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Determinants of Adoption of Improved (BH-140) Maize Variety and Management Practice, in the Case of South Ari, Woreda, South Omo Zone, SNNPRS, Ethiopia

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Abstract: *This study was conducted at South Ari Woreda, South Omo Zone, Southern Nations, Nationalities and Peoples Regional State of Ethiopia. Due to poor adoption of improved (BH-140) maize variety and different constraints, the maize production and productivity is low in the study area. The aim of this study was to identify the determinants of adoption improved (BH-140) maize variety and its management practice in the study area. By using a systematic random sampling technique a total of 142 sample households were selected from 4 kebeles were interviewed by using a structured interview schedule. Qualitative data were collected using group discussion and key informants interview. Secondary data for this study obtained from the book, journals, published and unpublished documents. Data were analyzed using SPSS.version.16, descriptive statistics, Chi-square and t-test and logistic regression (binary logit) model. The descriptive statics result of the study indicated that about 48.59% of the sample respondents were non-adopters of the improved (BH-140) maize variety, while 51.41 % adopters. The status of management practices was found below research recommendation because of inadequate extension service, a high cost of fertilizer, pest, and lack of credit access. Farmers selection criteria for improved (BH-140) maize variety were high yielding, early maturity, disease resistance, price advantage, storability and market demand 42.95%, 39.46%, 8.45%,5.63% ,2.11%,1.4% respectively. Results of the logistic regression analysis indicate that among 14, identified explanatory variables, 8 of them education and, contact with extension agent significance at1%, sex Livestock, Income, demonstration were significant at 5% and credit were significant at 10% and positively affect adoption of improve maize technologies, Whereas, distance from market center significant at 10% but negatively affect the adoption. Based on this finding, the study suggests that the government, agricultural and natural resource and research center should focus on strengthening the existing extension service; provision of quality seed, adapt other new variety, credit service in maize farming. Moreover, attention should be given to those significant variables which have a potential impact in determining farmer's adoption decision in the study area.*

Keywords: *Binary logit, maize, variety, technology adoption*

1. INTRODUCTION

In Ethiopia agricultural sector have been played significant role in securing food security and economic growth with its share in GDP (43%), 90% of the poor earn their livelihood, its employment generation (80%), share of export (70%) and providing about 70% raw material for the industries in the (UNDP, 2013). Despite such outstanding potentials roles, currently, the productivity of the agricultural sector in Ethiopia has been limited and challenged due to many determinants (Ketema and Kebede, 2017). lack of appropriate and affordable new agricultural technologies, poor infrastructure, inefficient marketing systems, land degradation, rapidly expanding population, and inaccessibility to agricultural inputs and low adoption rate toward new agricultural technologies are important determinants that have limited the productivity of agricultural sector (Bihon, 2015)

Currently, Ethiopia is the fourth largest maize producing country in Africa, and first in the East African region (FAO, 2012). It is also significant that Ethiopia produces non-genetically modified (GMO) white maize, the preferred type of maize in neighbouring markets. This strategy envisions exports markets being a significant part of the demand sink for Ethiopian maize. Maize is largest cereal commodity in terms of total production, acreage, and the number of farm holdings. It ranks second after teff in area coverage and first in total production. The results of the year (CSA, 2016), Meher season postharvest crop production survey indicate that total land areas of about 12,558,444.55

hectares were covered by grain crops. Out of the total grain crop areas, 81.27% (10,144,252.30 hectares) was under cereals. Of this maize covered 16.98% (about 2,135,571.85 hectares) and average yield Q/t/ha (3.67) and gave 78,471,146.57quintals (CSA, 2016). The productivity of is very low as compared the developed counties 6.2t/ha because of lower utilization of improved agricultural technologies such as improved maize variety and chemical fertilizer among maize producing farmers.

