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Factors Affecting Adoption of Improved Maize Varieties in Babile and Fedis Districts of East Hararghe Zone, Oromia Regional State, Ethiopia

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Abstract
Increasing agricultural productivity and improving the sustainable livelihoods of rural farmers are among the government of Ethiopia policy priorities. In this effort, adoption of improved agricultural technologies is expected to play a vital role. However, the uses of improved maize varieties are constrained by various factors. Hence, in this study, an attempt was made to examine factors affecting adoption of improved maize varieties. A multi-stage random sampling technique was employed to select 218 sample households from both Babile and Fedis Districts using cross-sectional data. Probit econometric model was used to identify factors affecting households' adoption decision to improved maize varieties. The model results indicated that age of household head, level of education of household head, farm experience in maize production, total farm size owned, access to extension services, access to improved maize seed, the distance nearest market and districts dummy were significantly affect the adoption of improved maize varieties in the study districts. The empirical results of this study suggests that strengthening the extension services, improvements in improved seed delivery systems for further promotion. The study also suggests that policy intervention should be made on improving the educational level of farming households is also important.
Keywords: Adoption, Improved maize varieties, Probit model, East Hararghe
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1. Introduction

Maize is a widely grown food and cash crop that can be found within a broad range of environments a cross Sub-Saharan Africa. In Ethiopia, maize is currently produced by more farmers than any other crop (Chamberlin and Schmitd, 2012) and its total cropping area is still expanding (Taffesse *et al.,* 2012). According to Agricultural sample survey 2016/17 provided by the Central Statistical Agency at national level there are 11 million maize producing households on a total of 2.1 million hectors of land under maize. Of the major cereal crops, maize ranks second to tef [*Eragrostis tef* (Zucc.)] in area and first in production. Over the last five years, the area under maize has increased by about 50% and production by 66%, with the national average productivity of maize increasing from 34.31 to 39.92 Qt/ha (CSA, 2018). However, the average productivity of maize is still low in drought prone areas. In Ethiopia, drought prone growing areas consist of approximately 40% of the maize growing area yet contribute only 20% of the total production. That is mainly because the adoption rate of improved maize seed is low and farmers continue using varieties, which are old and do not have drought tolerance traits (Bediru, 2013).

Thus, improving the productivity of crop technologies can be an option for rural farmers to get rid of hunger and food insecurity by increasing production, reducing food price and making food more accessible to the poor. The use of high yielding crop varieties facilitates the growth of agro-processing enterprise and non-farm sectors, and stimulates the transition from low productivity subsistence agriculture to a high productivity agro industrial economy. Further, developing and promoting the adoption of yield increasing crop varieties in a sustainable manner helps improve livelihood of rural farmers (Asfaw et al., 2012).

In line with this Fedis Agricultural Research Center has been developed, conducted the adaptation trials of improved maize varieties for the decade. After adaptation trial these varieties have been widely promoted through on-farm demonstration and small pilot seed production by agricultural extension research team of the research center. Recently, Districts Agriculture and Natural Resource development offices and NGOs are working on the further promotion (scaling up) of these maize varieties in the drought prone districts of the Eastern Hararghe Zone). In spite of such intervention, information with regard to adoption of improved maize varieties on location specific factors affecting adoption of improved maize varieties being promoted in the districts was not empirically studied and documented. In addition, though several studies have been conducted so far related to maize technologies adoption in other parts of Ethiopia *(*Abadi (2014); Bediru (2013*);* Yu *et al.,* (2011); Shiferaw and Tesfaye, (2005); Yishak and Punjabi, (2011); and Alene *et al.,* (2000)). There was no study conducted on the adoption of improved maize varieties in the study districts. Hence, this study was aimed at analyzing factors affecting adoption of improved maize varieties in order to draw important conclusions and policy implications for future intervention.

