# Determinants of Varietal Replacement of Haricot Bean by Farmers in *Boricha* District, Southern Ethiopia

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**Abstract**

Seed is a fundamental input in crop production, which plays a significant role in enhancing productivity. Associated with seed, the choice and the decision to replace crop varieties in use are critical to increase productivity. This study examined determinants of varietal replacement among farmers producing Haricot bean varieties in *Boricha* district. Four *kebele* administrations and 162 sample respondents were selected using a multi-stage sampling procedure and data were collected by using a structured questionnaire. The findings show that improved haricot bean varieties promoted by the extension system were released during the last 6 to 12 years. Farmers mainly grow old varieties and hence varietal replacement is low. From total sample respondents, 77% had grown varieties that were released from research centers in the past 6 to 12 years whereas the remaining 23% had grown Red *Wolaita*, which was released four and half decades ago and now considered as a local variety. Out of 162 farmers, 72% of sampled farmers replaced the old variety by *Hawassa Dume*, which was released in 2008 and is the most recent variety available in the district. The Logistic regression model showed that age of household head, size of landholding, market price of varieties used for replacement, livestock ownership measured in Tropical Livestock Unit (TLU), availability of recently released varieties, participation on extension demonstration, and perception about yield of varieties used for replacement significantly affected varietal replacement decisions. Hence, it is important to enhance resource endowment of households, improve access for recently released varieties, integrate growers with high value market and organize extension demonstration of improved varieties to facilitate varietal replacement.

**Key words**: Key words: Haricot bean; Logit; Meher; Varietal replacement
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## INTRODUCTION

Haricot bean production plays an important role at household level as source of cash, nutrient dense food crop (poor man meat) and nitrogen fixer to replenish soil fertility. In 2013/14, the total pulses export volume of Ethiopia was 353,645 thousand tonnes and 251 million USD (Boere et al., 2015). The major export pulse crops in order of importance are haricot bean, horse bean and chickpea, which account for 35%, 26% and 23%, respectively, while the remaining share was covered by lentil, green mung beans and faba bean (Mulugeta, 2010). Numerous haricot bean varieties have been released from research centers that are currently in production in Ethiopia. According to Ethiopian Ministry of Agriculture (MoA, 2014), about 50 varieties of Haricot bean are under production. The pure red and white haricot beans are the most market demanded varieties (Ferris and Keganzi, 2008). The value of Haricot bran in terms of economic return and food security increases with the use of recently released varieties that have better yield and resistance to disease and moisture stress. Although there is a general understanding and recognition on the benefit of using improved varieties, the practice of varietal replacement is low in the study area. Varietal replacement is farmer's decision to change an adopted cultivar by a better one based on expected utility (Gemeda et al., 2001). As indicated by Oladele (2005) an understanding of factors influencing technological change including varietal uptake by potential clients in agriculture is vital to the design of policies and strategies.

In the study area, about four varieties of haricot bean namely *Hawassa Dume*, *Ibbado, Nasser* and Red *Wolaita* varieties are grown by smallholder farmers during 2014/15 main production season. The first three varieties cultivated currently were released in the last 12 years from research centers for their better yield, marketability or disease resistance, whereas Red *Wolaita* variety was released in 1974 and almost considered as a landrace.

Empirical evidence show that about 90% of the estimated annual seed requirement of 420,000 tonnes comes from farmers' own sources (Thijssen et al., 2008). IFPRI (2010) reported that the formal seed system, which supplies seed through public and private companies still, has a limited footprint in Ethiopia, covering the highest use at approximately 50 percent for maize and the lowest use at less than 10 percent for barley. Whereas the informal seed system (defined as farmers producing and

exchanging their own seeds) is highly dominant except for hybrid maize seed.

Therefore, this research was undertaken with the objective of assessing why some farmers continue growing old varieties whereas others replaced their old varieties with recently released ones. The findings of the study would have a policy implication through creating insight and conducive environment for smallholder farmers' producing haricot bean and would like to replace better quality varieties through generating pertinent information for research and extension systems.

