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Factor affecting adoption and intensity of use of improved maize varieties: The case of Kiremu District, Oromia Regional State, Ethiopia

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Abstract

Improving agricultural productivity and improving smallholder farmers' income requires increased efforts in influencing farmer to use yield enhancing technologies like improved maize varieties. It is from this ground the need to analyses the factors that influence the adoption and intensity of use of improved maize varieties. sampling procedure was employed to select the target households. In the first stage, out of 19 kebeles in Kiremu district three kebeles were selected using simple random sampling. Secondly, stratified random sampling method was employed to identify sample households. Finally, sample of adopters and non-adopters were selected by using simple random sampling. Structured instrumental questionnaire was developed, pre-tested and used for collecting data from 189 randomly selected households. Descriptive statistics and double hurdle model were employed to analyse data. Results of descriptive analysis showed that there were statistically significant differences between adopter and non-adopter households with family size, education, and distance to market, number of oxen, farm income, livestock owned and frequency of extension contact. Similarly, Double hurdle model results showed that improved maize varieties adoption decision of farm households has positively and significantly determined by education, family size, farm income, livestock owned, number of oxen and frequency of extension contact and intensity of use of adoption of improved maize varieties also positively and significantly determined by education, farm income, number of oxen, membership of farmers' cooperative union and livestock owned. It is therefore recommended that government and other development organizations should create a favourable environment like strengthening farmers' knowledge on modern agriculture production throughout strengthening of the extension services, creating awareness on the advantage of being the membership of farmers' cooperatives union and giving more attention to farmers' priorities and needs.

Key Words: Adoption, Intensity, Improved Maize Varieties, Double Hurdle Model, Ethiopia

Introduction

As the world's population is expected to reach 9.1 billion by 2050, the production of food, mainly staple crops is expected to increase accordingly, especially for the 870 million people who are currently food (IFC, 2013). This suggests that the dominant role of agriculture as the primary source of food and employment creation in the

developing economies should be stepped up. A study by Alexandratos and Bruinsma (2012) indicated that agricultural production needs an increase of 60% by 2050 to meet the world's consumption demand. This expected growth means that smallholder farmers who are the principal agent of agricultural production have a significant role to play. In Sub-Saharan Africa (SSA), a majority of the population is agriculture dependent with about 55% in the rural areas (IFC, 2013).

Therefore the ultimate goal of any rural or farming development strategy or program is to improve the welfare of rural households. This goal is achieved among other things by increasing productivity at farm level and by raising farmer's income and by improving their welfare. This is possible if and only if improved are properly transferred and disseminated to farmers so as to deepen and intensify their production. Institutions that are involved in generating agricultural technology need to have the capacity to carry out studies that document the process of adoption and help in explaining the rationale for framer's decisions (Assefa and Gezahegn, 2009).

According to Abate *et al.,* (2015) furthermore, the Ethiopian Maize market has been dominated by BH660 and BH540; the average of 80 % of the currently grown varieties is more than 20 years. There are also hybrids that came into production between 2005 and 2008, but their amounts remain limited, with the exception of the Pioneer hybrids Shone and Agar.

Generally, From Oromia region Kiremu district is potential producers of Maize and no study has been conducted on adoption and intensity of use of improved maize varieties previously in this areas. This study therefore conducted to examine the determinants of adoption and intensity of use of improved maize varieties with a purpose of generating information that help understand and evaluate the key challenges to the adoption of improved maize in the study areas which will enhance informed decision making to improve adoption of maize, their production and productivity by increasing land allocated for improved maize varieties in the study area.

Statement of the problem

One of the main reasons for seed waste in either public or private seed stocks during high demand has been associated with the limited efficiency of targeting seed production and distribution in Ethiopia (Dawit *et al.,*2010). It is also believed that some superior cultivars that have been released might not have been adopted because of lack of sufficient considerations of farmers' preferences in their development process (Derera *et al.,* 2006).

Smallholder farmers' knowledge and use of agricultural technologies in general and improved maize varieties in particular, are restricted due to various factors that are either internal or external to the farmers' circumstances. Most commonly studied internal factors that affect adoption and use of agricultural technologies are farmers' attitude towards risk, household characteristics that affects the level of production and consumption, resource endowments, etc. External factors could be access to technologies, in particular through a well-developed seed system (Croppenstedt *et al.,* 2003; Alemu *et al.,* 2008; Asfaw *et al.,* 2011), infrastructure, institutions (Beke, 2011), markets, and enabling policy environments (Smale *et al.,* 2011).

In the study area, there was no empirical information so far on the adoption of improved maize varieties. Therefore, improving agricultural productivity and development and thereby improving smallholder farmers' income requires increased efforts in influencing farmer to use yield enhancing technologies like improved maize varieties. It is from this ground the need to determine the factors that influence the adoption and intensity of use of improved maize varieties in kiremu district study area seen as a thoughtful gap that must be bridged if the problem of limited improved maize varieties adoption among farmers is to be addressed to be improved.

Objectives of the Study

To identify the factors affecting adoption and intensity of use of improved maize varieties in the study area.

Literature Review

Definitions and Concepts

The adoption of a production technology is not a unit and instant act; it consists of several stages and involves sequence of thoughts and decisions. Adoption is a process consisting of three stages namely pre- adoption, adoption and post- adoption. At the pre-adoption stage, people may examine a new technology and consider adopting it. At the adoption stage, they form an intention to adopt the technology, and they eventually purchase and use it. At the post-adoption stage, people can either continue or discontinue using the technology. It is well recognized that improvement in agricultural productivity among farmers is achieved through improved agricultural technologies (Moshi, 1997).

