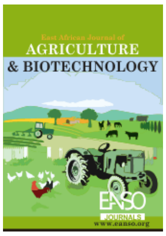

East African Journal of Agriculture and Biotechnology
eajab.eanso.org
Volume 6, Issue 1, 2023
p-ISSN: 2707-4293 | e-ISSN: 2707-4307
Title DOI: https://doi.org/10.37284/2707-4307

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia

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Article DOI: https://doi.org/10.37284/eajab.6.1.1230

Date Published:

29 May 2023

Keywords:

Adoption, Adoption Intensity, Double Hurdle Model, Mung Bean.

ABSTRACT

The mung bean crop is an essential legume crop among smallholder farmers because of its benefits like income generation, foreign currency earnings, supplies for local industries, and rural employment. The study intended to find determinants of the adoption of the mung bean variety in the Ebinat District. A multipurpose random sampling technique was used, and 150 smallholder farmers were chosen randomly to collect primary and secondary data. Both econometrics modelling and descriptive statistics were employed to analyse the data. A double hurdle model was used. It showed that, respectively, 46% and 54% existed adopters and non-adopters of mung beans. Model outcomes indicated that total livestock holdings, training, participation in demonstration sites, sex, and access to market information influenced mung bean cultivars. Additionally, the government, non-governmental organizations, and stakeholders should focus on strengthening participation in demonstration sites and training, encouraging, and improving the extension system, and increasing access to farmer's market information.

APA CITATION

Tigabu, G. (2023). Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia. *East African Journal of Agriculture and Biotechnology*, *5*(1), 155-168. https://doi.org/10.37284/eajab.6.1.1230

CHICAGO CITATION

Tigabu, Getnet. 2023. "Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia". *East African Journal of Agriculture and Biotechnology* 6 (1), 155-168. https://doi.org/10.37284/eajab.6.1.1230

HARVARD CITATION

Tigabu, G. (2023) "Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia", *East African Journal of Agriculture and Biotechnology*, 6(1), pp. 155-168. doi: 10.37284/eajab.6.1.1230.

IEEE CITATION

G. Tigabu, "Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia", *EAJAB*, vol. 6, no. 1, pp. 155-168, May. 2023.

MLA CITATION

Tigabu, Getnet. "Determinants of Adoption of Mung Bean Variety in Ebinat District, Ethiopia". *East African Journal of Agriculture and Biotechnology*, Vol. 6, no. 1, May. 2023, pp. 155-168, doi:10.37284/eajab.6.1.1230.

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Article DOI : https://doi.org/10.37284/eajab.6.1.1230

INTRODUCTION

Ethiopia's agriculture is the backbone of a low-income, low-yielding rain-fed agricultural system. Despite government initiatives to promote contemporary intensive farming methods, the use of improved fertilizers and seeds is very limited. Smallholding of agricultural inputs, financial services, enhanced production technologies, agricultural and irrigation markets, and more serious land management methods that worsen land degradation are all contributing factors to low agricultural productivity (Degaga & Angasu, 2017).

In Ethiopia, mung beans are grown mainly by Small-scale farmers who have a lesser output capability for pulse crops because of the drier bordering environmental situations. Because of the producers in the production industry, the fruits of the muscle are used as large foods, but they can be important for the cultivation of income. The type of mung bean used for indoor events may vary from one that can provide stable performance under harsh environmental conditions. The results of agricultural practices that serve as food, medicine, economics, ecology, socio-cultural, religious, traditional, and cultural needs. Mung beans are cultivated for their edible seeds, income generation, and fodder (CSA, 2015).

It is important to clarify the importance of improved nutrition and distribution of mung beans to change the current state of food security problems in the study area. Food consumption (as a protein-rich food source), high market demand (source of income and foreign exchange earnings), agricultural purpose, raw materials for local industries, and agroecological suitability are important for growing this cropped area of the study. Towards the end, the adoption of mung bean varieties was promoted in the study area for five years. At the site level, farmers who wanted to grow mung beans were designed for the farmer's extension feed (Asfaw *et al.* 2012).

The adoption rate of mung bean is not clear as farmers living in the Ebinat area have different geographical location and cultural practices and their technology adoption problems may vary. This study aims to reveal these problems. Understanding the current recommended adoption conditions for mung bean cultivars to promote higher adoption rates is a key concern for those concerned with agricultural development. The adoption rate of mung bean varieties among farmers still remains low. Therefore, this research aims to make two important contributions to smallholder farmers, namely providing the necessary information about the adoption of mung bean varieties and selection and estimation techniques.

