

EFFECTS OF FARMERS' KNOWLEDGE, ATTITUDE, SKILLS ON HIGHLAND MAIZE ADOPTION IN WESTERN ETHIOPIA

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Abstract: Understanding farmers' indigenous knowledge is vital in hybrid maize popularization. Despite different opportunities, adoption was constrained by the failure of infusing local knowledge in the modern extension system. Hence, farmers' capabilities, preferences, and practices towards adoption were studied. Data were collected from key informants and focus group discussion participants. A cross-sectional survey was to collect data from 154 respondents. Knowledge and attitude were assessed by using a 5-point Likert scale. Descriptive statistics and econometric analyses were run to analyze data accordingly. The results indicated among demographic characteristics; family and land size, owning of ox and experience have positively affected highland maize adoption at 1 per cent significance level; while education, age, and on-farm income have positively affected highland maize adoption at a 1% significance level. However, religion and sex did not affect highland maize adoption at all. Pearson chi-square result indicated, there was a positive and significant relationship of knowledge ($\chi^2=41.49$; $p=0.000$) to adoption. Consequently, an increase in farmers' knowledge of favoured adoption. Finally, poor institutional support, insufficient involvement of resource-poor farmers, and lack of training were major bottlenecks hampering highland maize adoption. Hence, provision of special training, credit services, and farmers-responsive training should be in place for better adoption.

Keywords: Adoption, Ambo, Binary Logit, Highland maize, Knowledge-Attitude-Skill

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INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal grains grown worldwide. It is the third major cereal crop mainly used as a food source and now has become the most important raw material for animal feed. The global production of maize is next to wheat and rice, and it is the second most important crop in Ethiopia. (Anley *et al.*, 2013; CSA, 2015; Smale, 1995). By contributing 31% of grain production, maize production in sub-Saharan Africa is predicted to double in 2050. The crop contributes 15% of the world's protein and 19% of calories. Hence, millions of people in Ethiopia depend on it for protein and daily calorie requirements (Mbuya *et al.*, 2011; Vasal, 2002). Consequently, owing to its wider cultivation, maize received the greatest attention of

all food crops under the extension program in Ethiopia (Kafle, 2010; Monela, 2014).

Of the 22 countries in the world where maize forms the highest percentage of calorie intake in the national diet, 16 are in Africa; where regional average yields are as high as 1.7 t/ha in West Africa and 1.5 t/ha in East Africa, and 1.1 t/ha in Southern Africa (Smale *et al.*, 2011). Even though Ethiopia with >3 t/ha have made significant productivity gains, the average yield of maize is still far below the global average yield of maize (5 t/ha) and considerably below the 4.4-5.4 t/ha on-farm trial results of improved varieties under optimal inputs and improved management conditions undertaken by CIMMYT in Sub-Saharan Africa.

The adoption of improved maize hybrids in developing countries has been constrained by the failure of inculcating indigenous knowledge, skill,

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and attitudes in the modern extension system. In Kenya, though the area devoted to maize production and income generated from maize is increasing, the status of production of hybrid maize is still lower than the open-pollinated varieties (Tiwari *et al.*, 2004).

Differences in farmers' cognitive ability, attitudes, and perceptions across locations have greatly influenced farmers' decisions on Adoption (Jain, 2007; Power *et al.*, 2013). This, in turn, forced farmers to cast-off adoption of improved maize varieties; which sequentially resulted in an information gap among them. According to Demissew *et al.* (2012), Improved maize varieties in Ethiopian highland farmers were not well popularized, and therefore significant differences are portrayed in the adoption of improved maize varieties which brought large differences in yield per unit of land areas (Cheesman *et al.*, 2017).

Advanced knowledge about agricultural technologies commonly drives policy reform and leads to change if only reinforced with apt contexts of remedies. Nevertheless, until recently, research and development efforts are becoming futile due to the limitation of inculcating farmers' knowledge, attitude, and perceptions of highland maize adoption schemes. Hence, interventions made so far were so scarce, and even these were infertile. It also lacks collaborative linkage among stakeholders to bring about desirable effects.

