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Determinants of the adoption of improved faba bean varieties in Enda-Mehoni district, South Tigray, Northern Ethiopia

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This paper examines determinants of faba bean varieties adoption in Enda-Mehoni district using a cross-sectional data collected from 223 sample households. An interview schedule was employed to collect the data and presented using frequency, percentage and mean. We employed t-test and χ2-test statistics to see the significant difference between adopter and non-adopter and a binary logit model to know the influence of explanatory variables on faba bean varieties adoption. The findings reveal that the decision to adopt improved faba bean varieties is positively influenced by annual farm income and training obtained but negatively influenced by residents of the household heads. The study concludes that adoption decision was found to be a combination of economic, physical and institutional variables of the farmers. Hence, the understanding of the significant factors that lead farmers to adopt improved faba bean is imperative in policy design and implementation for further improved technology adoption in the area. In addition, providing appropriate training, improving the annual farm income and targeting domains of faba bean producing areas will contribute to improved faba bean varieties adoption in the district.

Key words: Adoption, binary logit, faba bean.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the best crops among the grain legume (Singh et al., 2013). Similarly, faba bean is one of the major pulse crops grown in the highlands (1800 – 3000 m asl) of Ethiopia (Temesgen and Aemiro, 2012; Tafere et al*.,* 2012). Ethiopia is the second largest producers of faba bean in the world, next to China (Biruk, 2009). However, the national productivity of faba bean in the country is still very low. According to the report of Central Statistics Agency (CSA), the national average yield of faba bean under smallholder farmers' is 20.53 quintals per hectare (CSA, 2017). In Tigray region, faba bean covers an area of 9228.25 ha and its production accounts 151,091.02 quintal. Based on the CSA data, the productivity of the faba bean in Tigray region is 16.37

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Table 1. Definition of independent variables and expected sign for analyses.

Variable name	Type of variable	Measurement	Hypothesis
Residence of household head	Dummies	1 if Embahasti, 0 otherwise, 1 if H/teklehaymanot,0 otherwise 1 if Mekan, 0 otherwise and 1 if the Simret, 0 otherwise	+/-
Age of household head	Continuous	Years	±
Education level of household head	Continuous	Years	+
Household size	Continuous	Man equivalent units	+
Cultivable land size	Continuous	Hectare	+
Livestock size	Continuous	Total livestock in TLU	+
Mobile phone access	Dummy	1 if yes , 0 otherwise	+
Membership in any organizations	Dummy	1 if yes, 0 otherwise	+
Field days participation	Dummy	1 if yes, 0 otherwise	+
Trainings participation	Dummy	1 if yes, 0 otherwise	+
Engagement in off farm activities	Dummy	1 if yes, 0 otherwise	+
Household annual farm income	Continuous	Ethiopian Birr	+
Access to credit/cash	Dummy	1 if yes, 0 otherwise	+

quintals/hectare, which is lower than the national average (CSA, 2017).

Faba bean is a high-value crop that fetches high income to farmers. Besides, it is an important rotation crop which farmers are using to restore the fertility of their plots (Negash et al., 2015). It is also the most important protein source for the rural people and used to make various traditional dishes in Ethiopia (Goa and Kambata, 2017). Similarly, in the southern zone of Tigray, particularly in Enda Mehoni district faba bean is the dominantly grown crop next to wheat and barley. In the area, the crop is widely used for food in different forms like *sprouted bean* and *green pod* alone and stews *(whot)* with other mixtures. In addition, farmers commonly used faba bean as crop rotation with cereal crops like wheat and barley for soil fertility improvement as well as disease and insect pest break. Accordingly, different efforts were made by the governmental and non-governmental organization (Office of Agriculture and Rural Development of the district, Agricultural Research Centers, Universities, and NGOs) to promote improved faba bean varieties in Southern Tigray in general and Enda Mehoni district in particular as to the Southern Zone Development Corridor Office report (SZDCO, 2016).