The Adoption process is the change that takes place within individuals with regard to an innovation from the moment that they first become aware of the innovation to the final decision to either use it or not. Also, as it is emphasized by Ray (2001) adoption does not necessarily follow the suggested stages from awareness to adoption; trial may not always be practiced by farmers to adopt new technology, they may adopt the new technology by passing the trial stage. The adoption pattern for a technological change in agriculture is a comprehensive process. A large number of personal, situational and social characteristics of farmers have been found to be related to their adoption rate.

Dissemination of innovation theory: Dissemination of innovation theory (DIT) by Rogers (2003) is the theory guiding this pack. According to Medlin (2001) DIT is the most appropriate for investigating the adoption of technology in higher education and educational environments. Actually Rogers (2003) used the word innovation and technology as synonyms. He defined technology as a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. Adoption as the decision of full use of an innovation as the best course of action available whereas rejection is a decision

not to adopt an innovation and diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system. As expressed in the definition of diffusion, innovation, communication channels, time, and social system are the four key components of the diffusion of innovations. The most important objective of this theory is to understand the adoption of innovation in terms of four elements, including innovation, communication channels, time and social systems and five stages, including knowledge stage, persuasion stage, decision stage, implementation stage and confirmation stage.

Innovation: Rogers describe innovation as an idea, practice, or project that is perceived as new by an individual or other unit of adoption. It may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. The newness characteristic of an innovation is more related to the three steps, namely knowledge, persuasion, and decision of the innovation-decision process. According to Rogers (2003) uncertainty is an important obstacle to the adoption of innovations. An innovation's consequences may create uncertainty, whereas consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of an innovation. To reduce the uncertainty of adopting the innovation, individuals should be informed about its advantages and disadvantages to make them aware of all its consequences.

Communication channels: The second element of the diffusion of the innovation process is communication channels. For Rogers (2003) communication is a method in which participants create and share information with one another in order to reach a mutual understanding. This communication occurs through channels between sources. Besides Rogers defines source is an individual or an institution that originates a message and the channel is the means by which a message gets from the source to the receiver. In addition Rogers states that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units of adoption, and a communication channel. Mass media and interpersonal communication are two communication channels. While mass media channels include a mass medium such as TV, radio, and newspaper, interpersonal channels consists of a two-way communication between two or more individuals. On the other hand, diffusion is a very social process that involves interpersonal communication relationships. Thus, interpersonal channels are more powerful to create or change strong attitudes held by an individual. In interpersonal channels, the communication may have a characteristic of homophiles, that is, the level to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like, but the diffusion of innovation requires at least some degree of heterophony, which is the degree to which two or more individuals who interact are different in certain attributes. In fact, one of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous.

Time: According to Rogers (2003) the time aspect is unnoticed in most behavioural research. He argues that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoption all include a time dimension.

Social System: The social system is the last element in the diffusion process. Rogers (2003) defined the social system as a set of consistent units engaged in joint problem solving to accomplish a common goal. Since diffusion of innovations takes place in the social system, it is influenced by the social structure of the social system. For Rogers (2003) structure is the patterned arrangements of the units in a system. He further claimed that the nature of the social system affects individuals' innovativeness, which is the main criterion for categorizing adopters. Furthermore, technology adoption-decision process involves information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of that technology. As demonstrated by Rogers (2003) the technology adoption-decision process involves five steps, namely knowledge, persuasion, decision, implementation and confirmation.

Empirical studies on farmers' adoption of improved maize varieties

Through demonstration farms, farmers become aware of the attributes of IMV and acquire sufficient knowledge to make adoption decisions. Farmers learn more and become more sensitize through visuals and hands-on than hearing, hence the importance of demonstration fields. These results complement those of Mmbando and Baiyegunhi (2016) and Gecho and Punjabi (2011). Finally, farmer's membership of FBO variable is significant and positively related to the intensity of IMV adoption, implying that farmers belonging to FBOs adopt IMV more than the non-members of FBOs. Similar results were reported by Mmbando and Baiyegunhi (2016) in Tanzania, Ojo and Ogunyemi (2014) and Ugwumba and Okechukwu (2014) in Nigeria.

According the result of Assefa and Gezahegn (2009) that younger farmers, famers with larger land size, farmer living closer to market, and farmers who had closer contact with the extension system are more likely to adopt new technology and use it more. The result underscores the need for research and extension programs to be sensitive to the needs of farmers when developing and disseminating technologies that are relevant to their agro-ecologies.

According to Jaleta *et al.,(*2013) results by using Poisson, binary and multinomial Probit, Tobit and Heckman's selection models show that household characteristics, availability of family labor, wealth status, social networks, and access to credit to buy seed and fertilizer, better soil fertility and depth, market opportunities (number of traders known in villages) affect the number of improved maize varieties known to farmers, their adoption and intensity of farm area allocated to improved varieties, and the use of freshly purchased hybrid and/or OPV maize varieties. Generally, institutional arrangements that strengthen farmers'

access to input and output markets and accumulation of wealth could enhance the knowledge and use of improved maize technologies for better productivity and household income.