Thus, it was mainly because Farmers' Knowledge, Attitude, Skills (KAS) on maize adoption was given little attention in the study area. Hence, farmers' capabilities, preferences, practices, and reactions towards the technology needs to be explicitly studied to ameliorate farmers' awareness and productivity towards improved agricultural technologies in Ethiopia, among other things. This would be practical if gaps on KAS were identified, and due consideration was given to farmers' felt needs and interests. Hence the overall objective of this research is to analyze the effects of farmers' knowledge, attitude, skills, and determinants on highland maize adoption in the study areas.

RESEARCH METHODOLOGY

Description of the Study Area

The study was conducted in the Ambo district of Western Oromia of Ethiopia; and location lies

between latitude and longitude of 8°59'N and 37°51'E, respectively. Its elevation ranges from 1380 to 3030 meters above sea level. Ambo district is bordered on the West by Toke Kutaye, on the North by Elfeta and Jeldu, on East by Dendi, and on the South by Toke Kutaye, Wenchi, and South-west Shewa Zone (CSA, 2013). The district is administratively divided into 33 *kebele*¹ and has three town *kebeles*.

Sampling techniques and sample size determination

Multistage sampling was employed to select respondents where first, Western Shoa Zone was selected purposefully due to the agro-ecological suitability of highland maize. Then by excluding lowland areas, 14 high and mid-altitude *kebeles* were selected purposefully at the second stage. Then, three *kebeles* were randomly selected (out of 14) by using simple random sampling since the technique gives an equal chance of selecting locations. Then, at the fourth stage, Slovene's sample size determination formula (Altares *et al.* 2003, Ellen, 2012) was used to determine the number of adopters' sample size

$$n = \frac{N}{1 + Ne^2}$$
 Where n is expected sample size; N is total population e=error term at 95% confidence level, which makes the total sample size 64.

Subsequently, by using probability proportional to size (PPS) at the fifth stage, a proportional sample size of adopters and non-adopters for each Kebele was set accordingly to determine the number of total respondents from the three *kebeles*. Finally, by using a sampling frame collected from each Kebele Administrations, systematic random sampling was used to select actual respondents.

Table 1. Summary of a sample size from each *Kebeles*

Selected <i>Kebeles</i>	Adopter		Non-adopter		Total
	M	F	M	F	
Gosu Kora	24	11	35	15	85
Bilo	12	5	17	7	41
Boji Gebisa	8	4	11	5	28
Total	44	20	63	27	154

¹ Kebele is smallest administrative level in Ethiopian public governance

Types of Data and Methods of Collection

Before conducting a cross-sectional exploratory survey, a preliminary survey was conducted to develop a workable hypothesis. For this, three focus group discussions were held with groups of farmers. Similarly, 15 key informants were involved in discourses made with government officials, chairpersons, local farmer leaders, and elders to generate qualitative data.

KAS survey was employed to identify the knowledge gap and behavioural patterns that facilitate/hinder acquaintance, action, and barriers on highland maize adoption strategies. For this five-point Likert-scale was used to analyze the extent of respondents' degree of agreement of choice with each question. Then, results were transformed into a dichotomous variable. A semi-structured interview schedule was used to collect data from a cross-sectional survey.

Methods of Data Analysis

Quantitative data were computed by using descriptive statistics that were run by using SPSS version 20; while MS-Excel 2016 was used to narrate and describe qualitative data. Binary logistic regression was run to identify the determinants of farmers for adopting highland maize econometrically.

RESULTS AND DISCUSSIONS

Farmers' Knowledge

Pearson chi-square result indicated there was a positive and significant relationship of knowledge ($\chi^2=41.49$; $p=0.001$) with adoption. Though the knowledge level of both adopters and non-adopters was low, adopters were better off to their counterparts (more than two folds). Hence, adopters were better in knowledge and thus showed a better tendency to utilize the technology.

Attitude of Farmers

The relationship between adoption and attitude was positive and significant at 5% ($\chi^2=25.23$; $p=0.032$). This result was also supported by the chi-square result, which showed farmers showed positive feelings not only for highland maize in question but also to extension agents who brought the technology to the farmer. The outcome was further reinforced by Focus Group and Key informant participants who felt a positive psychological tendency to highland maize than their complements. However, this chance was not fully exploited by formal extension services due to imperilling outlay which impoverished farmers not to practice the technology further.

