particular is therefore important to meet farmers' interest regarding trait preference.

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