Maize is mainly grown in the four big regions of the country: Oromia, Amhara, SNNP, and Tigray. Oromia and Amhara contribute to almost eighty percent of the maize produced in 2012 (CSA, 2015/2016). Among the top maize producing zones are: East wellega (4, 2 million q), kelemwellega (4.16 millionq), Kemashi(4.1millionq), West gojam (4millionq), Horoguduru (4 millionq), Silte (3.45millionq), Awi(3.9 miillionq), west wellega (3.9 millionq), West Arsi (3.8millionq),Metekle (3.8 millionq). Other zone such as Gurage, Gamo Gofa and Ilubabor Zone also grow maize and have the potential to increase their current production level in the future.

2. STATEMENT OF THE PROBLEM

The adoption of agricultural innovation in developing countries including Ethiopia has attracted Considerable attention because it can provide the basis for increasing production and productivity. Have been stated that adoption is the process of a decision to make full use of a technology as the best course of action available and consists of three stages namely pre-adoption, adoption, and post-adoption. It is apparent that agricultural productivity improvements will be improved among farmers through improved agricultural technologies which had developed at the research centers and disseminated to farmers' mainly through extension services (Stephen *et al*., 2014). On the other hand, the farmers' integration of these improved agricultural technologies into their farms is greatly influenced by socio-economic, institutional, attitude and perceived technology attributes (Bihon,2015).

The limiting maize productivity include production and market risks, low level of crop management practices, weeds, pest and diseases, erratic rainfall, erosion, low soil fertility, poor infrastructure, and post-harvest crop losses (Sisay., 2016).

In study area During 2009-2010 meher cropping season maize covered a total of 4500 ha of land from these 2700 ha was covered by local maize varieties and 35100 quintal of maize was obtained while 1800 ha of land was covered by improved maize varieties and 43200 quintal of maize was obtained. The productivity of maize crop is very low because of lower utilization of improved agricultural technologies such as improved maize variety, poor management practices, seed quality, disease and pest infestation and chemical fertilizer among maize producing farmers.

Moreover, information with regard to maize production in the study area has been focused mainly on the adaptability study of newly released different maize Varieties (Gebre and Mohammed, 2015).

Thus, research in this area is vital for understanding the problems related to the improved (BH-140) maize variety production, adoption level of improved maize technologies and its management practices. Therefore, with the above mentioned gaps, the researcher intended to conduct examining the determinants of improved (BH-140) maize variety, adoption level and recommended management practice with a view to filling the existing knowledge gap into the study area.

3. RESEARCH METHODOLOGY

Multi-stage sampling techniques were applied to select the sample households. In the first stage, South Ari Woreda was selected purposively based on accessibility and agro-ecological suitability for maize production (among eight woredas) and where improved maize variety has been introduced in the woreda (presence of adopters and non-adopters of improved maize variety).

In the second stage, from the woreda, 20 kebeles were selected purposely based on the basis of Agro-ecology and potential production of maize. From the 20 maize growing kebeles, 4 kebeles (Kayisa, Bitsemal from low land, Shishir, and Peala from Midland) were selected purposely based on the level of adoption of new (BH-140) maize variety. The sampling frame (complete village household lists) was identified in collaboration with Kebele leaders and development agents of the respective Kebele.

In the third stage, from maize grower farmers adopter and non-adopter of BH 140 maize variety were identified by using stratified sampling techniques. In the fourth stage, 142 farm household heads were selected using systematic random sampling technique taking into account proportional to size to the population procedure. The sample size was determined using (Kothari, 2004).

$$\cdot \frac{z^2\, pqN}{(e^2(N-1)+z^2 pq}$$

$$\frac{(1.96)^2 * 0.11 * 0.89 * 2403}{(0.05)^2 * 2402 + (1.96)^2 * 0.11 * 0.89}$$

n= 142

Where:

n = sample size

N = total number of household (2403HHs).

P = 0.11(proportion of population to be included in sample size i.e., 11%)

q = estimate of the proportion of the population to be sampled (1-p).

e = is the degree of accuracy desired (0.05), 5% error term.

Z= standard normal deviation (e.g. 1.96 for 95% confidence level).