However, despite the efforts made to introduce and promote the improved faba bean varieties in the study district, many smallholder farmers still used local cultivars. Empirical evidences on technology adoption in Ethiopia and elsewhere in the world reported that the decision of farmers' adoption of a given technology is influenced by different factors across space and time. For example; Letaa et al. (2009) in Tanzania, found out that the likelihood of improved beans adoption was positively influenced by wealth index and possession of ICT (like radio, television, and mobile) whereas negatively influenced by distance to market of the farmers. Abdelaziz and Ishitag (2013), in Sudan also reported that households that participated in field days have a higher probability of adoption of beans than those that did not participate. Moreover, In Ethiopia Bale highlands, Zenaye (2016), reported that adoption of improved food legume varieties significantly influenced by age square in year, livestock holding, membership in farmers cooperatives, frequency of contact with research centers, distance from the main market, participation in off-farm activity and district dummies of household head are some of the few empirical evidences related to our topic of interest.

Yet, to the researchers' knowledge there are inadequate evidences on factors that facilitate and or hinder adoption of improved faba bean varieties in the district. As indicated in Table 1, thirteen explanatory variables were expressed as the most important variables that influence the adoption decision of faba bean varieties by smallholder farmers in Enda-Mehoni district. Therefore, this study was initiated to assess the determinants of adoption of improved faba bean varieties in which it can be used as springboard for sustainable faba bean adoption and initiated other researchers to conduct their study in a different perspective of the commodity.

MATERIALS AND METHODS

Area description

The study was conducted in Southern Zone of Tigray Regional State, Northern Ethiopia particularly in Enda Mehoni district in 2016. Geographically, it is located between 12° 15' and 13° 41' N latitude and 38° 59' and 39° 54' E longitude, at an altitudinal range of 1350 – 3925 m.a.s.l (Figure 1). The district is located 660 km north of Addis Ababa and about 120 km south of Mekelle city, the capital city of Tigray National Regional State. Enda Mehoni district is characterized by three distinct agro-ecologies, including lowlands (locally named as *Kolla*), Midland (''*Weinadega''*) and highland (''*Dega''*). The ''D*ega''* cover the largest part which accounts for about 65% of the total hectare while ''*Weinadega*'' and ''K*olla''*