CONCEPTUAL FRAMEWORK

Figure 1 illustrates the results of the interaction of several aspects that affect the adoption and extent level of adoption of the mung bean variety in the study. Socioeconomic factors (animal husbandry, market news, education, plus off/nonfarm involvement, and demographic characteristics are background factors, such as (gender, age, and availability of labor) and institutional factors (distance to the nearest place). Market, expansion of contacts with, frequency, credit of visits, participation in demonstration and training sites, and it is expected that the characteristic factors of the farm (land tenure) affect the adoption and intensity of the variety of mung bean in the study area, as shown as *Figure 1* presented**.**

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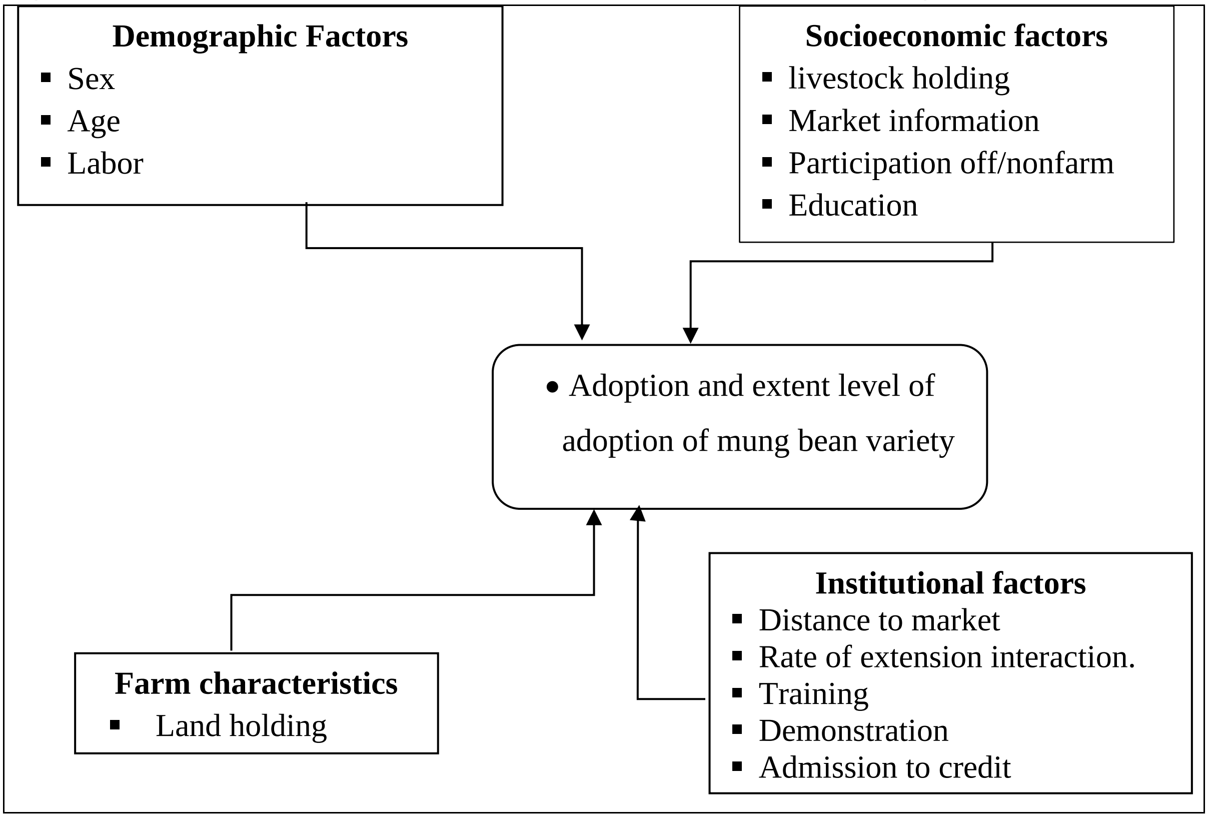
Figure I: Conceptual framework adoption in addition to intensity of mung bean variety.



METHODOLOGY

Description of the Study Area

Ebinat is one of 13 districts and 5 cities in the South Gondar Administrative Zone. Ebinat is bordered by Farta District in the South, Fogera District in the Southwest, Libo Kemekem District in the West, Balsa District in the North, Meket District in the East, and Wag Hemra Zone in the Northeast. Ebinat is divided into 29 rural kebeles and 2 urban kebeles according to the traditional agroecological classification; there are three agroecological zones in the area. Ebinat is defined as 24% highland, 43% moderate, and 33% lowland. The yearly regular rainfall in the district bounds from 850 to 1035-mile meters. The annual middling temperature also ranges between 16-28 degree Celsius. The altitude of the district ranges from 1600 to 2700m asl (EWAO, 2022).