## MATERIALS AND METHODS

The study was carried out in *Boricha* district, southern Ethiopia which is located between 6°04'N and 38°00'E to 7°00'N and 38°02'E. The district comprises 39 rural *kebele* administrations (Figure 1). The agriculture of the study area is rain fed crop-livestock production system characterized by maize-haricot bean-*Enset* farming system. The district has two cropping seasons, *belg* (short rainy season mostly from February to May*)* and *meher* (long rainy season mostly from June to October). Major crops grown in the study area are maize, haricot bean, coffee and root crops like *Enset* (*Enset ventricosum*), potato and sweet potato. The altitude of the area ranges from 1250 to 2000m above sea level and its mean annual rainfall ranges between 500 and 1242 mm. Concerning the monthly average temperature of the study area, it varies between 21.93$^{o}$c in July and 25.3$^{o}$c in February. Total area of the district is 603.45 square kilometers.

Multi-stage sampling procedures were followed to select the study *kebele*s and sample households. In the first stage, the district was purposely selected based on high production and wide area coverage of haricot bean. In the second stage, the 39 rural *kebele* administrations were stratified in to two groups based on proximity (those *Kebele*s found in a radius of 15 kilometer categorized as nearest and otherwise as farthest) to the district agricultural office, which distributes certified seeds to farmers. The reason why *kebele* administrations grouping undertaken was to include farmers from nearest and farthest area from certified seed source. From each group, two *kebele*s were randomly selected and total of 162 Haricot bean farmers were selected based on probability proportional to size-sampling techniques.

Data were collected using a structured questionnaire and pre-tested on five farmers outside the sample *kebele* to avoid the problem of contamination. Besides the researchers, trained field enumerators were involved in primary data collection. Furthermore, farm visit, direct observation and informal interviews were made. Secondary data were collected from documents of central statistics agency, district office of agriculture annual reports, published articles and unpublished sources.

**Data Analysis**

The data were summarized by descriptive statistics and econometrics model. By following Gujarati (2004), logistic regression model were used to analyze determinats of varietal replacement of haricot bean by farmers. All analyses were performed by using STATA 13 software.

**Definition of variables used**

Farmers are categorized as "varietal replacers" if they grew varieties released from research centers in the last 6 to 12 years specifically those varieties such as *Hawassa Dume*, *Ibbado and Nasser* in 2014 *meher* season and "non-replacers" are those who are producing older varieties released earlier than 12 years.

**Dependent variable: status of varietal replacement**. It takes value of '1' if the farmers used a variety released from research centres in the last 12 years and '0' otherwise.

The following explanatory variables were included in the econometric model based on empirical review of literature:

**Education status:** It is measured in number of years the respondent attained in formal education and '0' is recorded if no formal education is reported (Krishna et al*.,* 2008).

**Farming experience:** It is measured in number of years of experience in haricot bean production.

**Farm size:** It represents the total owned and cultivated land by household. It is expected to be positively associated with the decision to adopt new varieties for replacement.

**Farm income:** It refers to the total annual earnings of the family from sale of agricultural products and measured in Birr (Ethiopian currency).

**Livestock ownership in TLU:** It is measured in terms of Tropical Livestock Unit (TLU) in which all livestock owned by farm households were converted to standard values by using conversion factors developed by Storck et al. (1991).

**Participation on off-farm /non-farm activities:** This variable refers to participation of the respondents in income generating activities out of own farm or non-farm activities. It is dummy

variable and defined as whether farmers participate on non-farm and or off-farm activities.

**Perception on market price of output:** It is dummy variable and takes value 1 if farmers perceived recently released varieties are more marketable with high price and 0 otherwise.

**Frequency of contact with extension agent(s):** This refers to the number of contacts per year that the respondent made with extension agents. Here, the frequency of contact between the extension agent and the farmers is hypothesized to be the potential force, which accelerates the effective dissemination of adequate agricultural information to the farmers.