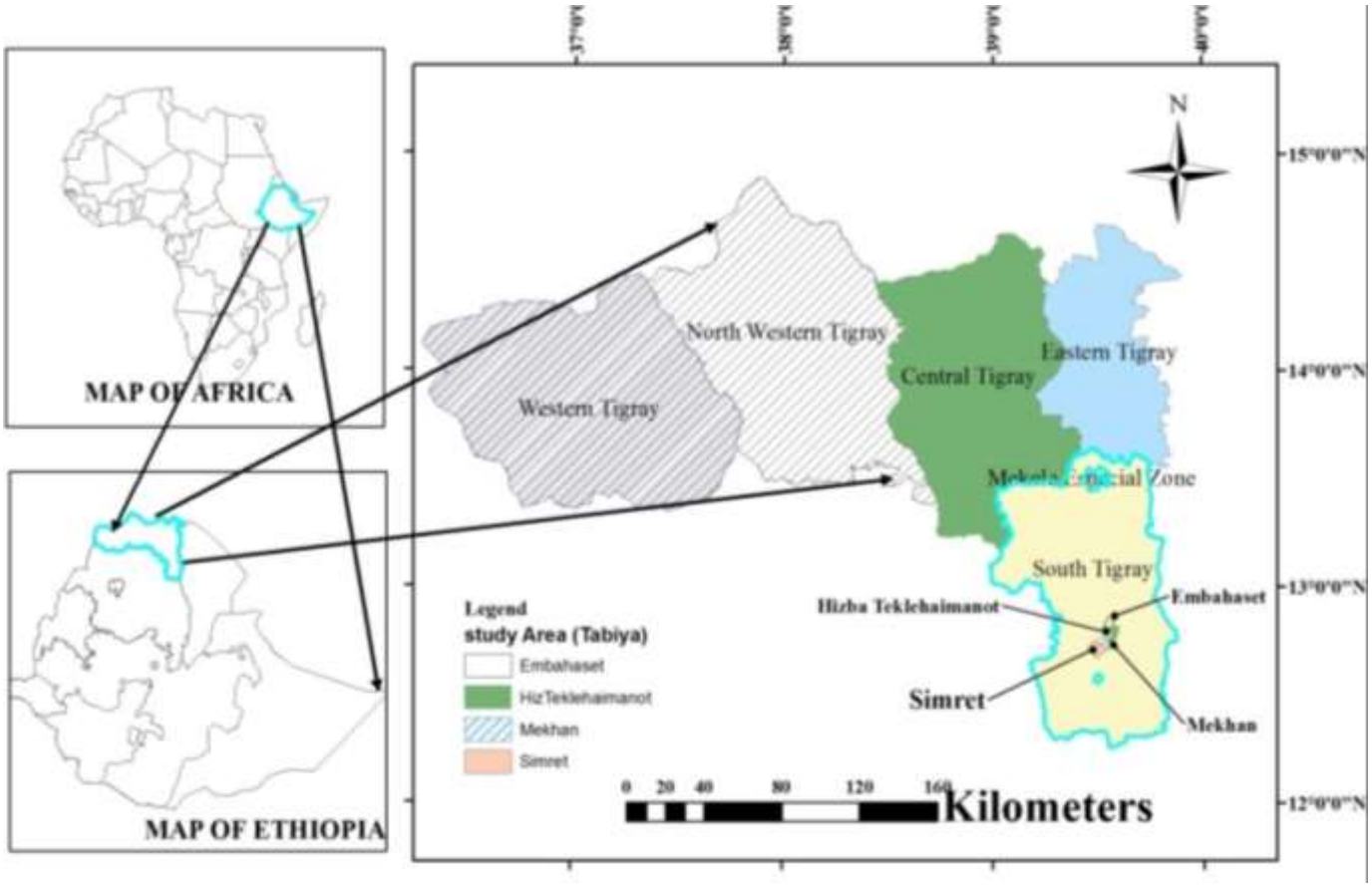

Figure 1. Map of the study area.

covers about 30 and 5%, respectively. The average landholding of the district ranges from 0.25 - 0.5 ha per household. The district has experienced two rainfall seasons; the short rainy season locally known as "*Belgi*" that occurs usually from February to April and the main rain season locally described as "*Kiremti*" that comes during June to September. On average, the area receives annually about 600 mm rainfall with the mean annual temperature of 25°C. Wheat, barley, faba bean, and field pea are among the major crops grown on the highland agro-ecology including Enda Mehoni district (SZDCO, 2016).

Data collection and method of sampling

Multi-stage sampling technique was employed to select the sample respondents. In the first stage, Enda Mehoni district was purposively selected based on the facts that faba bean varieties were highly promoted. In the second stage, four kebeles namely, Mekan, Simret, Embahasti and Hizba Teklehaymanot were randomly selected based on proportionate to size from potential faba bean growing kebelles (Figure 1). In the third stage, a total of 223 respondents were randomly drawn from the lists of faba bean growers in the district.

Both primary and secondary data were used for this study. Primary data was mainly collected from sample respondents through a structured questionnaire. In addition, secondary data sources from published and unpublished documents were gathered to supplement the primary data. Moreover, one-day training was given for the enumerators to have a common understanding of the questionnaire and ways to interviewing. Finally, the actual household survey was conducted by the trained enumerators.