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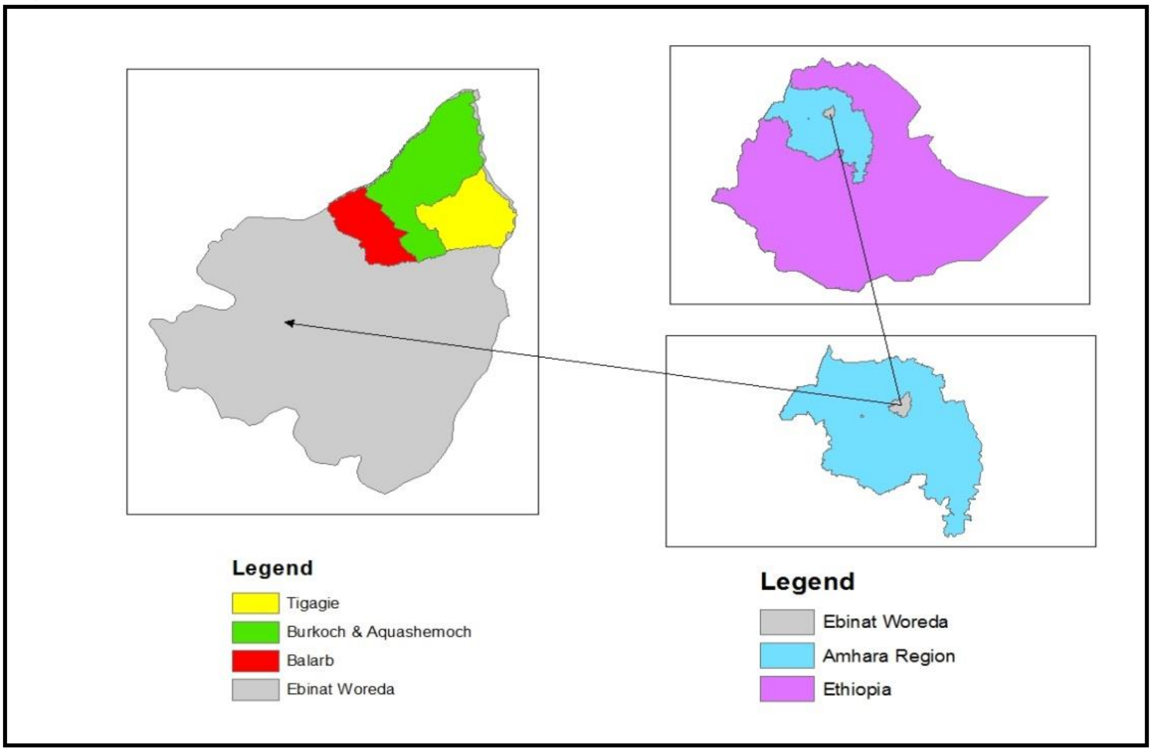
East African Journal of Agriculture and Biotechnology, Volume 6, Issue 1, 2023
Article DOI : https://doi.org/10.37284/eajab.6.1.1230

Figure II: Map of the study area



Sample Size Determination and Sampling Technique

A multistage sampling technique was employed to select a representative sample of farmers from 29 rural kebeles. In the first stage of the sampling technique, the Ebinat district was purposively selected. The district was selected because of its unique production of Moon Bean, agroecological suitability, and accessibility. At the second level, Ebinat Woreda is classified as a producer of kebeles for the mung bean variety, and the remaining one is not a producer of the mung bean variety. Out of 29 Kebeles, 6 Kebeles were producers of mung bean, and the other 23 Kebeles were not producers of cowpea. At the third stage of the sampling technique, Balarb, Berkoch, Akashmoh, and Tegagi Keble were randomly selected from mean bean growing (producers) Kebeles. Finally, respondents in sampled Kebeles were classified into adoption besides non-representative mung bean cultivar participants from mung bean cultivar producers. Using a straightforward random sample method in the chosen Kebeles, 150 representative households were chosen at random for the sampling process.

When calculating the sample size, if there is no relevant work before, it is recommended to conduct an experimental study and provide the necessary data to determine the value of P, but due to a lack of time and financial resources, the researchers were unable to conduct surveys. Current research pilot. Therefore, when calculating the appropriate sample size for P. following assumptions, two conditions should be considered. First, if any estimate of P is known, you can use that value in the equation. Second, if the estimated value of P is unknown, P = 0.024 should be used. This value provides a large enough sample size to confirm Cochran’s (1977) predictions.

$$n = \frac{z^2 q * p}{e^2} \quad [1]$$

Where, n = sample size, z = confidence level (α=1.96), P = sample proportion, q = 1-p, e = given precision rate or acceptable error

Where: Z=1.96, of the selected critical value, p is the valued proportion of an attribute P = 0.024 present in the population in an area of the study; q =1-p i.e., 0.976, and e = 0.0245 is the favorite level of precision.

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$P = \frac{4770}{201257} = 0.0236 \approx 0.024$, $q = 0.976$ $e = 0.025$

Hence, Z = 1.96; $n = \frac{z^2qp}{e^2} = \frac{1.96^2 \times 0.024 \times 0.976}{0.0245^2}$ =149.9 ≈150

Method of Data Collection

Both primary and secondary sources of information were employed in this investigation. Semi-structured one-on-one interviews were used to gather primary data. Interview schedules with the enumerator were pre-tested and updated. To adequately examine the social and cultural practices or attitudes, the study was supported by the qualitative data obtained from interviews. The secondary data was gathered from secondary sources that include books, the Ebinat Woreda agriculture office, the Ebinat Woreda administration office, journals, and other published Federal and Regional level reviews of related literature and District level information on the mung bean variety of the study area.