The number of respondents was used in this study were illustrated in the following

Table1. *The number of sampled kebeles (BH-140) maize variety grower*

S/No	Sampled kebele	Adopter	Non-adopter	Total HHHs	Sampled adopter	Sampled Non- adopter	Total sample
1	Kayisa	482	253	735	30	13	43
2	Bitsemal	377	176	553	21	12	33
3	Shishir	408	201	609	22	14	36
4	Peala	313	193	506	17	13	30
Total		1580	823	2403	90	52	142

Source: *own survey, 2010*

The collected data was analysed by descriptive statistics such as average, percentages, frequencies, maximum and minimum were applied to describe farmers adoption level and management practices of BH-140 maize variety production in to study areas while by using Statistical Package for Social Science (SPSS) (Version, 16) and Inferential Statistical methods such as the Chi-Square Test was conducted to measure the association between categorical variables with dependent variable, whereas t-test was run to assess whether statistically significant differences exist in the mean values continuous variables for adopter and non-adopter. The Logistic regression was employed to for modelling and parameter estimation on the determinants of improved BH-140 maize variety adoption decision by the sample household.

For assessing the level of adoption of improved maize variety production, respondent farmers were grouped into four categories such as none, high, medium, and low adopter based on the percent of farmers input utilization and land proportion covered improved technology. A higher percentage indicates a higher level of adoption, while a lower percentage indicates a lower level of adoption of a technology. Adoption level was categorized as zero percent (none adopter), (70-100%) as high, (50-69%) as medium, and <50% as low adopter.

The logit and probit are the two most commonly used models for assessing the effects of various factors on the probability of adoption of improved maize technology. These models can also provide the predicted probability of adoption. The logit model follows a logistic distribution function, whereas the probit model follows a normal distribution function. Yet both models usually yield more or less similar results. The choice between the two models is thus a matter of convenience to the analyst. However, often logit model is preferred as it simplifies the estimation and interpretation of parameters (Fernando, 2011). Hence, the current analysis opted for the logit model and employed in modeling

demographic, socio-economic, institutional and psychological (perceptions) factors influencing the probability of adoption of improved maize variety by farm households in the research area.

4. RESULT AND DISCUSSION

4.1. Adoption Level of Improved (BH-140) Maize Variety in the Study Area

This study is based on cross-sectional data collected from a total of 142 farm households selected from South Ari district of South Omo Zone during 2009/10 cropping season. Of the total sampled households, (51.41%) were adopters and whereas, (48.59%) were non-adopters farmers to improved BH maize variety.

Table3. *The level of adoption of improved (BH-140) maize variety*

Adopter category	adoption level	Frequency	Percentage
Non-adopter	0%	69	48.59
low adopter	<50%	36	25.35
Medium adopter	51-69%	25	17.6
high adopter	70-100%	12	8.45
Total		142	100

Source: *own survey 2010.*

The existing technology adoption level on the maize production is presented in the above Table3. There are four levels of adoption categories of improved maize production in South Ari Woreda. Adoption categories were determined by the proportion of land which was allocated for the production of maize and the utilization of inputs. These are non-adopter, low adopter, medium adopter and high adopter of improved maize technologies in the study area. Non-adopters were 48.59% from total respondents and zero percent covered by improved maize. Household heads that have not used any improved maize technologies for the production of the maize crop. Low adopters were36 (25.35%) and less than 50% of farmland covered by improved maize and utilization of input below the recommendation for the production of the maize crop.

Medium level adopter farmers also were (17.6%) and the proportion was 51%up to 69% of maize land covered by improved maize and input utilization between 51% up to 69%. The high-level adopters were (8.45%) and 70% up to 100% maize land covered by improved (BH-140) maize variety and utilization of input according to the recommendation for the production of maize crop farm in the production season. From sampled kebeles majority of none adopters found Karissakebele and high level of adopter found only two Karissa and Bitsemalkebeles the rest pilla and Shishir the adoption level was found none, low and medium level.

The high level of adopters are very low in percentage this implies during a focus group discussion both adapters and non-adopters mentioned various reason for not expanding their improved variety land for next cropping season. The most important reasons were the variety susceptibility to disease, insect-pest, increasing input price time to time, seed quality, storage problem and market demand problems are the major problems related improved maize variety produced in the study area. Hence it needs more efforts, farmers, to follow extension agent advisory service, training, and awareness to scaling up a wider area of improved maize variety for all maize grower household heads in to study area. This result is consistent with the finding of (Rehman *et al*., 2016) at Bangladesh.