Skill of Farmers

Respondents' practice on highland maize showed, 36.4% of adopters and 22.7% of non-adopters exercised improved maize technology. The chi-square result supported there had been a positive and significant relationship between skill and highland maize adoption ($\chi^2=36.56$; $P=0.000$) at a 1% significance level (Table 3). Hence, as farmers' practice increases, Adoption of High Land Maize varieties had augmented, adoption was getting better.

Table 2. Distribution of adoption category of Farmers

Category	Non-adopter		Adopter		P-Value
	N	%	N	%	
Don't Know	67	43.5	14	9.1	0.01***
Knowledgeable	23	14.9	50	32.5	
Total	90	58.4	64	41.6	
Negative Attitude	58	37.7	15	9.7	0.03**
Positive Attitude	32	20.8	49	31.8	
Total	90	58.4	64	41.6	
No Skill	55	35.7	8	5.2	0.04*
With skill	35	22.7	56	36.4	
Total	90	58.4	64	41.6	

(Source: Survey data result)

Demographic Factors Influencing Farmers adoption

Among different variables, family size, land size, owning of an ox, and experience have positively affected highland maize adoption at 1 per cent significance level; while education level, age, and income earned from crop and livestock have positively affected highland maize adoption at 1 per cent significance level. Nevertheless, being a follower of any religion and sex did not affect highland maize adoption at all. The explanations are listed as follows

Age of respondents

Household age, a continuous variable measured in years, positively affected maize adoption at a 5 per cent significance level (Mean= 38.83; standard deviation=10.13). Similarly, the t-test result showed that data set were farther from the mean by +8.56 years. The result implied, there were significant associations of age with adoption since data were not concentrated around the mean, i.e. 38.83 Years. ($t=8.56$, $p=0.032$).

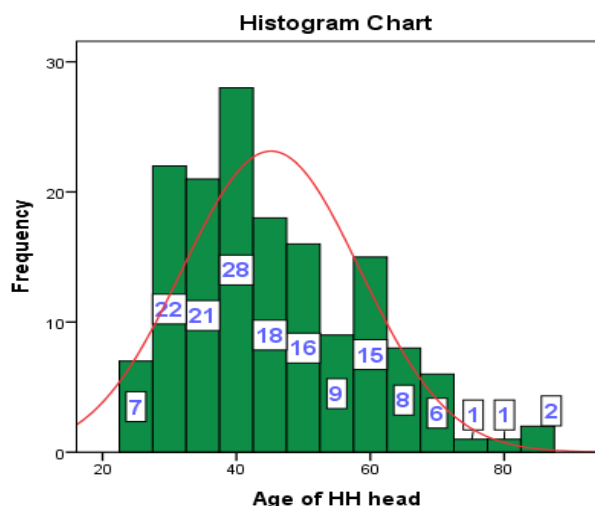


Figure 1: Frequency distribution of age of household heads in highland maize adoption. (Source: Survey data result)

The minimum and maximum age of household heads were 25 and 84 years (Table 3) and the majority of household heads were ranged inactive/ productive age group (15 to 60 years old). The standard curve on the histogram showed adoption was increasing to a maximum at an earlier age of respondents then it started to decline the total mean age of respondents (Figure 1) confirming the result that youngsters were more inclined to adopt.

Table 2. Descriptive Statistical result of demographic and institutional characteristics

Variable	Non-adopters (n = 90)		Adopters (n = 64)		P-Value
	N	%	N	%	
	Female	27	18	21	
Male	63	41	43	27.9	
Wit Membership	16	10	6	3.9	0.142
No membership	74	48	58	37.7	
Got credit	89	58	58	37.7	0.015**
No Credit	1	0.6	6	3.9	
ICT accessed	54	35	8	5.2	0.000***
ICT not accessed	36	23	56	36.4	
No perceived risk	75	49	38	24.7	0.001***
Perceived risk	15	9.7	26	16.9	

Experience

Respondents' practice which was a continuous variable measured in the number of years, has positively affected adoption at a 1% significance level

(Mean= 3.21 years and SD of 3.37). But 41.1% of non-adopters did not have highland maize farming experience at all, implying that they rejected highland maize