Data analysis method

The collected data was analyzed using STATA software version 13. A descriptive statistical analysis was used to discuss the results of the survey using frequency, mean, standard deviation and percentages. The t-test was used to test for significant difference in the socio-economic characteristics of adopters and non-adopters. In addition, the $\chi 2$-test was employed to test for the significant association in socioeconomic characteristics between adopter and non-adopters. A binary logit econometric model was also employed to know the influence of hypothesized variables on the decision to adopt and or not adopt faba bean varieties (Table 1).

RESULTS AND DISCUSSION

Descriptive analysis results of the explanatory variables

The descriptive analysis showed that the mean age of sampled respondents was 42.3 years. This implies that the mean age of the respondents was at productive age. The average household size in man equivalent was 4.54;

Table 2. Descriptive and inferential analysis results of continuous explanatory variables.

Variable	Adopter		Non adopter		Total		t value
	Mean	SD	Mean	SD	Mean	SD	
Age of household head (years)	42.39	11.03	42.27	12.79	42.30	12.23	-0.067
Family size (count in man equivalent)	4.58	2.07	4.52	1.78	4.54	1.87	-0.199
Cultivable land size (hectare)	0.79	0.45	0.65	0.46	0.694	0.46	2.312**
Livestock holding size (TLU)	3.90	2.71	3.13	2.61	3.40	2.66	-2.258**
Education level (years)	3.66	3.39	3.34	3.69	3.44	3.59	-0.625
Annual farm income (Birr)	12676.67	19249.87	7279.2	9912.52	9021.88	1383.1	2.765***

, * represent significance at 5 and 1% levels, respectively. SD= Standard deviation.

whereas, the average educational background of the respondents was 3.44 years of schooling. The inferential statistics (t-test) shows that there is no significant difference between adopter and non-adopter categories related to age of the household, family size and educational level of the household head (Table 2). On the other hand, the mean cultivable land holding size of adopter and non-adopter was 0.79 and 0.65 ha respectively whereas, the overall respondent average land holding size was 0.69 ha per household. This indicated that the cultivable land size of the respondents was smaller than national average which is 1.14 ha per household (CSA, 2015). However, the result of the analysis shows that the cultivable land size of the adopters was higher than the non-adopters. The t-test analysis result shows a significant difference between the two categories at 5% significance level.

Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into Tropical Livestock Unit (TLU), so as to facilitate comparison among the households. The average livestock holding of the adopter and non-adopter was also 3.90 and 3.13 TLU, respectively. The t-value shows that there was significance livestock holding mean difference between respondents in both categories at less than 5% significance level. Moreover, the average annual farm income received by the respondents in the district was 9021 ETB per household per year. The income received by the adopters and non-adopter category was 12676 and 7279 ETB respectively, per year. The annual income of adopters was much higher than the non-adopters which means, they received more additional 5397 ETB than the non-adopters. Hence, the t-test analysis result revealed that annual income has a significant mean difference between both adoption categories at less than 1% significance level (Table 2).

As indicated in Table 3, of the randomly selected respondents' the majority 151 households (67.71%) were non-adopters while the remaining 72 (32.29%) were adopters of improved faba bean varieties. The majority (71.25%) of respondents were male-headed, whereas the remaining were female-headed households. The percentage of male-headed household in the adopter category was higher than in the non-adopter category whereas, the percentage of female-headed households in the adopter category was smaller than in the non-adopter category. The result from chi-square ($\chi 2$= 5.45) shows significant association between sex of household head and faba bean adoption at less than 5% level of significance. In recent years, owning personal mobile phone can have an important effect on receiving up to date information on day to day activity of the household from others with minimum cost. About 57.40% of the respondents owned mobile phones, whereas 61.1% were adopters while 55.63% were non-adopters household heads. The chi-square result ($\chi 2$=0.56) indicated that there was no significant association between owning mobile phone and adoption categories.