Method of Data Analysis

To ensure correctness, homogeneity, and consistency, field data were edited and cleaned. Data processing tools from STATA version 14 were used to enter the data into computer software for analysis. Data were analysed and discussed in this study utilizing both descriptive and econometric models that analyzed the information gathered.

Descriptive Analysis

The analysis of the mean, standard deviation, frequency distribution, percentages, chi-square, and t-test were utilized in descriptive statistics. A chi-square test and an independent sample t-test were used to identify variables that differ significantly among adopters and non-adopters. A chi-square test was applied to compare about qualitative characteristics of adopters and non-adopters. A t-test was used to see if there is a statistically significant difference between the mean of the adopter and non-adopter classes concerning a continuous variable.

Econometric Analysis

According to Cragg (1971), farmers' decision to adopt is faced with two tiers. These are whether to adopt or not adopt the knowledge and stage that exists related to the adoption level. Suppose the relationship between these two ideas is connected by (Berhanu and Swinton, 2003).

Heckman's selection model is another way to use it. Regarding Jones (1989), it is significant that one of the sources of zero for the variances between the two models. Under no circumstances will non-adopters adopt the Heckman model. On the other hand, non-adopters are the utility maximization model's corner solution in the two-column model. Heckman's premise concerning mung beans appears overly restrictive. Changes in input costs or comprehensive marketing strategies may persuade non-adopters to adopt it. As a result, the two-span model is superior to Heckman's. The double hurdle model was employed in this study to identify the factors that influence and the extent to which different mung bean cultivars are adopted. Because it enables differentiating between the adoption rate and the adoption rate of mung bean production through two separate stages, the two-column model was used for this study. The model estimation procedure involves the use of all sample populations to identify the factors that influence the decision of adoption activities by running probabilistic regression in the first stage and the analysis of the truncated regression model of the family adopted in the second stage to analyse the degree of adoption. Therefore, it is appropriate to adopt the two-column model in this study. Since the Heckman model is limited by its assumptions, it is determined by the same underlying process and influencing factors, and the second affects the first dependent variable.

In the double-barrier model, there are no restrictions, and it is more flexible. It can be estimated separately according to the explanatory variable elements at each decision-making stage. This means that the decision-making levels of mung beans can be analysed separately. Because of this separability, probabilistic regression can be

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used to obtain an estimate of the adoption decision, and truncated regression analysis can be used to adopt a decision-level estimate. According to Burke (2009), if possible, separable estimates cannot be confused with separable estimates. Then, to develop the likelihood function, we start from the first stage (adoption decision), and through probabilistic analysis, we identify families based on whether they are adopters or non-adopters.

The binary index function is di. The number is "1" if farmers choose to grow mung bean types during the 2018–2019 production year; otherwise, the value is "0." Let qi also represent the area of land designated for growing mung beans in a particular production year. The probability function of the two-column standard model can be therefore derived as follows:

$$\text{Log probit} = L(\alpha, \beta) = [1\text{-}\phi\ (di\alpha)\ \phi\ \frac{xi\beta}{\sigma}]\ [2]$$

$$\text{Log truncate} = [((\phi\ (\frac{dif}{\sigma}))\ (\frac{q(q_1 - x'L\beta}{\sigma}))] \quad [3]$$

Where Φ is the cumulative distribution function of the standard normal distribution and σ is the variance of the error components. The first line represents the log-likelihood for a probit, while the second line represents the log-likelihood for a truncated regression, with the continuous dependent variable in the second stage (in our instance, the acreage allotted for mung bean in the survey year) being truncated at zero value. The log-likelihood from the double hurdle Cragg type model is hence the result of adding the log-likelihoods from a probit and a truncated regression. Because of this, it is possible to estimate these two component pieces separately from this reduced regression (Koch, 2008; Burke, 2009). Consequently, the double hurdle model's log-likelihood function is as follows:

$$\text{LogL} = L(\alpha, \beta) = [1\text{-}\phi\ (di\alpha)\ \phi\ \frac{xi\beta}{\sigma}] + [((\phi\ (\frac{dif}{\sigma}))\ (\frac{q(q_1 - x'L\beta}{\sigma}))$$

That Φ is the standard normal cumulative distribution function and ϕ also the density function. The maximum likelihood estimation method is used to estimate the log-likelihood function. Finally, (Greene, 2000) can be used to calculate the likelihood ratios for the test statistics double hurdle model.

$$LR = -2[\text{logL LT}-(\text{logL LP}+ \text{logLL TR})] \approx x^2$$

When: The log-likelihoods of the relevant Tobit, Probit, and Truncated regression models are LT=LLT, LP=LLP, and LTR=LLTR. When the null hypothesis is rejected (LR >x2), it confirms the superiority of the Double-hurdle model over the Tobit model and shows that the adoption and level of adoption of the mung bean variety is decided in two distinct stages.