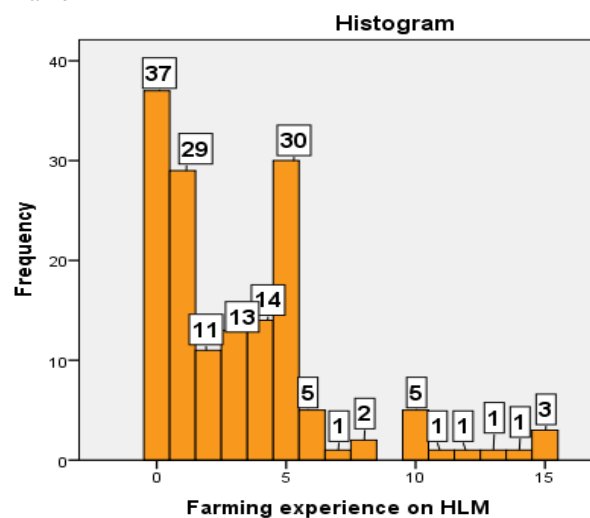


Figure 2: Frequency Distribution of Farming Experience (Year) by household heads (Source: Survey data result)

Education status

The relationship between education to adoption indicated that most non-adopters (45.45%) were less involved in formal education and thus it could be pronounced that lack of involvement in formal education deterred non-adopters from getting involved in adoption. Nevertheless, comparatively, most adopters have joined formal education than their counterparts since only 22.94% refrained from classes while the rest joined formal educations. Accordingly, better entitlement to education ameliorated adoption (p=0.003). Hence the ability to acquire new information and determining the readiness of household heads through education played a significant role in improving innovations and willingness to participate in highland maize adoption.

Family size

With an average family size of 4.43 and 5.84, non-adopters had smaller family size than adopters. Correspondingly, the mean family size of non-adopters was less than the national average; which was five. The result implied better availability of active labour force in for adoption process. The minimum and maximum family sizes of the household were 1 and 17; and the total mean and SD was 5.13 (4.81), while the mean and SD of adopters and non-adopters were 5.84 (5.11) and 4.43 (4.52), respectively. Thus, the statistical values (t=5.63; p=0.000) showed that there was a significant mean

difference between the family size and adoption of highland maize. Hence, family members living in the household head were responsible for farm activities as input and plays a role in highland maize adoption in study areas.

Sex of household heads

Distribution of highland maize adoption by sex of households showed, 68.8% of total male respondents took a larger proportion than females (Table 3). Therefore, the result clearly showed the existing gap between male and female household heads in terms of involvement in adoption. However, the Pearson chi-square test indicated that the sex of household heads had no significant relationship ($\chi^2=0.14$, $p=0.71$) with highland maize adoption. This result could emanate from a smaller number of female household heads and a high proportion of non-adopters.

This result was in line with Anik and Salam (2015) who reported prevailing social set up of rural households placed a varying responsibility among male and female members. In most parts of rural Ethiopia, women were disfavored groups of the society who could not easily access technical information. Thus, numerous adoption studies had come up with results showing being a female-headed negatively influencing technology adoption decisions. Consequently, male-headed households influenced the cultural norms and traditions because of their better access to information to use innovation than female-headed households, which can.

Table 3. General Characteristics of Sample Respondents in the Study Area

Characteristics	Non-adopters		P-value
	Mean (SD) (N=90)	Mean (SD) (N=64)	
Age	42.48 (12.94)	35.17 (7.32)	0.031**
Family size	4.43 (4.52)	5.84 (5.11)	0.000***
Education level	Mean (%)	Mean (%)	
Illiterate	45.45	22.94	0.003***
Read and write	25.21	28.59	
Primary school	17.22	29.28	
Post-primary	12.12	19.19	
Land size	0.13 (0.18)	0.32 (0.18)	0.000***
Ox ownership	1.92 (1.01)	2.80 (1.31)	0.002***
Experience	1.44 (2.13)	5.69 (3.25)	0.000***
Annual Income	Family Mean (SD)	Mean (SD)	
Crop (USD/family)	957 (22.78)	1245 (15.37)	$p=0.01$ **
Livestock/ family)	742 (2.52)	1095 (21.74)	
Religion	Mean (%)	Mean (%)	
Orthodox	43.24	45.34	$p=0.4$
Muslim	26.63	27.27	
Protestant	17.92	17.15	
Others	12.21	10.24	
Marital status	Mean (%)	Mean (%)	
Single	15.61	12.45	$p=0.07$ *
Married	57.01	52.31	
Divorced	17.15	24.23	
Widowed	10.23	11.01	