2. Methodology

2.1. Description of the study areas

The study was conducted in Babile and Fedis districts of East Hararghe Zone, Oromia Regional State, Ethiopia. In both districts mixed crop-livestock agriculture is the main economic sources of the smallholder farmers. The main crops grown in both districts are sorghum, maize, groundnut and khat. Babile district is located 9° 13′ 09′′ N latitude and 42° 19′ 25′′ E longitude; 1642m above sea level; and Fedis district is also located 9°07′N Latitude and 42°4′E Longitude; 1702 meters above sea level (Figure 1). Babile district is located 35Km away from Harar and about 555 km East of Addis Ababa, the capital city of Ethiopia. The district has a total area of 3,169.06 Km^2. It has a predominantly well drained sandy loam soil that is ideal for groundnut production. The rainfall distribution of the area is bimodal, with the main rain (locally referred to as Meher rain) received during July to October and short rain (locally known as Belg rain) during March to May The mean annual maximum and minimum temperatures are 28.1°C and 15.5°C, respectively, with the total annual rainfall ranging from 507 to 984mm. Fedis district is located 24Km away from Harar and about 544Km South East of Addis Ababa, the capital city of Ethiopia. Rainfall distribution at Fedis is also bimodal. Fedis has a total area of 1,105.02 km^2. The mean annual maximum and minimum temperatures in Fedis are 27.8°C and 8.8°C, respectively, with a total annual rainfall of 659.2 mm. The agro-ecology of the districts is lowland (100%).

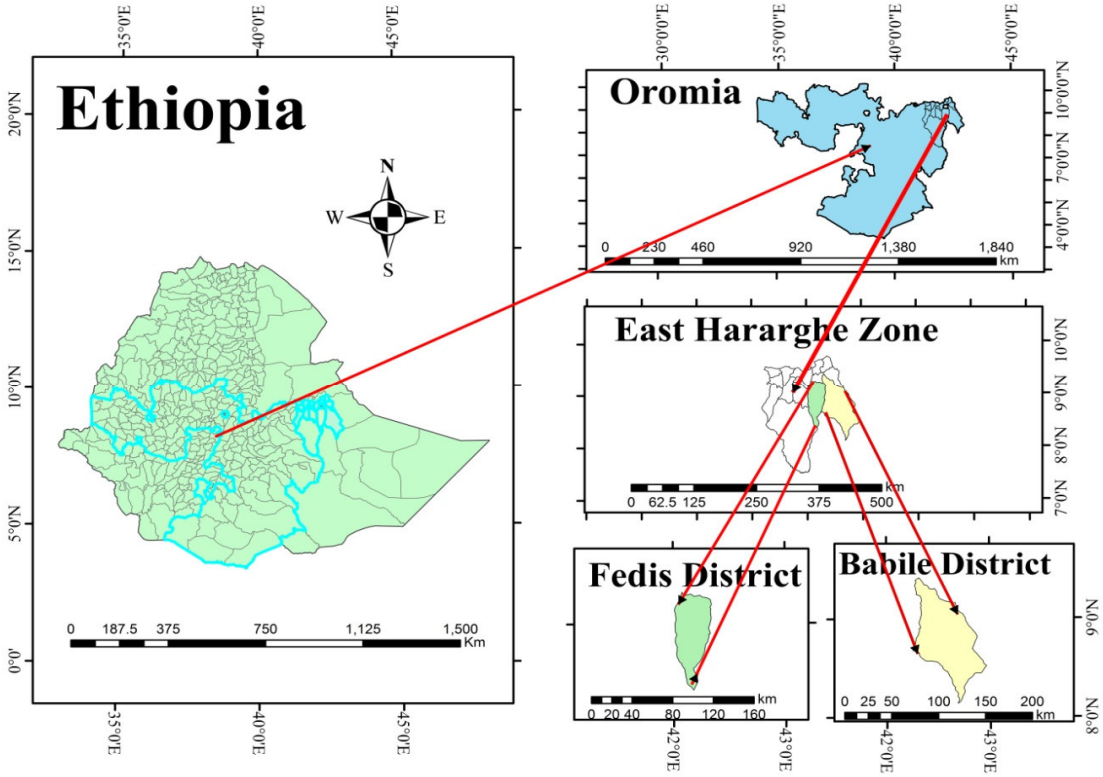

Figure 1. Map of the Study Areas

2.2. Sources of data and Methods of data collection

The study was used both primary and secondary data. Primary data were collected from sampled household heads interviews that were randomly selected from the selected kebeles using structured and semi-structured questionnaire. Secondary data were gathered from secondary sources (published and unpublished materials), Districts Office of Agriculture and Natural Resource Development and other sources.