According to Julius (2016) paper there are four results. First, the findings suggest that the adoption of improved maize varieties is determined by a whole range of factors that include land cultivated, education of the household head and the total asset holdings of the household. Second, the results show that the adoption of improved maize varieties is associated with higher levels of income, food security, child nutritional status and lower levels of poverty. Third, the counterfactual analysis applied in this thesis shows that if non-adopters had adopted improved maize varieties, they would have realized higher levels of welfare than they currently have. Fourth, the results show that adoption of improved maize alone has greater impacts on maize yields, but given the high cost of inorganic fertilizer that limits the profitability of adoption of improved maize, higher household incomes are associated rather with the adoption of multiple SAPs.

The paper done by Tura *et al.,* (2010) analyses the factors that explain adoption as well as continued use of improved maize seeds in one of the high potential maize growing areas in central Ethiopia. Using a bivariate probit with sample selection model approach, the study provides insights into the key factors associated with adoption of improved maize seed and its continued use. The result revealed that human capital (adult workers, off-farm work and experience in hiring labor), asset endowment (size of land owned), institutional and policy variables (access to credit, membership in farmer cooperatives union) all strongly influence farmers' decisions to adopt improved maize varieties, while continuous use of the seed is influenced by the proportion of farmland allocated to maize, literacy of the household head, involvement in off-farm work, visits by extension agents, farmers' experience, household land size, and fertilizer usage. Accordingly, policies and interventions that are informed about such factors are required to accelerate adoption and continued use of improved maize seeds in order to increase farm yields and remedy shortage of food and fight food poverty and insecurity more effectively and more sustainably.

According to the paper written by James *et al.,* (2014) Intensity of adoption of improved maize varieties varies continuously and this feature allows estimation of the dose response function. The dose response function was estimated using generalized propensity score useful for analysing causal effects of continuous treatments. The results indicated an increasing dose response function between intensity of adoption and per capita food consumption expenditure.

Research Methodology

This chapter summarizes description of the study areas, data types, and source of data and method of data collection, sampling procedure and sample size. It also describes method of data analysis descriptive and econometrics.

Description of the Study Area

The study was conducted in Kiremu district of East Wollega zone. Kiremu district is one of the 17 administrative Woreda's in the zone. This district is bounded with Amuru Woreda of Horro Guduru Wollega zones in the East, Gida Woreda of East Wollega Zones in the West, Amhara Region in North, and Abe Dongoro Woreda of Horro Guduru Wollega zones in the South. Geographically the altitude varies from 750 up to 3020 meter above sea level. The district is classified into three agro ecological zones; namely, highlands (4.91%), Midlands, (53.17%) and lowlands (41.92%). Averagely the temperature is 280c. The capital town of the district is Kiremu which is about 140 KMs far from Nekemte Town and 458 from Addis Ababa. The total population of the district is 91,562. 21% of the population lives in urban and 79% in rural residents. Administratively the district is divided in to 19 Kebeles.

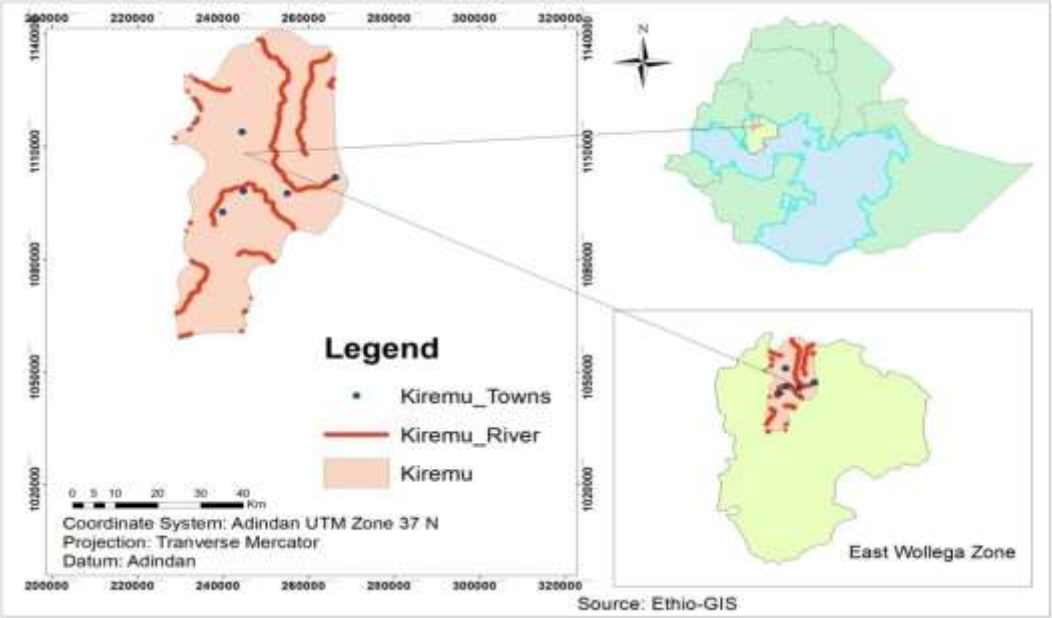

Figure 1: Map of Kiremu District
Source: Ethio-GIS, 2019

Data Types, Sources of Data and methods of Data collection

For this study both quantitative and qualitative data were collected. This study used both primary and secondary data. The data was collected from primary sources generated through structured questionnaire. Secondary data was obtained from internet, through the desk review; the study assessed the existing literature on the perception of farmers on improved maize varieties and the factors affecting adoption and the intensity of use of improved maize varieties. The data was collected by the instrument Survey questionnaire and by FGD organizing together for both quantitative and qualitative data collection respectively. For FGD from three kebele three group were arranged by which one groups contains 8 group, making 24 sampled households were selected from the three kebele using the kebele experts for some qualitative data.