**Participation in demonstration:** It is measured in terms of the number of times the farmer has participated in demonstration.

**Cooking quality:** This variable refers to whether varieties adopted for replacement are superior over old varieties in terms of compatibility with local dishes like "Kocho" and porridge. It is measured as 1 if the superior and 0 if it is inferior.

**Yield of recently released varieties**: This variable is measured in dummy variable and take value of'1' if farmers evaluate recently released varieties as more yielding and '0' otherwise.

**Access to variety:** It is access to new varieties that were released from research centers within the last12 years and available for production. It takes value of '1' if the farmer has access to variety in terms of availability and accessibility and '0' otherwise (Alene et al*.,* 2000).

## RESULTS AND DISCUSSION

### Socioeconomic characteristics of sample farmers

The respondent farmers in this study were about 49 years old on the average (Table 1). The variety replacers and non-replacers mean age was 38.04 and 50.00 years, respectively. There is a significant mean age difference between variety replacers and non-replacers at 1% significance level (t-value, -6.05). The mean schooling years for variety replacers and non-replacers were 3.42 and 1.24, respectively, and were significantly different (t- value= 4.09, P<0.01). The finding revealed that, exposure to formal education assumed to increase farmers' ability to obtain, process, and use information relevant to the utilization of certified seed of improved haricot bean varieties and replace the same with careful analysis of utilities. Education is therefore expected to increase the probability of utilization of recent varieties.

The mean participation value of household head in extension demonstration was 0.96 days per a year. Variety replacers significantly differed with non-replacers concerning participation in extension demonstration (t= -4.30, P < 0.01). Krishna et al. (2008) also reported that participation in extension events has been positively associated with adoption of new technology.

The mean of years of experience in haricot bean farming was 9.91 and 6.78 for variety replacers and non-replacers, respectively. There was significant difference in mean experience years between variety replacers and non-replacers (t-test=3.57) (Table 2). Experience of the farmer is likely to have a range of influences on utilization of agricultural technologies. A more experienced grower may have a lower level of uncertainty about the technology's performance (Oladele and Wakatsuk, 2011; Tiamiyu et al., 2009). Farmers with higher experience appear to have often full information and better knowledge and able to evaluate the advantage of the technology.

Table 1: Summary of the socio-economic characteristics of households

| Variable definitions | Mean | Min | Max | t-value |
|---|---|---|---|---|
| Age of household head (yrs) | 40.85 (11.77) | 22 | 88 | 6.05 |
| Educational status of household head | 2.90 (3.01) | 0 | 13 | 4.09 |
| Haricot bean farming experience (yrs) | 9.17 (4.87) | 4 | 30 | 3.57 |
| Frequency of contact with development agent | 1.22 (1.65) | 0 | 8 | 3.95 |
| Frequency of participation in demonstration | 0.96 (1.30) | 0 | 5 | 4.30 |
| Livestock holding (TLU) | 2.70 (2.16) | 0.01 | 10 | 6.82 |
| Land holding (hectare) | 0.87 (0.58) | 0.15 | 3.25 | 6.03 |
| Cash income from sale of farm products(Birr)[1] | 3933(3906) | 750 | 20850 | 3.06 |