2.3. Sampling procedure and sample size

A multi-stage sampling technique was used to draw sampled households heads in the study areas. In the first stage Babile and Fedis districts were selected purposely based on their improved maize research intervention and promotion sites of Fedis Agricultural Research Center (FARC). In the second stage, three intervention *kebeles* were also purposively selected from each district. In the third stage, stratified random sampling was used to categorize maize producer farmers into adopter and non-adopters of improved maize varieties in each of the *kebel*e. Finally, simple random selection of household heads in each of two categories was employed based on proportional to population size.

2.4. Methods of data analysis

Both descriptive statistics and econometric data analysis were employed in this study. First, descriptive statistics approaches like means, standard deviation, frequencies, percentages, and inferential statistics like independent *t*-test and chi-squared test were applied for analysis. The independent *t*-test was used to determine statistically significant differences between adopters and no-adopters with regards to continuous variables of sampled maize producers. The chi-square test was applied to determine statistically significant differences between adopters and no-adopters with regards to categorical variables of sampled maize producers. Second, the probit econometric model was used to examine factors affecting the adoption decision of the maize producers in the study districts.

3. Results and Discussion

Households' Demographic and Socio-economic Characteristics

Table 1 and 2 show the summary results of the descriptive statistics of the socio-economic characteristics of sampled household heads. The descriptive statistics results showed that the mean age of sample households was 36.22 years with standard deviation of 11.03. On average adopter household heads have 35.96 years while that of non-adopters of improved maize varieties have 37.35 years (Table 1). The survey results showed that mean difference between adopter households and non-adopters was found to be insignificant. This is implying that the absence of significant relationship of age with adoption of improved maize varieties. Average family size of the all-sample farm households was 6.89 members. On average adopter household heads have 7.22 members while that of non-adopter of improved maize varieties have 6.49 family members.The mean difference between the two groups was statistically significant at 5% significance level (Table 1). Landholding refers to the total area of farm land that a farm household owned in hectares. The average total land holding of the all-sample farm households was 0.88 hectares. The average total land holding of the non-adopters was 0.71 hectares whereas the adopters were 0.97 hectares. The mean difference between adopters and non-adopters of improved maize varieties was found to be statistically significant at 1% in land holding in the study area.

Table 1. Households' demographic and socio-economic characteristics (Continuous Variables)

Variables	All sample (N= 218)		Adopter (N=142)		Non-Adopter (N=76)		t-test
	Mean	SD	Mean	SD	Mean	SD	
Age of household head	36.22	11.03	35.96	10.35	37.35	12.27	0.45
Family size	6.89	2.84	7.22	2.80	6.49	2.76	2.30**
Total land holding (ha)	0.88	0.58	0.97	0.59	0.71	0.49	3.36***
Total livestock (TLU)	2.49	2.29	2.74	2.57	2.18	1.88	1.38*
Farming experience (years)	18.51	10.11	19.08	9.16	17.49	11.63	1.01
Distance to market (Minutes)	72.25	39.55	77.20	41.41	63.03	34.24	2.81***
Farm income (Birr/year)	32721	15205	38925	16490	24517	13920	5.48***

Source: Own data, **Note:** ***, ** and * indicates significance level at 1%, 5% & 10%, respectively

As to sex of household heads, out of the total 218 farm households, about 77% were male and the rest 23% were female headed farmers (Table 2). Based on sex of respondents, male adopters of improved maize varieties in the area is account for about 82% of the total adopter of improved maize varieties and female adopter accounts for 18% while out of 76 non-adopters of improved maize varieties, 68% of non-adopters are male and 32% of non-adopters are female. The result of chi-square analysis revealed that there is significant relationship between sex and the adoption of improved maize varieties at 1 % significant level.