Sampling procedures and sample size

This study implemented two- stage sampling procedures to collect the required primary data. In the first stage, out of 19 kebeles in Kiremu district three kebeles were selected using simple random sampling. Secondly, stratified random sampling method was employed to identify sample households for inclusion in the study. To this effect, list of adopter households was obtained from district agricultural office (district agricultural office, 2018) and from development agents at each sample kebeles and then households in the area were categorized into 2 strata, that is 1291 adopter of improved maize households, and 1223 non-adopter households. Finally, sample of adopters and non-adopters were selected by using simple random sampling. The sample keeping the proportion to each kebeles were selected by using Yamane (1967) sample size formula and 7% Precision Level Where Confidence Level is 95%.

$$n = N / 1+ N(e)^2$$

$$n = 2514 / (1+ 2514 (0.07)^2 = 189$$

Where: n is the sample size, N is the population size, and e is the level of precision.

In general, using the above sample size and the total number of households from the selected Kebele's, the proportion and the number of sample households have been summarized in the following table.

Table 1: Sample distributions of HHs in the study area

Kebele	Total households		Sampled house hold		Total sample
	Adopter	Non adopter	Adopter	Non adopter	
Gudina Jeregna	613	545	46	41	87
Chefe Soruma	266	266	20	20	40
Burka Soruma	412	412	31	31	62
Total	1291	1223	97	92	189

Method of Data Analysis

The study used descriptive statistics, and econometric models to analyses the data.

Descriptive statistics

Descriptive statistics analysis was used to clearly compare and contrast different characteristics of the sample households along with descriptive statistics such as ratios, frequencies, percentages, means and standard deviations to analyze the collected data.

Econometric analysis

Following data collection, the collected data were coded, edited and made ready to data entry. Based on objectives of this study, both descriptive and inferential statistics; Double-hurdle econometric model was applied for data analysis.

Definition of Variables and Working Hypothesis

Dependent variables

Dependent variable for first double hurdle model

Adopter and non- adopter categories was identified based on the adoption of improved maize variety. In this study, the data (2017/18) on area allocated to improved maize varieties and continues use of improved maize varieties for long period of time up to present were used to categorize the two groups. Adopters (participants) are those that allocated land to improved maize varieties for two or more years while non-adopters (non-participants) are those who did not allocate land for these varieties at all. It is equal to one if the farm household has adopted the varieties and zero otherwise.

Dependent variable for second double hurdle model

Land allocated for improved maize: It is a continuous variable, which refers to the land allocated for improved maize varieties. It was used in the 2nd hurdle model as dependent variable to analyse the factor affecting the intensity of use of improved maize. It was measured in ha.

Independent variables

The independent (explanatory) variables which are expected to determine the adoption decision of the farm households in this study are categorized into three. They are: The socio-cultural factors: such as age, education, family size, farming experience which were hypothesized to influence agricultural technology adoption significantly. Economic factors: such as owned livestock, number of owned oxen, farm income, off farm income and the Institutional factors: such as distance to market centre, extension visits, and X1,..., Xi, are factors that promote or prevent farm households' from adopting improved maize technologies. They are explanatory variables in the equation above described as follows:

Table 2: Summary of dependent and independent variables, their definitions and expected effect

Dependent Variables	Definitions of variables	Unit of measurement	Expected sign
Adoption of improved maize varieties	Dummy, household participation in adoption of improved maize varieties	1 if adopted IMVs' and 0 other wise	
Land allocated for IMV	Continues, the amount land allocated for IMV	ha	
Independent Variables	Definitions of variables	Unit of measurement	Expected sign
Age	Age of household head	Years	-
Family size	Number of persons per household	No	+
Education	Continuous, number of years of schooling of the HHH	years	+
Total income from farm	Log of Farm Income	birr	+
Total income from non/off farm	Log of off Farm Income	birr	+
Membership of farmers cooperatives union	Membership to farmers cooperatives union, dummy	1=Yes 0= No	+
Number of livestock owned	Number of livestock owned	Tropical Livestock unit	+
Number of oxen owned	Number of oxen owned	No	+
Distance to market	Distance of farmers house from market	minute	-
Farming experience	Maize farming experience of farmer	years	+
Extension	Contact with extension agents	No of extension contact per year	+

Source: Own definition

Result and discussion

This section consists of two sub-sections. The first one is description of sample households' characteristics and the second subsection is econometric methods.

Descriptive Results

In this chapter the overall findings of the study is presented under different sections. Next to description of status of adoption and intensity of use of improved maize varieties, the influence of different personal, demographic, social, economic, institutional and psychological factors on adoption and intensity of use of improved maize discussed consecutively. In this section of analyses descriptive statistics such as mean, percentage, were employed using STATA 13 software programs. In this study, adopters of a technology refer to farmers who have used improved maize varieties and those who are more productive by allocating proportion of their land for improved maize varieties and those farmers who experienced growing of local variety considered as non-adopters.

Land allocation and production of improved maize varieties

The mean area planted by improved maize varieties was about 0.66 hectare for adopters. The Study indicated that the average size of cultivated land holding of adopter households was 2.15 hectares with standard deviation of 0.637 and they allocated about 30.70 % of their farm lands for improved maize production. The maximum area allocated for improved maize varieties was 1.5 hectare and minimum land allocated to improved maize varieties was 0.25 hectare.