RESULT AND DISCUSSION

Descriptive Findings

Demographic Characteristics Households

About 69 (46%) sampled households head were adopters and 81(54%) sampled household heads were non-adopters from the study area. According to *Table 1*, of the total sampled household heads, 65 (94%) were headed by men, whereas 4 (6%), on average, were female household heads of mung bean farmers. The proportion indicates male headed were more adopting the mung bean variety than female household heads. These results show that in the district, men have more access to land that can be used to produce mung bean variety while 68(84%) male-headed and 9(16%) female-headed not mung bean producers. It was determined that the chi-square test of the sex distribution between adopters and non-adopters was significant. That implies that there is a sex relationship between adopters and non-adopters. According to survey findings (*Table 1*), around 50 (33%) of the household heads had literate, while the remaining 100 (77%) were illiterate.

Agricultural training also encourages the acceptance of cutting-edge technology. Approximately 46% of adopters and 2% of non-adopters among the sampled farmers had taken part in the training for the mung bean variety about production and other activities, while about 54% of farmer adopters and 98% of non-adopters have not participated in training through the

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Article DOI : https://doi.org/10.37284/eajab.6.1.1230

interview time by different organizations. The x^2 test outcome shows that, at a 1% level of significance, the amount of training acquired by adopters compared to non-adopters was significant. This indicates that farmers who receive training are more likely to adopt the mung bean variety because training makes it simpler for farmers to acquire and comprehend technology than non-trainer farmers (*Table 1*).

Participation in the demonstration is important to disseminate the upscale mung bean variety at the demonstration site. These help farmers compare new and existing technologies. As can be seen in *Table 1*, only 5% of non-adopters and 49% of adopters participated in local mung bean crop demonstration sites, while 95% of non-adopters and 49% of adopters participated in field day activities for mung bean crops. In the x2 test of involvement in the demonstration, there is a substantial difference between adopters and non-adopters. Accordingly, there is a 1% significant level relationship between adopters and non-adopters in terms of demonstration activities.

Access to market information is increasing the adoption of the mung bean variety. Radio, mass media, traders, extension agents, and mobile devices used by the household head are sources of market knowledge that might help him or her learn about the circumstances surrounding production and marketing. Farmers can learn about new technology in the nation and their communities by using these communication variables. Of the respondents in the sample, about 56% of adopters and 44% of non-adopters had easy access to market information, while just 4% of adopters and 96% of non-adopters did not get information. The difference between adopters and non-adopters was determined to be significant by the x2 test of access to market information. Accordingly, there is a 1% significant level relationship between adopters and non-adopters in terms of obtaining market information (*Table 1*).

Table 1: Sample Households' Demographics and Characteristics

Variable		Adopter N=69		Non-adopter N=81		X^2 value	P value	Total	
		f	%	f	%			f	%
Sex	Male	65	94	68	84	3.892**	0.048	133	89
	Female	4	6	9	16			17	11
Education	Illiterate	24	35	26	32	0.121	0.728	50	33
	Literate	45	65	55	68			100	67
Training	Yes	32	46	2	2	40.98***	0.000	34	23
	No	37	54	79	98			116	77
Demonstration	Yes	34	49	4	5	38.72***	0.000	38	25
	No	35	51	77	95			112	75
Credit	Yes	38	55	52	64	1.293	0.256	90	60
	No	31	45	29	34			60	40
Participation off/nonfarm	Yes	18	26	23	28	0.100	0.752	41	27
	No	51	74	58	72			109	73
Market information	Yes	39	56	3	4	51.56***	0.000	42	28
	No	30	44	78	96			108	72

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

Source: Computed from survey data, 2020

Access to credit is an essential institutional service for the improved technology adoption decision of the farmers, particularly for farmers facing a shortage of finance to purchase agricultural inputs. To purchase agricultural inputs availability of credit was found important economic variable, mostly for farmers who did not have enough amount of money to purchase it.

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Due to this reason, the availability of credit created strong assistance for farmers to adopt the mung bean varieties. As presented in *Table 1*, about 60% of households got access to credit, while about 40% do not have access to credit.

Participants in off/nonfarm activities are household members and it has been done within the same year as the main farm operation. Off-farm income means income obtained from any activities outside the farm. Due to the lack of adequate infrastructure in the research area, most farmers who were interviewed stated that they did not participate in off- or non-farm activities. According to shown in *Table 1*, about 27% of farmers were participating in off/nonfarm activities, while about 73% of farmers did not participate in off/nonfarm activities.