Source: Survey result, 2019; Own computation, 2019

Institutional factors

Land size

The total mean land size used for the highland maize cultivation was 0.21 ha with SD of 0.20. The result resembled with average highland maize land coverage (0.25ha) responses obtained during Focus Group Discussions and Key informant discussions in each kebele (Table 3).

From non-adopter and adopter categories, mean and standard deviation values for adopters and non-adopters were 0.32 (0.184) and 0.13 ha (0.18), respectively. Besides, the results of the t-test value ($t=6.38$) and P-value ($p=0.000$) showed a statistically significant mean difference in land size between both adoption categories implying the larger the size of cultivated land of highland maize, the greater would be its adoption.

Ownership of ox

Ownership of ox (Tropical Livestock Unit) has been an essential source of draft power and effective means of tillage or land cultivation in the study district. The result of this study indicated in (Table 3) that minimum and maximum oxen ownership among respondents ranged from zero to eight, respectively. The total was found 2.29 TLU with an SD of 1.22 for all household heads. It was observed that the non-adopters had a mean of 1.76 TLU and SD of 1.27, whereas the adopters had a mean of 2.89 TLU and SD of 1.83. The statistical t-test values ($t=4.29$; $p=0.002$) also showed that there had been a significant difference in ox ownership of non-adopters and adopters of highland maize, indicating a strong association (at less than 1% probability status) in between them. Household heads who have a pair of oxen (in extra number) would adopt the technology as compared with those who have one or have not any ox. However, owning ox/oxen alone would not draw the attention of farmers to adopt highland maize. There would be awareness creation, raise, or applicable demonstration activities as interventions about the benefits of the technology improving the available resources.

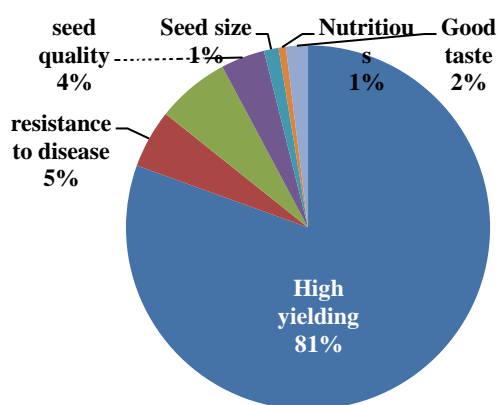


Figure 3: Major Criteria for Preferring the highland maize by Respondents
(Source: Survey data result)

Highland maize related institutional variables include membership to the organization, highland maize extension service access, highland maize credit access, and use of ICT among respondents. Being a member of a group with a particular purpose and socialization brought households together mainly for the benefits of farming activities. Being membership, helped in

information sharing and building mutual trust and bondage among the households in the study district. In this study, the frequency distribution of total member household heads, 85.7% took a larger proportion than non-members, 14.3% in highland maize adoption (Table 3). The proportions of non-members were relatively high within non-adopter groups, 10.4% than within adopter groups, 3.9%. The majority (48.1%) of non-adopters were members at least in one of the organizations in the area. However, the result clearly showed the existing gap between members (high) and non-member (low) households had been not worth mentioning for adoption. Thus, calculated values ($\chi^2=2.157$; $p=0.142$) indicated household heads' membership of the organization had no significant relationship with the adoption of highland maize statistically in both categories.