Table 3: Yield and area of land allocated to improved maize varieties

Description	Mean	max	min	Std
Total land cultivated(ha)	2.15	3.53	1.01	0.637
Area of improved maize (ha)	0.66	1.5	0.25	0.359
Total production of maize (Qt)	26.25	60	10	12.98

Source: Own Survey, 2019

Adoption of improved maize varieties

In this study, Adoption decision should be the use or non-use of improved maize varieties. Based on their use or non-use of improved maize varieties farmers were classified as adopters and non-adopters. As results, a farm household is adopter of improved maize varieties if he/she used at least one variety of improved maize varieties during the cropping season. Under normal conditions, improved maize varieties are preferred by smallholder farmers in the study area which have better yield potential, shattering resistance, disease resistance and marketability. There is some maize varieties in use and tend to stay with farmers due to resisting crop diseases and other ecological characteristics of varieties and few of them were discarded from production due to poor disease resistance and environmental problems. The resistant high yielding maize varieties such as Shone (75.26%) have been widely demonstrated to farmers and adopted with associated cultural practices in the study areas.

Table 4: Types of improved maize varieties adopted by smallholder farmers

improved Maize varieties	Freq.	Percent
Shone	73	75.26
BH660	16	16.49
Owner Limmu	8	8.25
Total	97	100

Source: Own Survey result, 2019

Descriptive Statistics for Continuous Variables

The descriptive and inferential results presented on Table 5 show that there was statistically significant difference between adopters and non-adopters in terms of distance to market, number of oxen owned, TLU, Education level the household heads , Family size, Frequency of extension visit and farm income in favor of the adopters. The descriptive and inferential result of each variable is interpreted as below:

The mean of the family size of household head was about 4.49 for adopters and 2.65 numbers for non-adopters of improved maize varieties. The t-test result indicated there was significant difference between the average adopters and non-adopters for improved maize varieties sample farmers at 1% significance level.

The average livestock ownership (exclude oxen) of adopters of improved maize varieties was 9.36 and for non-adopters 5.19. The implication is that adopters have more access to financial capital by selling their livestock to purchase improved seed from suppliers. This result suggests that, those farmers who owned more livestock have better chance to use improved seed technology.

The education level of the household head is expressed in terms of years of schooling results indicate that the average number of years of education for the head of households in the years. Adopting households have significantly more years of education (3.94 years) than non-adopting households (2.43 years). suggesting that there is a positive correlation between adoption and the number of years of formal education. The t-test indicated that, from sample farmers the mean differences for a year of schooling were found to be at 1% significant level between adopter and non-adopter of improved maize varieties.

The average frequency of extension contact in a year was 32.85 for adopters and 19.78 for non-adopters of improved maize varieties. Extension access is a necessary catalyst to technology adoption as it is the major source of agricultural information in Ethiopia. The t-test indicated that, from sample farmers the mean differences for frequency of extension contact were found to be at 1% significant level between adopter and non-adopter of improved maize varieties. Farmers who have a frequent contact with extension agents could have more information that would influence farm household's demand for new technologies.

Adopting households have significantly shorter distances to the village market 41.26 minutes than non-adopting households 45.2 minutes. The findings suggest that farmers with access to markets have a higher probability of adopt improved maize varieties than those that with limited access to markets. The t-test result showed that the near market distance mean difference between the two groups is significant at 5% level.

The farm income is the amount of income (in Birr) generated from activities of crop and livestock production by the house hold then the average income generation from farm activities by transforming it to Log form was 8.88 for adopters and 7.13 for non-adopters. The availability of farm income is positively related with adoption decision since households engaged in farm activities are better endowed with additional income to purchase seeds or other essential agricultural inputs. The t-test indicated that, from sample farmers the mean differences for farm income generation were found to be at 1% significant level between adopter and non-adopter of improved maize varieties.

The average oxen ownership of adopters of improved maize varieties was 5.47and for non-adopters 3.74. The implication is that adopters have more livestock asset and oxen for farm work than non-adopters. The t-test result showed that the oxen owning mean difference between the two groups is significant at 1% level.

Table 5: Descriptive statistics of continuous independent variables

Variable	Mean across adoption categories		
	Adopter (N=97)	Non adopter (N=92)	t test
Age	47.37	47.97	0.47
Familysize	4.49	2.65	-8.39***
Farming experience	20.80	19.56	-0.89
Education	3.94	2.43	-4.70***
Extenservice	32.85	19.78	-6.43***
Distmarket	41.26	45.2	2.57**
Lnoffarmin income	5.17	5.12	-0.12
Ln farm income	8.83	7.13	-13.92***
TLu(exclude oxen)	9.36	5.19	-6.94***
Number of oxen	5.47	3.74	-6.78***

Source: Own survey 2019, *** and **indicates that significance level at 1% and 5%respectively.

Descriptive Statistics for Dummy Variables

The descriptive and inferential statistics results presented in Table 6 show farmers cooperatives to membership of farmer union 59.79% of them were members of cooperatives farmers union. Compared to non-adopters, adopter households has got satisfied with their joining of membership of farmer cooperatives union needs for fertilizer and improved seed purchases.