4.2. Factors Determine Adoption of Improved BH-140 Variety of in the Study Area

The logit model results used to study factors influencing the adoption decision of improved maize variety are shown in table 4.

Table4. *Maximum likelihood estimates of log it model result*

		B	S.E.	Wald	df	Sig.	odds ratio
Step 1a	Sex	2.445**	1.098	4.962	1	0.026	0.087
	EDUC	3.916***	1.037	14.26	1	0.001	50.198
	FAMS	0.346	0.188	3.382	1	0.185	1.413
	EXP	0.184	0.069	7.202	1	0.169	1.202
	TCLAN	0.959	0.429	5.002	1	0.203	2.609

	TLU	0.28**	0.118	5.585	1	0.018	1.323
	TFAMI	0.0002**	0.00013	8.414	1	0.004	1.0002
	MARKTD	-0.942**	0.369	6.526	1	0.011	0.39
	credit	3.361**	1.279	6.903	1	0.009	0.035
	DACONT	3.958***	1.079	13.457	1	0.021	0.019
	FELD	-1.519	0.982	2.395	1	0.122	0.219
	ATT	0.602	0.476	1.6	1	0.206	1.826
	DEMON	3.735**	1.473	6.43	1	0.011	41.868
	TRIAN	0.162	0.881	0.034	1	0.854	1.176
	Constant	-8.865	2.45	13.088	1	0	0

Source: *model results (2018) *,**,and *** significance level 10%, 5% and 1% level, respectively.Correct predicted: Non adopter 91.3%; Adopter 91.8% and Overall 91.5%.*

Among the 14 variables used in the model, 8 variables were significant with respect to the adoption of improved maize variety with less than 10% of the probability level. These variables include Sex, education, TLU, farm income, credit, extension agent contact, distance to market and demonstration whereas the rest 6 explanatory variables were found to have a not significant influence on adoption. The effect of the significant explanatory variables on adoption in the study area are interpreted and discussed below.

4.3. Sex of Household Head (SEX)

As expected, sex of household head, i.e., being male-headed household has a positive and significant relationship (at 5% level) with the probability of adoption of improved maize variety. The odds-ratio in favour of adopting improved maize varieties, other factors being kept constant, increases by a factor of 0.087 with the change in sex of the head from male to female. The positive sign implies that male-headed households tend to adopt the varieties more than their female counterparts. This may be due to relatively better access of male-headed households to information and agricultural resources than females' household heads. The result is in line with the finding of similar studies (Isaiah *et al*, 2013).

4.4. Education Level of Household Heads (EDUC)

As expected, education level of household head has a positive and significant relationship (at 5% level) with the probability of adoption of improved maize variety. The odds-ratio in favour of adopting improved maize variety, other factors kept constant increases by a factor of 50.198 for the farmer who assumed household heads become literate than that who did not. This implies that the educated farmers are more likely to adopt improve maize variety than those who are not educated. This may be due to relatively educated farmers have more access to information and they become aware of new technology, and this awareness enhances the adoption of technologies.

4.5. Livestock Holding (TLU)

As expected, the variable has a positive and significant relationship (at 5% level) with the probability of adoption of improved maize variety. The odds-ratio in favour of adopting improved maize variety, other factors kept constant increases by a factor of 1.323 as livestock increases by one TLU. This implies that a farmer who has number livestock will be more likely to adopt improved maize variety. This may be due to relatively having more livestock offer a means for a better propensity to buy improved maize seed and also farmers who have a large number of livestock might consider their asset base as a mechanism of ensuring any risk associated with the adoption of improved maize variety.

4.6. Total Farm Income (TFAMI)

Household's total farm income has a positive and significant relationship (at 5 % level) with probability of adoption of improved maize variety, The odds ratio favour adopting improved maize variety, other things being constant increase by a factor of 1.0002 as farm income increase by one unit of Ethiopia birr. This implies that a farmer who has better income will be more likely to adopt

improved maize variety. This may be due to the resource demanding nature of maize production activity particularly when the production purpose is beyond the home consumption and for purchasing agricultural inputs.