Econometric Results

Model Test

The result of the double hurdle regression model is shown and discussed. Different socioeconomic, technological, and institutional aspects influenced farm households' decisions to adopt. Thus, adoptions of mung bean varieties were affected positively and significantly by sex, training, attendance on participation at demonstration sites, and access to market information, whereas overall livestock holding had a negative and significant impact on the adoption of mung bean cultivars. However, the intensity of adoption was impacted by total land holding, training, access to market information, and frequency to contact extension services positively and significantly, while participation in off/nonfarm activities affected the intensity of adoption of the mung bean variety negatively and significantly.

As a result, various factors play a role across time and in various contexts in explaining how farmers adopt new technologies. Based on theoretical models and empirical data, several factors are hypothesized to affect the acceptance and intensity of the mung bean variety. When the determinants in both hurdles are comparable, it is possible to compare when the Tobit model has nested these two models in the Cragg model using the common likelihood ratio test (Buraimo et al., 2010). Calculations for the statistics test can be found in Greene (2000):

$$LR= -2[logLLT-(logLLP+logLLTR)] \approx x^2$$

Where the log-likelihoods of the Tobit, probit, and truncated regression models, respectively, are LT=LLT, LP=LLP, and LTR=LLTR. The Double-hurdle model outperforms the Tobit model, and the rejection of the null hypothesis (LR> x2) indicates that the decisions about adoption and level adoption are made in two different stages (*Table 2*).

Table 1: Test Statistics on Double hurdle (Probit + Truncated model) versus Tobit model

	Probit	Truncated	Tobit
Number of observations (N)	**150**	**69**	**150**
Wald > x^2	92.3	167.05	132.62
Prob > x^2	0.000	0.000	0.000
Log –L	-57.42	149.57	108.53
Test statistics Double hurdle I=32.76 >$x^2$0.05(16) =25.98			

Source: Own Estimation Result, 2020

The truncated model's log-likelihood function and the probit model's log-likelihood function are added to create the log-likelihood function of the double hurdle model. When Probit model likelihood = -57.42, Truncated Model likelihood = 149.57, and Tobit model likelihood = 108.53. The calculation was thus:

LR= -2((-57.42+ 149.57) -108.53)

= -2(92.15 -108.53)

= -184.3 + 217.06

= 32.76

Since LR-Test Double Hurdle: LR =32.76 > x^2 (13), 32.76>22.36

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Based on the test statistics, LR = 32.756 and above, and at a 5% level of significance, the tabulated result, x2 (13) =22.36. Consequently, the double hurdle is a better model than the Tobit model. This implied that the farmer's decision on adoption and the level of adoption of the mung bean variety were made at two separate stages. The test adapts to the former studies whose effects showed that the decision to adopt and intensity of agricultural technologies was made in two isolated stages (Kuti, 2015; Gebremichael and Gebremedhin, 2014).

Determinants of Adoption and Intensity of Adoption of Mung Bean Variety

Estimates of the parameters of the variables expected to determine the adoption and intensity of adoption of mung bean variety. Five variables were found to be significant at 1%, 5%, and 10% levels of significance in affecting farmers' decisions to adopt the mung bean variety out of the model's thirteen explanatory variables. Five variables were shown to be significant in impacting the intensity of adoption at 1%, 5%, and 10% significant levels. The variables are sex, livestock ownership, demonstration participation, training, and market information access. The factors include total land area, training attendance, frequency of contact with extension services, involvement in off-farm activities, and access to market data.

Table 2: Determinant of adoption factors and adoption intensity of mung bean variety

Variables	Probit regression			Truncated regression		
	Coef	Std. Err	Marginal effect	Coef	Std. Err	Marginal effect
Sex	0.297**	0.146	0.042	-0.01	0.000	0.229
Age	-0.017	0.018	0.341	0.000	0.001	0.832
education	0.124	0.119	0.298	-0.080	0.007	0.270
Land size	0.185	0.158	0.242	0.060***	0.011	0.000
Livestock	-0.090**	0.050	0.071	0.003	0.003	0.312
Demonstration	0.407***	0.118	0.001	0.006	0.007	0.383
Training	0.454***	0.114	0.000	0.014**	0.008	0.073
Frequency of extension	-0.069	0.080	0.389	0.011**	0.005	0.034
Credit	-0.122	0.133	0.359	0.008	0.008	0.319
off/nonfarm participation	0.167	0.136	0.219	-0.01**	0.009	0.044
Distance	0.002	0.002	0.337	-0.00	0.000	0.557
Market information	0.450***	0.112	0.001	0.023***	0.000	0.001
Labour availability	0.115	0.105	0.273	-0.00	0.007	0.378
Constant	-0.527	1.663	0.751	0.204	0.048	0.000
Sigma				0.027	0.002	0.000
Number of observations=150				Limit lower=0		
LR chi (13) =92.14				Upper limit=+inf		
Prob >x^2=0.000				Number of observations=69		
Log-likelihood = -57.42				Wald > x^2(13) =167.05		
Pseudo > x^2=0.445				Prob >x^2=0.000		
				Log-likelihood =149.57		

*Note: ***, **, and* show the values statistically significant at 1%, 5%, and 10% levels, respectively.*

Source: Own Estimation Result, 2020.