Table 6: Descriptive statistics of Dummy/ discrete Independent Variables

	Adoption category				
Variables	Adopter (N=97)	%	Non adopter (N=92)	%	$\chi 2$ value
Membership of farmer cooperatives union					11.84***
Yes	58	59.79	32	34.78	
No	39	40.21	60	65.22	

Source: Own survey 2019, *** indicates 1% of significance probability level

Major crops produced

As presented in Table 7, in the study areas, maize is the dominant crop produced with mean 30.20 quintals for adopters and 4.60 for non-adopters and it is the basis of livelihood in the study areas. Around 35.34% of the lands of the sampled house hold are allocated for maize production. The second dominant crop produced is teff with mean of 10.84 and 3.22 quintals for adopters and non-adopters respectively. It is also the basis of livelihood in the study area. Sorghum is also the dominant crop produced with mean of 3.66 and 3.23 quintals for adopters and non-adopters respectively. Finger millet, wheat, Nug and Barley is also the major crop produced in the study areas with mean of 3.03 and 3.49, 3.15 and 1.86, 3.72 and 2.86, 1.75 and 1.33 quintals for adopters and non-adopters respectively. The result of t- test revealed that there is significant mean difference between adopters and non-adopters farmers in terms of amount of maize produced at 1% and 5% significance level respectively. But the mean of finger millet for adopter and non-adopter is not different so because of this t value is not significant.

Table 7: Major crops produced by sampled households (Qt)

Crops	Mean across adoption categories						
	Adopter (N=97)			Non adopter (N=92)			t test
	Area(ha)	Mean(Qt)	std	Area(ha)	Mean(Qt)	std	
Maize	0.77	30.20	13.68	0.10	4.60	2.36	-16.65
Teff	0.60	10.84	2.48	0.18	3.22	2.74	-20.08
Wheat	0.15	3.15	2.54	0.09	1.86	3.95	-2.69
Nug	0.31	3.72	2.96	0.24	2.86	2.89	-2.02
Barley	0.09	1.75	1.76	0.07	1.33	1.44	-1.80
Sorghum	0.12	3.66	5.77	0.11	3.23	4.83	-0.54
Finger millet	0.12	3.03	4.86	0.13	3.39	4.66	0.51

Source: Own Survey 2019

Sources of Improved maize varieties

According to sampled respondents, 95.88% obtained improved maize varieties from government supply. 2.06% respondents obtained improved maize varieties from market and research centre.

Table 8: Sources of seed for improved maize varieties

Source Of Seed	Freq.	Percent	Cum.
Research Center	2	2.06	2.06
Government supply	93	95.88	97.94
Purchase from market	2	2.06	100.00

Source: Own Survey 2019

Econometric Analysis

An econometric (double hurdle) model was used to determine the factors influencing adoption and intensity of use of improved maize varieties. The estimates of parameters of the variables expected to influence adoption of improved maize varieties are displayed on Table 9. Eleven explanatory variables were included in the model for analysis.

Determinants of adoption of improved maize varieties

Education: Level of Education of the head of the household has a positive and significant at 1% significance level, indicate that adoption and use of improved maize varieties with each additional year of schooling increasing the probability of adoption improved maize by 2.76 percent. Similar results were reported by Alene et al., (2000) and Ahmed (2015) showing that more educated farmers adopted improved maize varieties than those who had no education on improved maize varieties.

Family size: Found to be positive and significant at 1% significance Level, indicate that each additional of family size increases the probability of adoption of improved maize varieties by 5.85 percent. Similar results were reported by Milkias and Abdulahi (2018) but Contradicting with the research finding of Ahmed (2015) as their result the family size had contribution on adoption of improved maize.

Farm income: found to be positive and significant at 1% significance level, indicate that each additional amount of farm income by one birr increases the probability of adoption of improved maize by 9.50 percent. This indicates that, those farmers who have more farm income were more risk takers to try new technology such as improved maize adoption. The result of this research is identical with (Asfaw *et al.,* 2010), as cited in Afework and Lemma, (2015).

Number of oxen own: found to be positive and significant at 1% significance Level. Owning oxen is crucial for farming activity. Those farmers who have more oxen had higher probability to prepare their land for different improved varieties and can use their cultivable land more properly, thereby to adopt new technology more rapidly. The probability of adoption of the package significantly affected by number of oxen owned at 1% significance level and each unit increase of the number of oxen farmers owned increases the probability of

adoption of improved maize by 3%.This indicates when the number of oxen owned increases farmers' adoption of improved technologies, particularly improved maize varieties will increase. This result is similar with the result of Solomon (2012) and Jaleta *et al.* (2013) that as the number of owned oxen were adopted improved maize varieties than those who had no oxen.

Livestock (TLU excluding of oxen): Livestock holding was positively and significantly affect the adoption of improved maize varieties at 10% level of significance, this means that as the number of livestock holder farmers increase by one unit the probability of adoption of improved maize varieties are increased by 1.2% implying that farmers with more livestock holding are more likely to devote significant amount of produced improved maize varieties than those households with less livestock holding. This result is lined with Yenealem *et al.,* (2013) result that indicate those farmers with large number of tropical livestock units are more likely to adopt improved maize varieties than those who own small number of TLU.

Contact with extension agents: Found to be positive and statistically significant variable in determining adoption decision at 1 percent level which implies an increase in contact with extension agent increases probability of adoption of improved maize varieties production by 0.42 percent. This is due to the fact that, frequency of contacts with extension agents increases the probability of acquiring up-to-date information on the new agricultural technologies. The finding of this research result was also lined with the research result reported by Milkias and Abdulahi (2018) and Yenealem *et al.,* (2013) as their result the more the extension contact the farmers were adopt improved maize varieties more.