Farmers in their resident are involved in different social, economic and cultural organizations. The analysis result showed that 59.64% were member of farmers' organization, while the remaining 40.36% had no involvement in farmers' organization. The result of the chi-square analysis ($\chi 2$=0.797) shows that there was no significant association between farmers organization and adoption. Evidence from Table 3 reveals that the majority (77.58%) of the respondents have no access to credit in cash and or in kind. The percentage of households who have access to credit/cash is the same as the adopters and non-adopters. There is no significance association between adoption and access to credit/cash at ($\chi 2$=0.002).

The majority (64.57%) of the respondents (that is, 58.33% and 67.55% of adopter and non-adopter, respectively) did not participate in off/non-farm income activities, whereas; about 35.43% of the respondents (41.67% of adopters and 32.45% of non-adopters) participated in off/non-farm income activities. The chi-square result ($\chi 2$= 1.81) showed that there was no significant association between participation in off/non-farm activities and adoption (Table 3). About 40% of respondents attended field days, among which 47.22% and 37.75% were adopters and non-adopters respectively. However, about 59.2% did not participate in field days. The percentage of household who did not participate in field days was higher in non-adopter than

Table 3. Descriptive and inferential analysis results of dummy explanatory variables.

Variables	Description	Adopter		Non adopter		Total		χ^2
		N	%	N	%	N	%	
Resident of the household head	Embahasti	29	40.28	40	26.49	69	30.94	6.42*
	Mekan	18	25	40	26.49	58	26.01	
	Simret	17	23.61	37	24.50	54	24.22	
	H/teklehaymanot	8	11.11	34	22.52	42	18.83	
Sex of household head	Male	59	81.94	101	66.89	160	71.75	5.45**
	Female	13	18.06	50	33.11	63	28.25	
Access to mobile phone	Yes	44	61.11	84	55.63	128	57.40	0.560
	No	28	38.89	67	44.37	95	42.60	
Membership in any farmers organization	Yes	46	63.89	87	57.62	133	59.64	0.797
	No	26	36.11	64	42.38	90	40.36	
Access to credit/cash	Yes	16	22.22	34	22.52	50	22.42	0.002
	No	56	77.78	117	77.48	173	77.58	
Engagement in non/off farm activities	Yes	30	41.67	49	32.45	79	35.43	1.81
	No	42	58.33	102	67.55	144	64.57	
Training participation	Yes	41	56.94	91	60.26	132	59.19	0.223
	No	31	43.06	60	39.74	91	40.81	
Field day participation	Yes	34	47.22	57	37.75	91	40.81	1.811
	No	38	52.78	94	62.25	132	59.19	

**,* represent significance at 5 and 10% levels, respectively.

adopters. The result of the chi-square analysis ($\chi2=1.81$) shows that there was no significant association between file days participation and adoption. On the other hand, majority (59.2%) of respondents participated in training (that is, about 56.94 and 60.26% of the respondents were adopter and non-adopter, respectively). However, the remaining 43.06% of adopters and 39.79% of non-adopters were not attending training. The result of the chi-square analysis ($\chi2=0.223$) shows that there was no significant association between training participation and adoption (Table 3).

Determinants of household decision to adopt improved faba bean varieties

The result in binary logit model (Table 4) indicated that the household's decision to adopt improved faba bean varieties was significantly influenced by household residence, training participation and total annual income of the head of the households. Out of the three significant variables, total annual income and training participation positively influenced faba bean adoption while residence of household head influenced negatively faba bean varieties adoption.

Residence of the household head lived

The probability of improved faba bean varieties adoption was significantly and negatively affected by residence of the household lived at 1 and 10% significance level. The result of the model indicated that adoption of improved faba bean varieties decreased by 22.75, 13.37 and 12.58% respectively, as compared to base kebelle (Emba hasti). This implies that adoption of faba bean varieties from kebelle to kebelle has variation due to differences in soil types, rainfall pattern and elevation. The majority of the introduced improved faba beans varieties are long matured as compared to the local cultivars. This result is consistent with previous findings reported by Shiyani et al. (2002), in India, which shows adoption of improved chickpea varieties as significantly different from district to district. In addition, Zenaye (2016) from Ethiopia reported that district dummies of household head significantly affected food legume adoption.