Table 4. Descriptive Statistical Summary of Continuous Explanatory Variables

Variables	Non-Adopter, n=90	Adopter, n=64	P-value
	Mean (SD)	Mean (SD)	
Age	46.46 (13.89)	43.36 (12.24)	0.146
Education s	3.50 (3.30)	5.59 (3.76)	0.001*
No. of persons in family	1.76 (1.27)	2.89 (1.83)	0.000*
Cultivated land size	0.13 (0.181)	0.323 (0.184)	0.000*
No. ox owned	1.92 (1.01)	2.80 (1.31)	0.002*
Total asset owned	605.59 (988.66)	750.375 (1420.90)	0.484
maize grain av. yield	2112 (25.49)	3338 (17.26)	0.001*
Farming experience	1.44 (2.13)	5.69 (3.25)	0.000*

*** Means significant at 1% probability status; SD= Standard Deviation
(Source: Survey data result)

Different institutions have been arranging a variety of extension services or events (training, on/off-farm demonstrations, field days/visits, and others) relating to highland maize. These have been some of the means through which the surrounding farmers are getting highland maize information and access in the area. Respondents' highland maize extension service access is the derivative of access to institutional services. The result showed that 53.2% of household heads have extension access related to highland maize, while 46.8% did not get the service. Similarly, 29.9% of adopters had extension service

access to highland maize; whereas the rest 11.7% did not get the service. The highest number, 35.1%, did not access extension services, and 23.4% directly shared the service.

Credit

The existence of and affordability of formal highland maize related credit at least as entry became a central service to solve the financial constraint of the pro-poor rural households. It plays a significant role in income diversification, upgrading highland maize adoption status, in turn, positively influencing its production and productivity. The availability of improved highland maize -specific credit service (in-kind) usually on inputs required (during off-farm demonstrations, trials, e.g. for PVS) had been observed irregularly on some selected highland maize producers as payback and motivation. The Focus Group Discussions and Key informant discussions sessions' results also verified that few respondents had received a kind of credit service in terms of seed, chemical fertilizers, and pesticides from other projects too, highland maize research and extension case teams. There was no significant and formal credit service provider reported in the area during the study. As indicated in (Table 4), almost all sampled respondents, 95.5% reported that there was no permanent highland maize credit way in the area while only the remaining, 4.5% respondents accessed to highland maize credit (supply in-kind) in the study area. Concerning the credit accessibility, 0.6 % non-adopter and 3.9% adopters had kind of credit for highland maize production. Because of these on-adopters, especially the pro-poor, would become nonusers of the technology. Similarly, the statistic values ($\chi^2=5.887$, $P=0.015$) showed access to highland maize credit service had a positive and significant relationship between the two adoption categories which found nearly at 1 % probability status. Credit access to highland maize can be taken as a proxy indicator for the adoption of technologies expressly for the pro-poor rural household heads farmers at local levels.

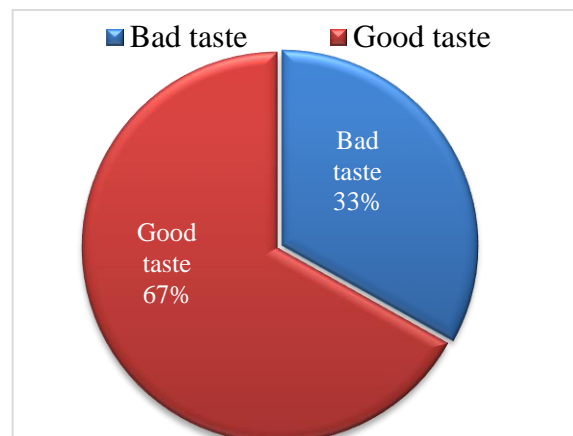


Figure 4: Taste of highland maize Flavor by household heads in the study area (Source: Survey data result)

The result showed that the majority of sample respondents, 73.4% had perceived risks in the production of highland maize. Out of this, 48.7% were non-adopters, and 24.7% were adopters. The number of respondents who did not relatively perceive risks were 9.7% from non-adopters and 16.9% from adopter categories. These imply that attention should be paid to the perceived risks identified to consider the high proportion of non-adopters to be beneficiaries. Thus, the statistic calculation values ($\chi^2=10.990$; $p=0.001$) showed that perceived risks during highland maize production had a significant relationship with both adoption categories, which was found at less than 1% probability status.