Table 9: Marginal effect estimates of1st Hurdle (Probit) model

Variable	Estimated coefficient	Std. Err.	Marginal effect	P>z
agehhd	0.0205	0.0201	0.0025	0.303
education	0.2221	0.0711	0.0276	0.001***
familysize	0.4701	0.1571	0.0584	0.001***
farmingexperience	0.0167	0.0171	0.0020	0.324
numberofoxen	0.2419	0.0973	0.0300	0.008***
TLu	0.0979	0.0587	0.0121	0.090*
extenservice	0.0338	0.0114	0.0042	0.002***
distmarket	-0.0211	0.0158	-0.0026	0.171
lntotfarminc	0.7643	0.1813	0.0950	0.000***
lnoffarmincome	-0.0181	0.0511	-0.0022	0.723
membshipfrmccoop	0.2957	0.3244	0.0367	0.361
Log likelihood			-42.022867	
LR chi2(11)			177.83	
Prob> chi2			0.0000	
Pseudo R2			0.6791	

Source: Model output, *, *** represents 10% and 1% level of Significance respectively

Factors determining the Intensity of use of improved maize adoption

Truncated regression is used in this case, which is the second stage of the double-hurdle model, to analyse the problem.

Education: Level of Education of the head of the household has a positive and significant at 1% significance level and influence positively the adoption of improved maize varieties by increasing the amount of land allocated for improved maize varieties. This finding indicates that with each additional year of schooling increasing the land allocated for adoption of improved maize varieties by 0.03ha. Similar results were reported by Alene *et al.* (2000) and Ahmed (2015) as their result the more educated farmers were allocated land for improved maize varieties than those who had no education on improved maize varieties.

Number of oxen owned*:* found to be positive and significant at 1% significance Level. The result of this decisions point towards with one addition of number oxen increases the land allocated for improved maize varieties by 0.06ha. Those farmers who have more oxen had more productive to prepare their land for different improved varieties and can use their cultivable land more properly, thereby to adopt new technology more rapidly. The productivity (production) of improved maize had significantly affected by number of oxen owned. This also implies that households who have more assets are likely to adopt more than farmers who have less. This finding is

also the same with the result of those authors Solomon (2012) and Jaleta *et al.,* (2013) that as the number of owned oxen were increased the productivity of farmers increased as well.

Farm income: found to be positive and significant at 1% significance Level, indicate that each additional amount of farm income by one birr increases the land allocated for improved maize varieties by 0.25ha. Amount of farm income obtained with-in a year was one explanatory variable in this analysis. This indicate that, those farmers who have more farm income more risk takers to try new technology such as improved maize adoption. The result of this research is identical with Alene *et al.* (2000) and the result of (Asfaw *et al.,* 2010), as cited in Afework and Lemma, (2015) on adoption of chick pea technologies.

Livestock (TLU): Livestock holding positively and significantly related to intensity of use of improved maize varieties at 1% level of significance, this means that as the number of livestock holder farmers increase by one unit the amount land allocated for improved maize is increased by 0.03 ha implying that farmers with more livestock holding are more likely to devote significant amount of produced improved maize varieties than those households with less livestock holding. A household with large livestock holding can obtain more cash income from the sales of animal products. This income in turn helps smallholder farmers to purchase farm inputs. This result is lined with Yenealem et al., (2013) result that indicate those farmers with large number of tropical livestock units are more likely to adopt improved maize varieties than those who own small number of TLU.

Membership in farmers' cooperatives union: Participation in cooperative society had positive influence on intensity of use of improved maize varieties at 5% level of significance. Organizing of farmers to be a member of cooperative society would facilitate access to credit, access to extension information and access to market. This implies Strengthening and expansion of rural cooperatives is paramount importance to enhance adoption of improved maize production package. The significant relationship between being member of a cooperative society and adoption is an indication for the importance of rural financial institutions in supporting agricultural production particularly oil crops farming. Cooperative members were found to be better in access to and use of credit services. This finding is confirmed with Tura *et al.,* (2010).

Table 10: Estimated coefficient of 2nd Hurdle (Truncated regression) model

Variable	Estimated coefficient	Std. Err.	P>z
agehhd	-0.0015	0.0033	0.654
education	0.0302	0.0113	0.008***
familysize	0.0086	0.0188	0.644
farmingexperience	0.0028	0.0033	0.389
numberofoxen	0.0621	0.0209	0.003***
TLU	0.0323	0.0092	0.001***
extenservice	-0.0007	0.0020	0.713
distmarket	0.0049	0.0031	0.108
lntotfarminc	0.2512	0.0456	0.000***
lnoffarmincome	-0.0077	0.0085	0.368
membshipfrmccoop	0.1224	0.0562	0.030**
Log likelihood	11.015959		
Number of obs	97		
Wald chi2(11)	97.80		
Prob> chi2	0.0000		

Source: Model output, *** and **represents 1%& 5% level of Significance respectively

Summary

This study was conducted in Kiremu District of Oromia Regional state, which is located about 458km away from Addis Ababa. In this area, maize is an important crop, which serves as source of cash and used for home consumption. New technologies that include improved varieties have been introduced by government institutions such as district agricultural office, agricultural research centres and other non–governmental

organization. However, factor affecting adoption and intensity of use of improved maize varieties were not well studied in the study area.