Total annual farm income

Farm income of the household head has a positive significant effect on faba bean adoption. In this study, farm income refers to all income derived from agricultural sector (crop and livestock) excluding income derived from non-farm incomes. The result of the model indicated that the probability of faba bean varieties adoption increased by 64.40% as the income of the household head increased by 1 Ethiopian Birr. This implies that farmers with higher farm income are more likely to adopt improved faba bean varieties because farm income helps

Table 4. Binary logit model estimates on determinants of faba bean varieties adoption (N=223).

Variable	Coefficient	Standard Error	Marginal effect	Z
Kebelle Embahasti (base)				
(Simret)	-1.3066	0.0675	0.2273	3.37***
(Mekan)	-0.6836	0.0765	0.1337	1.75*
(H/Teklehaymanot)	-0.6360	0.0759	0.1258	1.68*
Land size of the household	0.3763	0.0866	0.0797	0.92
Total livestock of the household	0.0828	0.0164	0.0175	1.07
Household size of the household	-0.0925	0.0194	0.0196	1.01
Total annual income	0.00003	0.0001	6.440	2.35**
Age of the household	0.0029	0.0030	0.0006	0.21
Off farm activity participation	0.1682	0.0759	0.0359	0.47
Education level of the household	0.0100	0.0104	0.0021	0.20
Cash/ input received	0.0636	0.0833	0.0136	0.16
Membership in any organization	0.0180	0.0734	0.0038	0.05
Mobile phone access	-0.2226	0.0760	0.0474	0.62
Training participation	0.0636	0.0077	0.0134	1.74*
Field days participation	0.5495	0.0753	0.1182	1.57
Cons	-0.7898	-0.7899	-	0.89
Observation		223		
LR $chi^2(15)$		25.77		
Prob > chi^2		0.040		
Log likelihood		-127.38		
Pseudo R^2		0.0919		
Predicted probability		0.3044		

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

them to cover the required expenditures (on seed, fertilizer, chemicals and hiring labor etc.) of the new technology under consideration. The previous study by Letaa et al. (2009) also showed the occurrence of a significant positive correlation between agricultural wealth and adoption of common beans in Tanzania. Similarly, a study by Masresha et al. (2017) in Ethiopia shows a significant effect of agricultural income on white haricot beans adoption in East Shewa zone, Ethiopia.

Training participation

The result of the model shows that farmers' attending training have a higher probability of adopting improved faba bean varieties than those who did not attend. The model indicated that adoption of improved faba bean varieties was increased by 1.34% as compared to households that did not participate in training. This implies that farmers that have the chance to participate in trainings can fill their gap of practical application (like time of planting, weeding, application of chemicals, harvesting, threshing and storage), and marketing that are provided to the farm households in farmers training centers by extension workers and other concerned bodies. Previous studies by Mulugeta (2011) and Masresha et al. (2017) in Ethiopia reported that training had a positive significant influence on the status of adoption of white haricot beans variety. The study concluded that farmers with better training status have better information and confidence and hence, are likely to adopt haricot beans variety.

CONCLUSION AND RECOMMENDATION

Faba bean contribution to households' nutrition, income and food security is very high. In the study area, the crop is consumed in a variety of forms. The study examined the factors influencing improved faba bean varieties adoption and revealed that household's residence, household farm income and training participation of household heads are responsible for increasing the probability of faba bean varieties adoption. Adoption decision was found to be a combination of economic, physical and institutional variables of the farmers. Hence the understanding of the significant factors that lead farmers to adopt improved faba bean is imperative in policy design and implementation for further improved technology adoption in the district. In addition, it is recommended that concerned governmental and non-

governmental organizations be taken into consideration to provide appropriate training, improving the annual farm income and targeting domains of faba bean producing areas in order to promote the adoption of improved faba bean varieties in Enda Mehoni district.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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