The decision of the sample farm households to adopt the mung bean variety has been found to be strongly influenced by the five independent variables. Four variables such as sex, participation at the demonstration site, access to market information, and training are factors positively affecting the adoption of the mung bean variety, while the remaining variable total livestock

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Article DOI : https://doi.org/10.37284/eajab.6.1.1230

holding is adversely affecting the adoption of the mung bean variety. The four explanatory variables, which were training, access to market information, frequency to contact extension services, and total land size are affecting the extent of adoption of mung bean variety significantly and positively as participation in off/nonfarm activities influenced the adoption of several mung bean varieties interpreted adversely and discussed below.

Head of the household sex: - One of the factors influencing the adoption of the mung bean variety is the sex of the household head. At a 5% level of significance, the probit model shows that the household head's sex had a favorable and substantial impact on the adoption of the mung bean variety (*Table 3*). This demonstrates that male-headed households are more likely to adopt mung bean varieties than female-headed households because they have better access to knowledge on their production. Female-headed families are not more likely to adopt the mung bean variety than male-headed households, nor do they have better access to information about it. This is consistent with the result of Beshir (2014), where the gender of the household head was significant and had a positive relationship with the intensity of use of improved forages in Ethiopia.

Participation in a demonstration (demonstration): - Farmers can increase agricultural productivity and output by learning new skills through demonstration. The probit result shows that a demonstration had a favorable and significant impact at a 1% significant level on the probability of adopting a mung bean production package (*Table 3*). This demonstrates the importance of the demonstration strategy for practically transferring agricultural production innovations to farmers. When farmers apply a new technique, they can consider the benefits and drawbacks of the new technology, which can speed up acceptance and help them use the new technology effectively. This outcome demonstrates that a farmer who takes part in the demonstration is more likely than other farmers to adopt the mung bean variety. This conclusion was in line with what Alemitu (2011) and Hadush (2015) had discovered.

Agricultural Training (Training): - Training is a machine to promote farmers' knowledge, technical information for new technology, and knowledge of adoption and production processes that improve farmers' capacity for making decisions. This training can enhance the capacity creation and awareness raising of mung bean producers in the research area. As a result, household heads who have the chance to take part in mung bean variety instruction are more likely to choose that variety for mung bean cultivation in the research area. At 1% and 5% levels of significance, farmer training attendance was positively and substantially associated with the adoption and intensity of the mung bean variety adoption, with all other factors being constant (*Table 3*). The probit model result shows that the marginal effect in favor of the household head adopting the mung bean variety improves by a factor of 49% if the household head engages in training. This further suggests that farmers taking part in training get the necessary information and expertise about the utilization of the mung bean variety, increasing the likelihood that respondents will embrace the new variety. According to the results of truncated regression, households that receive training develop their abilities and understanding of production methods, and extent level adoption of mung bean variety than non-trainer, which helps to increase production and productivity of mung bean variety by 35%. This study's findings are consistent with those made by Alemitu (2011), Hadush (2015), and Wuletaw (2015), who found that adoption and intensity of adoption of improved haricot bean varieties in Dale Woreda, SNNPRS, upland rice in Tselemti district, Northwestern zone of Tigray, and malt-barley technology in North Gondar, respectively, are positively influenced by training.

Participants on off/nonfarm (part off/non): - activities are household members and it has been done within the same year as the main farm operation. Off-farm income means income obtained from any activities outside the farm. The result of truncated regression indicates that the participation of off/nonfarm income had a significant (negative) effect on the intensity of

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Article DOI : https://doi.org/10.37284/eajab.6.1.1230

adoption of the mung bean variety at a 5% level of significance (*Table 3*). This shows that farmers who adopted the mung bean variety intensely had access to extra sources of income from off-farm pursuits and did not take part in the intensity of mung bean variety adoption. The marginal effect result indicates that, while other variables remained constant, there was a 10% reduction in the likelihood of choosing to adopt the mung bean variety intensively. Therefore, the decision of the household to embrace technology was negatively impacted by off-farm incomes. This finding was like those of Akudugu et al. (2012), who found that off-farm activities had a detrimental impact on farm households' decisions to embrace modern agricultural production technology in Ghana.

Livestock owned (TLU): **-** A continuous variable indicating the total quantity of cattle owned by the household, expressed in tropical livestock units. The outcome of probit regression shows that, at a 5% level of significance, the number of livestock owned by household heads negatively and significantly affects the adoption of the mung bean variety. This shows that, when all other parameters are held equal, the adoption of the mung bean variety reduces by -9.0 TLU as the number of animals owned by households increases by one TLU. The cause of this is that farmers with more livestock often sell them rather than grow mung bean varieties to meet their needs for household consumption and input payback. They may also want to focus on raising livestock as a source of income. The results support the study's conclusion in their study, Negera and Getachew (2014) discovered a negative correlation between the use of fertilizers and the growth of animals.