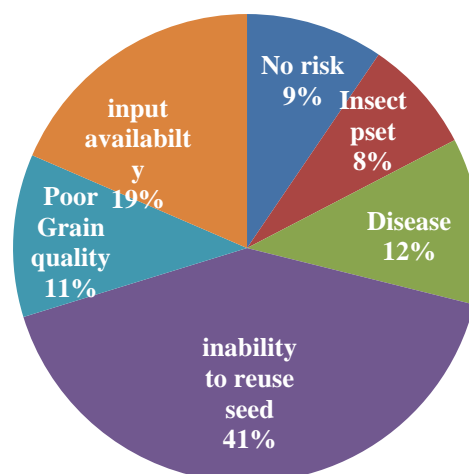


Figure 5: Risks Observed by Respondents in the Last Year of Cropping Season (Source: Survey data result)

Four explanatory variables (sex of household heads, Member of any organ, Inter/intrahousehold head, AGE, and Total asset owned at household head)

showed a statistically insignificant relationship. In all of the explanatory variables described, the intervening or confounding variables (KAS) have been identified as causes in the adoption processes. T-test results showed that the mean and SD of all continuous variables of adopters have been greater than non-adopters; whereas, categorical variables were in favour of the adopters' category, except credit. These would imply that KAS is playing a pivotal role in highland maize adoption.

Econometric Analysis of Binary Logistic Regression

Among 15 independent variables that were proposed to influence adoption, only eight predictors *namely*: sex of household heads, family size, ox ownership, estimated asset ownership, access to extension service, and use of ICT, perceived risk, and farming experience of household heads were found significant.

Sex: The probability of being a male household head positively influenced adoption by a factor of 3.58 than women counterparts at a 1% significance level, taking all other variables constant. It is likely due to that women hardly adopted highland maize since male household heads usually take a high share of resources in the study area. Men's household heads had a significant direct influence on highland maize adoption.

The result was in line with Christina *et al.*, (2001); Tshiunza *et al.*, (2001); Muche *et al.*, (2014) who reported sex of household head is positively associated with control over resources and technology adoption. Male is in a better position to pull the labour force as compared to household heads. Females often lack labour, rent their land on a sharecropping basis. Further, Abdi (2015) indicated that being male increases participation in irrigation activities positively.

Total family size: showed a positive influence on highland maize adoption among families. The model showed that family size had a positive and significant result at five %significant levels. The absence of a negative sign in the model was an indication of a high probability of being highland maize adopted with an increased number of family size in favour. The odds ratio of highland maize adoption was 1.72, indicating as the number of household head family size increased by one-unit adoption had increased by 1.72 units. This implies that increasing family size brought an ameliorating effect on highland maize adoption.

The finding was well supported by Feder *et al.* (1985); and Awotide *et al.* (2016) who reported

favouring the effect of large family size on adopting technologies. However, contrary to findings of Ayalew (2003), Tesfaye (2005), Guled (2006), and Mequanent (2009) that resulted in households with large family size, composed mainly of the non-productive population could face the probability to be food insecure due to high burden levied on active labour. An increase in household head size implies more mouth to be fed from limited resources and has a negative relationship with food security.

The number of oxen ownership: it was one of the wealth accumulations schemes in rural areas, and as expected, the number of ox ownership brought positive and significant influence on highland maize adoption at a 5% significance level. The model output on Exp (B) revealed as oxen ownership of household heads increased by one unit (TLU), the probability of highland maize adoption increased by a factor of 2.06. This implied, owning oxen power allowed practical use of resources (diversifying land, labour), and it is meant to cultivate land traditionally.

The finding was in line to Tesfaye (2005); Guled (2006); Mequanent (2009); Muche *et al.* (2014); Taruvunga *et al.* (2013); Megersa *et al.* (2014); Workicho *et al.* (2016), who reported a positive association of livestock ownership in moving dietary status of diversifications.

A total volume of estimated asset ownership: it was hypothesized to have a positive influence on highland maize adoption in the study area. According to the logit result, asset ownership of respondents positively and significantly influenced highland maize adoption at a 5% significance level. The result implied keeping the influence of other variables constant, a unit change on asset ownership facilitated highland maize adoption by a factor of 1,000.

This finding is incongruent with other studies that have reported farmers rarely had equal access to assets and market information (Hill and Vigneri, 2014) and asset ownership was positively related to Knowledge and Adoption of technology (Milkias, 2017).