Regarding the influence of farm income on adoption, many other studies have also found similar results (Ketema and Kebede, 2017) reported positive influence of household's farm income on adoption of improved technologies.

4.7. Distance to Market Center (MKTD)

As expected, distance to market center has also a negative and significant relationship (at 5 % level) with the probability of adoption of improved maize variety. The odds-ratio in Disfavours of adopting improved maize variety decreases by a factor of 0.39 as the market distance increase by one kilometer. The implication is that the longer the distance between farmers' residence and the market center, the lower will be the probability of improved maize variety adoption. This may be due to relatively Proximity to market also reduces marketing costs. This result is consistent with other studies by (Rahmeto, 2007)

4.8. Use of Credit (Credit)

Use of access to credit had positively and significantly influenced the likelihood of adoption of improved (BH-140) maize variety at a 5% significance level. From this result it can be stated that those farmers who have access to formal credit from Omo micro-finance institution are more likely to adopt improved maize technology than those who have no access to formal credit. The odds ratio indicated in the model with regard to credit implies that, other thing being held constant, the odds ratio in favour of adopting improved maize variety increases by a factor of 0.035 as farmers get access to credit. Earlier study also reveals that credit is one of factors that affect the probability of adoption of improved maize variety (Sisaye, 2016) also reported that use of credit correlate positively with the adoption of improved technologies by farmers.

4.9. Contact with Development Agents (DACONT)

The number of contact with Development Agents per month had significant positive effects on the adoption of improved maize variety at 5% significance level. The odds ratio favouring the adoption of improved maize variety by a factor of 0.019 for the respondents' number of contact with the Development Agents per month increases in a unit. Therefore, respondents who highly contact with Development Agents per month have more chance to adopt the improved maize variety in the area.

The result obtained from key informants interview revealed that farmers' contact with and gained advice and training from Agricultural Development Agents initiated farmers' attending in training; improved their knowledge and skills on farming practices and improved farmers' utilization of improved maize variety. This agreed with receiving training and advice from development agents and the perceived usefulness of development agents' advice are major factors that explain the likelihood of technology adoption and rate input use .This result is consistent with other studies (Agidew and Amanuel, 2017) found a similar result.

4.10. Participation on Demonstration (Demon)

Participation on demonstration had positively and significantly influenced the probability of adoption of improved maize variety at 5% level. The result of log it model in relation to this variable shows that farmers who have an opportunity to participate on demonstration of improved maize variety are more likely to use improved maize than those farmers who have no similar opportunity. Other things held constant, the odds ratio at for variable participation demonstration implies that, as farmers' exposure to agricultural information increases, the odds ratio in favour of adopting improved maize variety increases by a factor of 41.868. Similar results were identified by (Abdi. *et al.*, 2015) found a similar result.

5. CONCLUSION

Out of the total sampled households, (51.41%) were adopters and (48.83%) were non-adopters of improved BH-140 maize variety. Based on Farmland covered by improved BH-140 maize variety and

utilization of input the adoption level categorized in four levels, such as Non-adopters were 48.59% from total respondents and zero percent covered by improved maize variety. Household heads that have not used any improved maize variety for the production (local maize grower). Low adopters were 25.35% and less than 50% of farmland covered by improved maize and utilization input below recommended for the production of the maize crop. Medium adopter farmers also were 17.6 % and the proportion was 51%up to 69% of maize production land and high adopters were 8.45% and 70% up to 100% was covered by the technologies for the production of maize crop farm in the production season. This shows that high-level adopters are very low in percentage this might be maize grower farmers didn't follow the extension agent advisory service and lack of training and awareness on improved maize technology.