Regarding access to extension services, the result indicated that out of total sampled farm households, about 76% have access to extension services and 24% of total sampled households have no access to extension services on maize production (Table 3). As shown in table 2, about 85% of adopters and 41% of non-adopters have access to extension services on maize production in the study area. This implies that in a larger proportion of sampled farm households have accesses to extension services while smaller proportions have no access to extension services. The chi-square result shows statistically significant difference at less than 1% significance level between adopters and non-adopters with respect to farmers' access to extension services.

Table 2. Households' socio-economic characteristics (Categorical Variables)

Variables		All sample (N= 218)		Adopter (N=142)		N-Adopter (N=76)		Chi-square test
		Freq.	%	Freq.	%	Freq.	%	
Education level	Illiterate	106	49	61	43	45	59	16.82*
	Read and write	19	9	10	7	9	11	
	Informal/religious	17	7	13	9	4	5.26	
	Literate	76	35	58	41	18	25	
Marital status	Married	209	95.87	136	95	73	96	2.36**
	Single	3	1.38	1	0.7	2	2.63	
	Widowed	5	2.29	4	2.82	1	1.32	
	Divorced	1	0.46	1	0.7	0	0	
Sex	Male	168	77	116	82	52	68	5.96***
	Female	49	23	25	18	24	32	
Membership to cooperatives	Yes	75	34	61	43	14	18.4	12.79***
	No	143	66	81	57	62	81.6	
Participation in off farm activities	Yes	72	33	54	38	18	24	4.09**
	No	146	67	88	62	58	76	
Access to extension services	Yes	165	76	120	85	45	41	15.14***
	No	53	24	22	15	31	39	
Access to credit services	Yes	61	28	47	34	14	18	5.89***
	No	157	72	95	66	62	82	

Source: Own data, **Note:** ***, ** and * indicates significance level at 1%, 5% & 10%, respectively

Factors affecting adoption of improved maize varieties

The factors affecting adoption of improved maize varieties were estimated using probit regression model. The model result from Table 3 indicated that from fourteen variables included in the model eight were found to be significantly affecting the adoption of improved maize varieties at different probability levels. Details of significant variables from this model were discussed as follows.

The results revealed that the age of the household head significantly and negatively influenced the probability of improved maize varieties adoption. This result shows that older farmers are less likely to adopt improved maize varieties. Possibly, young farmers are more flexible, more often exposed to new ideas and more likely to bear risk than their older counterparts. The result is consistent with (Asfaw et al., (2012); Kassie et al., (2011) and Langyintuo and Mungoma (2008)).

Level of Education of the head of the household has a positive and significant influence on the adoption of improved maize varieties with each additional year of schooling increasing the probability of adoption improved maize varieties by 0.38 percent. Like previous studies (Ghimire *and Huang, 2016;* Alena and Rashid, 2000*).*

The farming experience was also positive and significant at 10% level of probability to adopt improved maize varieties by 0.93 percent. This implies that as the farmers acquire more experience in maize production of as the adoption of new varieties increases. It is also expected that experienced farmers may be able to understand the nature of risk associated with each of the technologies, having practiced or seen some of them used over time. The finding is also in line with the study (2011; Endrias, 2003).

Distance to the main market was found to be negatively significantly correlated with the likelihood of adoption. Each additional minute of walking was associated with 0.16% less probability of adoption when other variables were kept constant. This indicates that farmers living at a distance from the main market centers are less likely to adopt the improved maize varieties than those who are located closer. The implication is that the longer the distance between farmers' residence and the market center, the lower will be the probability of improved maize varieties adoption. This may be due to relatively proximity to market also reduces marketing costs. This result is consistent with other studies (Abadi, (2014); Kebede (2006); Tesfaye *et al*. (2001)).

Table 3. Parameter estimates of adoption of improved maize varieties

Variables	Coefficient	Marginal effects	Robust Std. Err.	P- value
Sex of household head	0.2164	0.0548	0.3475	0.534
Age of household head	-0.0003**	-0.00006	0.0002	0.042
Education level	0.0161**	0.0038	0.0710	0.036
Family size	0.0134	0.0031	0.0606	0.826
Farming experience	0.0391*	0.00928	0.0225	0.083
Distances to market	-0.0067**	-0.0016	-0.0033	0.042
Cooperative membership	0.3429	0.0771	0.3226	0.288
Land holding	0.5364*	0.1276	0.2831	0.058
Participation in Off-farm	0.1333	0.0309	0.2734	0.626
Access to credit	0.0320	0.0075	0.3278	0.922
Access to extension	0.8769***	0.2596	0.3161	0.000
Livestock holding	0.0058	0.0013	0.0559	0.917
Access to improved seed	0.5443***	0.1294	0.1165	0.000
Districts dummy	0.7834**	0.1766	0.3301	0.018
_cons	-3.003***		0.6063	0.000