Table 5: Binary Logit Model Output of Independent Variables Set on highland maize Adoption

Variable	B	SE.	Wald	Exp (B)
Sex of	1.27	0.75	2.85	3.581
Age of	-0.01	0.03	0.21	0.986
Education	0.01	0.09	0.01	1.012
Persons in family	0.54	0.30	3.20	1.723
Cultivated land size at	2.80	2.07	1.79	16.004
No. Ox owned	0.73	0.38	3.61	2.068
Total asset owned	0.00	0.00	3.52	1.000
organization	1.57	1.26	1.53	4.822
Membership				
Access to extension	1.85	0.77	5.71	6.328
Credit service	0.73	2.67	0.07	2.065
Use of ICT	2.67	0.84	9.88	14.366
Perceived risks	1.97	0.71	7.50	7.154
Maize av. Yield	0.00	0.00	1.05	1.000
Taste preference	0.25	1.01	0.06	1.286
Farming experience	0.86	0.20	17.85	2.358
Constant	-21.26	5.49	14.98	0.000

(Source: Logit Model output of survey data, 2019)

Access to highland maize extension service: model output result showed a positive and significant relationship between access to highland maize extension service and adoption at 1% significance level. Hence, getting access to highland maize extension services facilitated adoption by a factor of 6.33.

The finding is similar with Anik and Salam (2015); Awotide *et al.*, (2016); Million and Belay (2004), Nguezet *et al.*, (2011) who stated farmers with less access to extension service were hampered to adopt new technologies and agricultural input supplies. Hence, extension services influenced adoption positively.

Households' perceived risk aversion: this was a significant constraint to technology adoption in developing countries. In light of this, as it was hypothesized, risks brought negative influence on highland maize adoption, which could be initiated by farmers' awareness ahead of events. It is likely due to disfavoring climate change or risk-taking that households hardly used technology for production. As indicated on the model output, risks on highland maize production had indirect or disfavoring significant influence to adopt varieties at less than 1% significant level. The odd ratio/coefficient verified that if household heads relatively faced no perceived risk on highland maize production, keeping other variables constant, he would probably increase its adoption by 7.15 factors relatively than who perceived risks. This implies in the absence of negative influence of risks on highland maize, the

probability of being adopter is higher than that of non-adopters

The result agreed with findings that state insect and pest infestations were important biological factors restraining crop production and causes of food deficit Muche *et al.*, (2014)

CONCLUSIONS

Summary and conclusion

KAS study was aimed at assessing the overall effect of knowledge, attitude, and skill on the adoption pattern of highland maize varieties in the study areas. The descriptive statistical results showed out of 15 proposed only four, i.e. sex, age, membership to the organization, and asset ownership were observed having odds of nominal values or relationship. Focus Group Discussions and Key informant discussions pointed out that highland maize extension services and training were inadequate in the study area. Likewise, market facilitators, lack of producers' organizations, and involvement of traders in the business with a fair price as collectors and inputs service providers were the significant market constraints that farmers are facing in the study area. Besides, highland maize adoption has been being predominantly carried out by men's household heads in the area.

Since knowledge was a gap, giving additional acquaintances needs reasonable means of interventions. A large number of non-adopter farmers have negative aspirations towards a variety of adoption. The statistical attitude status of the household heads that had a positive and significant relationship with the adoption implies the status of farmers' attitude is directly proportional to highland maize adoption. Thus, further integrated action is needed to change and pull the aspiration towards the technology

As training has a special multiplier effect, adoption seemed to have the shortest marked effect on yield, food and feed security, and income generation due to less involvement of resource-poor farmers' at large. This showed that contributions and competencies of the majority of poor households were being less considered and addressed in highland maize adoption.

Recommendations

The following recommendations should be in place for better and augmented adoption:

- Local and regional extension system should incorporate indigenous knowledge, attitudes, and skills of local farmers
- due consideration should be given to raise farmers' awareness of the existing varieties and associated agronomic practices
- emphasis should be given for empowering pro-poor technology dissemination
- extension services should gear itself for communicating better farming experiences and platforms among potential highland maize producers and developers
- attention should be given to the capacity building of traditional practices, rural women household
- Establishing highland maize farmers' organization and significant market linkage should be in place to institutionalize the variety in rural development and agricultural endeavours

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