The status of management practices for improved (BH-140) maize variety such as Method of Sowing, weeding practices, pest management, land preparation, Seed Rate and Fertilizer application preparation were not carried out as appropriate level as recommended for maize production due weak extension advisory service and lack of close supervision with farmers. Farmers that adopted improved BH-140 maize variety applied average of 62.5 kg/ha NPS, and whereas, 50kg/ha urea. The non-adopters applied average 45.5 kg/ha NPS, and whereas, 22.5kg/ha urea. About 57.04% farmers follow the recommended seed rate (25kg/ha) the rest 42.96% were used either more or less amounts of seed than that of recommendation.

Around, 45 (31.69 %) of adopters were weeding maize twice whereas, 16 (11.28%) of non-adopters were weeded maize twice per production periods into the study area. Furthermore, from the current study around 64 (45.07) of respondents reported that at once weeding which implies farmers didn't follow the extension agent advisory service and lack of training and awareness on management practices. In into the study area, around 49(34.5%) adopters' farmers had planted maize in a row and from non-adopter, around the34 (23.94%) were planted maize in a row the remaining had planted maize either broadcast or row. Pertaining to maize farm cultivations, 30 (27.46%) of respondents who adopted improved BH-140 maize variety had cultivated 3-4 times whereas, 33.8% of non-adopter farmers have been cultivated land twice before planting. In addition, around 33(23.23%) adopter farmers had controlled maize pest by hand picking and killing and whereas, remaining 16 (11.26%) controlled maize pest by using chemical and cultural methods respectively.

The result of t-test and chi-square tests were indicated that from 14 explanatory variables that hypothesized to determine farmers" adoption of improved maize variety, 12 of them were significantly related with the adoption of improved BH-140 maize variety. From discrete variables education, sex, use of credit, extension agent contact, participation in field day, attending training, conducting demonstration and farmer's attitude, whereas continuous variables farm income, farming experience, family size, livestock were found significantly related with the adoption of improved BH-140 maize variety.

Sex of the household head was found to be positively and significantly, influencing adoption decision improved maize variety. This implies male-headed households were more adopted improved maize variety than female-headed households because female-headed households have less access to improved technologies, land and information than a male-headed household that helps for the adoption of improved maize variety.

Education was found to be positively and significantly influencing farmer's adoption decision of improved maize variety. The diffusion of the technology could, thus, be facilitated by educated farmers to be used as contact farmers, besides improving farmers' level of education.

Use of credit has a positive and significant effect on the adoption improved maize variety implies that farmers who don't have cash and access to credit may find it very difficult to adopt new technologies while those who have access to credit can overcome their constraints and be able to buy inputs.

Contact with Development agent has a positive and significant effect on the adoption improved BH-140 maize variety .The information obtained from key informants interview revealed that, farmers' contact with and gained advice and training from Agricultural Development Agents initiated farmers'

attending in training; improved their knowledge and skills on farming practices and improved farmers' utilization of improved maize variety production. Farm income has a positive and significant relationship with adoption of improved BH-140 maize variety. This implies that a farmer who has better income will be more likely to adopt improved BH-140 maize variety.

RECOMMENDATIONS

Based on the above conclusion the following recommendation is forwarded:-

- To improve pest management practices in the study area it is better to provide training on pest management practice by the concerned bodies for maize grower farmers. Because of in the area there was poor pest management practice.
- Extension organizations, NGOs, and private sectors should give special attention for women farmers in intervention of new technologies because of it is crucial to empowering them to adopt improved varieties and technologies.
- The government should made efforts in designing an appropriate policies to improve and address adult educational and training opportunities to the rural farming HHs. Because of less educated farmers had less access to adopt the technology than other group. Therefore, adult education and training improve farmers' knowledge and skill and that promote farmers to use/ adopter the technology.
- The Government should be given more emphasis to strengthening access to rural microfinance institutes have to provided agricultural credit service for farm households. Because it facilitate the adoption of improved technologies in the study area.
- Promotion of improved animal breeds and husbandry would enhance adoption of new technologies and improvement of standard of living of farm families
- Since the support and supervision of agricultural experts is an important factor in technological adoption. Therefore, it should be better to give the concerned bodies more emphasis on strengthening the contact with agricultural extension agent with special attention for women.
- Based on the results of this study further researches can be performed in the future in order to improve maize productivity in the study area.

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