Source: Own field survey data, Number of observations: 218; Log-likelihood: – 108.846; LR chi2 (14): 57.31; Prob > chi2: 0.0000; Pseudo R^2: 0.4965; ***, ** and * indicate significant parameters at 1 per cent, 5 per cent and 10 per cent levels, respectively.

Land holding was found to be positively related with the adoption of improved maize varieties at less than 10% probability level. The positive and significant coefficient indicates that as cultivated land area increases by one unit, the likelihood of adopting improved maize varieties also increases by almost 12.76 per cent, confirming the expectation that owning more farmland is correlated with higher adoption rates. Consistent with earlier findings (Kassie et al., 2011; Mariano et al., 2012; Mendola, 2007), the result likely reflects the importance of land area among rural farming households for the cultivation of new-generation crop varieties.

As hypothesized, farmers' access to extension services had a positive and significant effect on the probability of adoption of improved maize varieties at less than 5% significance level. Other variables held constant, for each additional contact with extension agents the probability of adoption of improved maize varieties increases by 87.69 percent. The result indicated higher probability of farmers with more contact with extension agents in adopting than farmers with less contact. The possible justification for this is that frequent contacts create awareness and build the necessary knowledge for using the innovation and enhancing the exposure of farmers on the adoption practice of improved technologies. This is in line with the previous studies (Getachew *et al.,* 2009; Susie and Bosena, 2020).

Access to improved maize seeds at the right time and in the required quantity was as the expected positive and significant influence on adoption of improved maize in the study areas at less than 1% significance level. Provision of improved maize seed to farmers in the required quantity and at the right time increases the probability of adoption of the seed by 12.94 percent. The finding is also in line with the study (Ghimire *and Huang, 2016;* Getachew et al., 2009; Alene and Rashid, 2000).

The district dummy variable was found to have a positively significant impact on adoption of improved maize varieties at less than 5% significance level. This implies relative to farmers in Fedis (the reference group), farmers in Babile district are more likely to adopt improved maize varieties. This implies that being the Babile district increases the probability to the adoption of improved maize varieties by 17.66 percent. This is due the fact that agro-ecologies differences, distance to the research center, distance to access to market infrastructure, existence of Non-government organization that are working on the seed multiplication and related to seed business (e.g. Integrated Seed Sector Development Project).

4. Conclusion and Recommendations

Increasing agricultural productivity and improving the sustainable livelihoods of rural farmers are among the government policy priorities. In this effort, adoption of improved agricultural technologies is expected to play a vital role. Therefore, this study was initiated to identify factors affecting adoption of improved maize varieties in the Babile and Fedis districts, Eastern Hararghe Zone, Oromia Regional State, Ethiopia. Cross-sectional data were collected from the sampled household head using structured and semi-structured interview schedule. In this study, both primary and secondary data were used. Both descriptive and inferential statistics were used to analysis the collected data. A Probit econometric model was employed. The model results revealed that age of household head, level of education of household head, farm experience in maize production, land holding, access to extension services, improved maize seed availability, the distance nearest market and districts dummy significantly affect the adoption of improved maize varieties in the study districts. Overall, the adoption of improved maize varieties

in the study districts was affected by demographic, socio-economics and institutional factors.

In the study areas, emphasis need to be given to increase adoption of improved maize varieties by making better access to improved seeds and improvements in seed delivery systems that effectively cope with the demands of smallholder farmers. Strengthening access extension services like emphasis on information dissemination, extension demonstration, and farmers' participatory research and training programs to popularize new varieties and to enhance rate of adoption is crucial. Since significant proportion of farmers had no formal education, the extension program should be targeted to the less educated people for its effective delivery.

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