Numbers in parenthesis represent standard deviation

[1]Birr refers to Ethiopian currency, 1USD=19.76 during survey period

Table 2. Comparison of replacer and non-replacer groups

| Categorical variables | Non-replacer | Replacer | $\chi^2$ |
|---|---|---|---|
| Sex of household head (Male) | 85.7 | 83.6 | 0.117ns |
| Perception on seed affordability | 39.2 | 83.5 | 32.99*** |
| **Continuous variables** | | | **T-value** |
| Age of household head | 49.7 (11.1) | 36.12 (9.3) | 8.21*** |
| Family size | 5.67 (2.19) | 6.28 (2.52) | 1.54* |
| Experience on haricot bean production | 6.91 (4.4) | 10.40 (5.24) | 4.20*** |
| Number of field demonstration attendance | 0.5 (0.12) | 1.21 (0.13) | 3.37*** |
| Number of seed extension contact | 1.02 (0.19) | 2.70 (0.190 | 5.61*** |
| Distance from certified seed distributors | 13.14 (9.87) | 22.33 (8.95) | 5.97*** |
| Cultivated landholding | 0.40 (0.30) | 0.72 (0.47) | 4.60*** |
| TLU | 0.94 (0.81) | 3.67 (2.08) | 9.44*** |

Note: *** and * significant at 1 and 10% significance level respectively

Among others, agricultural extension services affect farmers' decision to improved technology. Farmers in the study area had contacts with extension agents for 1.2 days in the average per year, which is very low, and there is a need to strengthen extension services.

Mean land holding of farmers was 0.87 hectare, which is below the national average of 1 hectare. The mean cash income from sale of farm products was 3933 Birr and the difference in income among the studied farmers was big with a range from 750 to 20850 Birr. Moreover, 61% of respondent farmers participated on off-farm activities and generated additional income other than their own farm. Out of the total respondents, 59% perceived that newly released varieties of haricot bean are more yielding than old varieties. About 64% of the respondents perceived that recently released varieties are easily accessible.

**Replacer and non-replacer households**

The category wise analysis of respondents based on replacement decision indicated that there is a statistical difference between the two groups in their household related characteristics (age, family size, experience in haricot bean farming), access to institutional service (attendance in field demonstration, number of seed extension contact), resource endowment (cultivated land, TLU) and proximity to certified seed distributors (Table 2). Except sex of the household head, all variables considered to compare the two groups were statistically significant. The two groups' perception of seed affordability to replace variety was also statistically significant.

**Varietal Attributes:** Four Haricot bean varieties, namely, *Hawassa Dume* (SNNPR-120), *Ibbado* (AFR-712), *Nasir* (Dicta-105) and Red *Wolaita* were the dominant varieties under production during the 2014/15 cropping season in the study area. The response of variety replacers was significantly different from non-replacers on three most important factors: perceived market price for the new variety, yield and cooking quality ($p<0.01$). The majority of the replacer group (83.8%) perceived new variety fetch high price in market as compared to old variety ($\chi2=39.39$). Similarly, replacers perceived the new varieties are better in yield ($\chi2=12.90$) and cooking quality ($\chi2=19.48$) (Table 3) than the non-replaces. The positive perceptions by replacer farmers on the traits of new varieties would influence their decision to replace the old by new ones.

Further discussion with key informants held at *Kebele* level revealed that, *Hawassa Dume* variety is a high yielder but less preferred for household consumption due to its poor cooking quality with local dishes. Although farmers perceive the new varieties to be superior in yield, they may continue growing the old varieties for their cooking quality. For instance, the discussants revealed that the old variety Red *Wolaita* gives less yields but it has superior cooking quality and suitable to be consumed with *kocho* as well as with maize.

Table 3. Perception of farmers on variety replacement traits

| Major variety replacement traits | | Variety replacement category | | | | Chi-square |
|---|---|---|---|---|---|---|
| | | Replacers | | Non-replacers | | |
| | | Count | % | Count | % | |
| Market price of new varieties | High | 88 | 83.81 | 22 | 38.6 | 39.39*** |
| | Low | 17 | 16.19 | 35 | 61.4 | |
| Yield of new varieties Per hectare? | High | 83 | 66.94 | 13 | 34.21 | 12.90*** |
| | Low | 41 | 33.06 | 25 | 65.79 | |
| Cooking quality of new varieties over old | Superior | 105 | 84.68 | 19 | 50 | 19.48*** |
| | Inferior | 19 | 15.32 | 19 | 50 | |