Access market information (mktinfo): **-** It is a dummy variable taking a value of 1 if the farmer had access to market information and 0 otherwise. Market access to information is one other important variable for the adoption and intensity of adoption of the mung bean variety. This is since relatively closer information to farmers in the market enables and facilitates the marketing of inputs and outputs. Having accessibility to market information on mung bean variety can affect farmers' adoption and intensity of adoption of mung bean variety positively and significantly both at a level of significant 1% (*Table 3*). According to the probit's findings, a farmer has better opportunities to adopt new mung bean varieties and more access to information in the market. Access to information increases in the market leads to an increase in the probability of adoption by 0.1%. The truncated regression results indicate that farmers with access to market information are more likely to extend the level of adoption of mung bean variety than those with an insufficiency of information. Therefore, farmers who had access to more knowledge increased in the market leads to an increase in the intensity of adoption of mung bean variety by 0.1% can supply extra proportion intensity of mung bean to learn more. Farmers are more likely to use technology if the information is readily available because it helps them decide how to use it to boost productivity with the least amount of risk. The adoption of chickpea technologies was thought to be favourably impacted by access to market information, according to the study published by Negera and Getachew (2014).

Total land size (land size): As anticipated in the initial hypothesis, a continuous variable that affects this variable on the rate of mung bean variety acceptance exists. At a significance level of 1%, truncated regression shows that the amount of land that the farmer or head of the family owns has a positive and significant influence on how strongly the mung bean variety is adopted. It shows that, when all other variables are held equal, the intensity of adoption of the mung bean variety increases by 0.06 when the landholding size of household heads grows by a hectare. The cause of this is that farmers with larger landholdings typically plough them rather than adopting a type of mung beans created specifically for grazing land with greater intensity. According to the findings (Yenealem et al., 2013; Solomon & Bekele, 2010), there is a positive and significant association between the size of landholding and the adoption of new technologies.

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Contact with extensions frequently (ferqserv): - Extension counseling is a crucial instrument for developing the home head's administrative skills. Farmers were hypothesised to adopt a higher proportion of their mung bean product than those who had fewer extension contacts and less access to information on mung bean variety production. At a 1% level of significance, the truncated regression's findings demonstrated that farmers' interactions with extension agents positively influenced the amount of adoption of the mung bean variety; other factors were kept constant. The marginal effect indicates that in favour, the intensity of adopting the mung bean variety increases by a factor of 34.9% for the farmers who had extension contact than those who did not have extension contact. This implies that farmers who have contact with extension agents become aware of and informed about new technologies in mung bean production packages and become more effective than the farmers who do not have got extension contact. This may be because farmers' knowledge and skill to boost mung bean productivity by connecting them with agricultural inputs and methods of their application rises with a small amount of extension advice. As a result, farmers who have interacted with extension agents may be more likely than those who have not adopted the mung bean variety. The study's findings concur with those of Ermias et al. (2015), who advocate that contact with extension agents has a favorable and significant impact on farmers' adoption.

CONCLUSION AND RECOMMENDATIONS

Food insecurity in Ethiopia is influenced by agriculture's use of inadequate production technology and climate and weather changes. Decision-makers and stakeholders have sought a variety of policies and investments to increase agricultural productivity to address these issues, particularly regarding food stability and cash crops that are essential for eradicating poverty. It is, therefore, crucial to have access to, be able to use and manage improved manufacturing technologies through cautious adoption of their acceptance status.

The findings of the double hurdle regression model also revealed the characteristics that are most important to policy and that have a significant impact on smallholder farmers' acceptance and intensity of adoption of mung bean varieties. In general, the study results in adoptions of mung bean varieties were affected positively and significantly by sex, training, attendance on participation at the demonstration site, and access to market information, While the adoption of mung bean cultivars is negatively and strongly affected by total livestock holding. On the other hand, adoption intensity was influenced by total land holding, training, frequency to contact extension services, and good access to market information positively and significantly, while participation in off /nonfarm practices was affected negatively and significantly. To facilitate farmers' adoption of new technology, agricultural extension offices, research institutes, and universities should provide effective, focused, ample, and crop-oriented training in production, management, and marketing activities. Governments and other policymakers should emphasise increasing the implementation of new technology and the ability to use mung bean farmers through mass media, mobile, extension services/agents, and other means of capacity building.

AUTHORS’ CONTRIBUTIONS

Execution of field/lab experiments and data collecting (GTA); Conceptualization of research work and experiment design (GTA); data interpretation and analysis (GTA); Manuscript preparation (GTA).

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