***, significant at 1%.

**Varietal replacement pattern:** Respondent farmers have grown Red *Wolaita* (64.20%), *Nasser* (14.81), *Ibbado* (9.88%), *Awash Melka* (2.47%) and local variety *Wahe* (8.64) in the last five years. During the 2014/15 *meher* season, respondent farmers grew *Hawassa Dume* (71.67%), *Nasser* (3.09%), *Ibbado* (1.85) and Red *Wolaita* variety (23.46 %). The findings show that there is a reduction in the type of improved variety portfolio (i.e. 5 to 4) as well as considerable replacement of old variety with recently released haricot bean overtime (40.74%).

**Determinants of Varietal Replacement**

Among 13 variables included in the model, seven variables significantly affected variety replacement decision by farmers (Table 5). The Pearson Goodness-of-fit chi Square (483.60) value shows, the logit model properly fit the data included in the analysis. The finding revealed that, the age of household head negatively and significantly influenced the likelihood of replacing the old with recently released haricot bean varieties ($P<0.01$) (Table 4). Similarly, Oladele and Wakatsuki (2011) reported that age negatively influenced replacement and adoption of rice varieties in Nigeria and Ghana. Land holding of respondent households had positive and significant influence on variety replacement decision ($p<0.1$) (Table 4). This implies that those farmers with larger land holding are more likely to use recently released varieties to replace the older varieties. The result is in agreement with Katengeza et al. (2012). Moreover, it is frequently argued that farmers with larger farms are more likely to replace an improved variety compared with those who owned smaller land as they can afford to devote part of their fields (sometimes the less productive parts) to try out new technologies and practices (Ghimire et al., 2012).

Market price of the Haricot bean varieties used for replacement positively and significantly affected varietal replacement ($p<0.1$) (Table 4). Those farmers who perceive higher market prices for the new Haricot bean varieties compared with the varieties that they were growing before more likely replace with new varieties. This clearly shows that, there is a need to link Haricot bean growers with high valued markets like Ethiopian commodity exchange to facilitate varietal replacement decision. The result is in line with Oladele and Wakatsuki (2011) that found market price influence positively replacement of improved rice varieties.

Livestock ownership of household in TLU is positively and significantly ($p<0.1$) related with varietal replacement decision (Table 4). Those farmers who owned larger livestock are more likely to replace old varieties with new ones. Livestock are important as income sources and draft power in the study area. The result is in accordance with the study of Katengeza et al. (2012) who found that, livestock ownership positively influence the adoption of improved maize varieties in Malawi.

Participation in extension demonstration is an essential means to introduce a new technologies, and practices and diffuse information to farmers. Participation on demonstration significantly was related with variety replacement (at $p<0.05$ probability level) (Table 4), which indicate that those farmers who participate on demonstration are more likely to have better information and as a result replace the old varieties with the new. Katengeza et al. (2012) also found that those household heads who participated on demonstration more likely adopt improved maize variety in drought prone area.

Table 4. Determinants of varietal replacement

| Variables | Coefficient | Std. Errors | P-value | Odds ratio |
|---|---|---|---|---|
| Constant | -1.563 | 1.754 | 0.373 | 0.209 |
| Age of household head (years) | -0.110*** | 0.036 | 0.002 | 0.895 |
| Haricot bean farming experience (years) | -0.028 | 0.104 | 0.785 | 0.971 |
| Land size (Hectares) | 1.572* | 0.851 | 0.065 | 4.818 |
| Appropriate price for the yield of new varieties (Yes=1) | 1.447* | 0.780 | 0.064 | 4.250 |
| Livestock ownership (TLU) | 0.749* | 0.424 | 0.077 | 2.116 |
| Educational status (Formal schooling) | 0.293 | 0.227 | 0.196 | 1.341 |
| Extension contact (Days) | 0.235 | 0.362 | 0.516 | 1.266 |
| Cooking quality of new varieties (Yes=1) | 1.387 | 0.902 | 0.124 | 4.003 |
| Timely available of new varieties (Yes=1) | 1.743** | 0.835 | 0.037 | 5.717 |
| Participation on demonstration (Days) | 1.609** | 0.628 | 0.011 | 4.998 |
| Participation on off/non-farm (Yes=1) | -0.978 | 1.126 | 0.385 | 0.376 |
| Cash from sale of farm products (Birr) | 0.0001 | 0.000 | 0.451 | 1.000 |
| Better yield of new varieties (Yes=1) | 2.903*** | 0.960 | 0.003 | 18.24 |
| Pearson Goodness-of-fit chi Square = 483.60 | Degree of freedom=148 | | | |
| Correctly predicted overall sample= 93.21 | LR chi2 (13) = 123.54 | | | |
| Correctly predicted variety replacers= 95.97, | | | | |
| Correctly predicted variety non-replacers= 84.21 | Pseudo R2= 0.6999 | | | |

Note: ***, ** and * significant at 1, 5 and 10% significance level respectively
Source: Model output (2015)

How haricot bean growers perceived yield per hectare obtained from use of recently released varieties was found to positively and significantly influence varietal replacement decision(at $p<0.01$ probability level) (Table 4). The significant influence of higher yield on adoption of new varieties were reported on various crops including sweet potato in Boloso Sore, Ethiopia (Endrias, 2003), soybean in Nigeria (Ojiako et al., 2007), and subsistence-oriented farmers in Punjab (Smale and Nazli, 2014).

The variables such as extension contact, haricot bean farming experience, educational status, contact with development agent, participation on non/off farm income, annual income and cooking quality did not have significant effect on variety replacement against our prior expectations. This may be due to farmers' production objectives and weak extension service for Haricot bean. In the study area there are about three extension workers per a *kebele* and all farmers have access to extension services, although, farmers differ in exploiting the extension services delivered. Therefore, it is justified to conclude that factors other than extension service affected varietal replacement in the study area. The other crucial variable but that has insignificant relationship with varietal replacement adoption was cooking quality. The result obtained by Timu et. al (2014), showed that ease of cooking positively influenced the adoption of improved sorghum in Kenya. One of the reasons for less influence of cooking quality in replacement of haricot varieties could be due to the reason that farmers mainly produce the crop not for own consumption but to sell. However, the discussions with key informants, revealed that farmers prefer to grow Red *Wolaita* variety (improved but old) for its taste and high compatibility with *Kocho*, a local dish made from *Enset* (*Enset ventricosum*). Recently released variety specially *Hawassa Dume* is meant for market but not home consumption by farmers and evaluation for cooking quality did not appear as a strong determinant for deciding on variety replacement.

Other insignificant variable was educational status of households. In studies related with improved variety adoption, education found to be significantly influencing factors (Timu et.al, 2014; Zegaye et. al., 2001). Whereas, Geta (2003) found that education has insignificant influence on adoption of improved sweet potato varieties.

## CONCLUSIONS AND RECOMMENDATIONS

This paper critically examined determinants of haricot bean varietal replacement by farmers in *Boricha* district; Ethiopia. Those varieties released from different organizations have better productivity, less prone to diseases and lodging. The finding of the study showed that, age of household head ($p<0.01\%$)

negatively and significantly influenced varietal replacement decision. Whereas, land holding ($p<0.1\%$), perceived appropriateness of market price ($p<0.1\%$), livestock ownership in TLU (0.1%), availability of recently released varieties ($p<0.05\%$), participation of household head in field demonstration ($p<0.05\%$) and perception of farmers about yield of recently released haricot bean varieties ($p<0.01\%$) significantly and positively influenced varietal replacement decisions. Thus, timely availing improved varieties by creating linkage among stakeholders is important. Field demonstrations in both Farmers Training Centers and farmers' field are very important to evaluate and compare the attributes of the newly released varieties and build the confidence of farmers to replace the old ones.

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