The objective of this study was to provide empirical evidence on factor affecting adoption and intensity of use of improved maize varieties on local maize variety. For this study, a total of 189 respondents were interviewed using structured questionnaire.

The results showed that there was statistically significant difference between adopters and non-adopters in terms of distance to market, number of oxen owned, TLU, frequency of extension visit, education of level of the house hold, family size and the results from double hurdle regression revealed that six variables were significantly and positively affected adoption of improved maize varieties and also five variables were affect significantly and positively the intensity of use of improved maize varieties.

Conclusion

The descriptive and inferential results show that there was statistically significant difference between adopters and non-adopters in terms of distance to market, number of oxen owned, TLU, frequency of extension visit, education of level of the house hold, family size and farm income. Education, family size, farm income, TLU, number of oxen, and frequency of extension contact affect adoption of improved maize varieties positively and Education, farm income, number of oxen, membership of farmers' cooperative union and TLU also affect the intensity of use of improved maize varieties positively and significantly.

Recommendations

Based on the findings of the study the following recommendations are suggested for the improvement of the livelihood of the smallholder maize producers in the study area.

- Education has a significant positive impact on adoption and intensity of use of improved maize varieties. Hence, strengthening adequate and effective basic educational opportunities to the rural farming households in general and to the study areas in particular is required. In this regard, the regional and local governments need to strengthen the existing provision of formal and informal education through facilitating all necessary materials. Such as:-Constant visiting site or demonstration site, preparing manual by their language and the other that is going with their farming practice and demonstration site.

- The family size has a significant positive impact on adoption of improved maize varieties this indicate that the study area were used the human capital (labour force) for farming activity and family size directly contributes to labour forces to farming activities but the recommendation to use the increased family size is contradicted with the use family planning, therefore, the government should substitute the technologies used in terms of family size such as tractors, harvester technology, thresher technologies and etc for different agricultural technology practice to minimize the human capital because it is not recommended to increase the family size.

- Government should make sure rural transportation and infrastructures are improved to make them passable in all seasons in order to make many producing areas accessible to input and output market and contribute to timely input delivery. Strengthening the knowledge of farmers' on the modern agricultural production by proper linking the extension services with farmers especially those smallholder maize producers by involving them in experimentation of innovations such as dissemination of those innovations to their fellow farmers which will motivate them to adopt the new agricultural technologies.

- From the finding of the study farm income has a positive effect on adoption and intensity of use improved maize varieties; therefore, scaling up and diffusion of improved maize varieties in the study area should be broadened and the income of small holder farmers were increased through their participation on farm activities. Increasing of small holder farmers' income had positive effect on the adoption and intensity of use improved maize varieties through supporting of the ability of farmers to buy improved seed and others input. Thus, it is recommended that encouraging households' participation on farming activities by creating favourable conditions and better opportunities for smallholders.

- Organizing of farmers to be a member of cooperative society would facilitate access to credit, access to extension information and access to market. This implies strengthening and expansion of rural cooperatives is paramount importance to enhance adoption of improved maize production.

References

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Kassie, M., Bogale, G., Tadesse, B. and Keno, T., (2015). Factors that transformed maize productivity in Ethiopia. Food Security, 7(5), pp.965-981.

Afework Hagos and Lemma Zemedu. 2015. Determinants of improved rice varieties Adoption in Fogera District of Ethiopia. Science, Technology and Arts Research Journal, 4(1): 221-228.

Ahmed, M.H., (2015). Adoption of multiple agricultural technologies in maize production of the Central Rift Valley of Ethiopia. Studies in Agricultural Economics, 117(1316-2016-102848), p.162.

Alemu D., W. Mwangi, M. Nigussie, and D.J. Spielman (2008). The maize seed system in Ethiopia: challenges and

opportunities in drought prone areas. African Journal of Agricultural Research, 3(4):
Alene, A. D. Poonyth and R.M. Hassan., (2000).Determinants of Adoption And Intensity of Use Of Improved Maize Varieties In The Central Highlands Of Ethiopia: A Tobit Analysis
Alexandratos, N., & Bruinsma, J. (2012). World agriculture towards 2030/2050: The 2012 Revision (ESA Working Paper No. 12-03). Rome: Food and Agriculture Organization of the United Nations (FAO), Agricultural Development Economics Division.
Asfaw, S., B. Shiferaw, F. Simtowe, and M.G. Haile (2011). Agricultural technology adoption, seed access constraints and commercialization in Ethiopia.Journal of Development and Agricultural Economics. 3(9): 436-447.
Assefa Admassie and Gezahegn Ayele., (2009). Adoption of Improved Technology In Ethiopia
Beke, T.E. (2011). Institutional Constraints and Adoption of Improved Rice Varieties: Econometric Evidence from Ivory Coast. Review of Agricultural and Environmental Studies, 92(2): 117-141.
Croppenstedt, A., M. Demeke, and M.M Meschi (2003). Technology adoption in the presence of constraints: The case of fertilizer demand in Ethiopia. Review of Development Economics 7(1): 58–70.
Dawit, A., Shahid, S., & Tripp, R. (2010). Seed system potential in Ethiopia: Constraints and opportunities forenhancing the seed sector. Washington DC: International Food Policy Research Institute.
Derera, J., Tongoona, P., Langyintuo, A., Laing, M. D., & Vivek, B. S. (2006). Farmer perceptions on maize cultivars in the marginal Eastern belt of Zimbabwe and their implications for breeding. African Crop Science Journal, 14, 1-15.
Gecho, Y., & Punjabi, N. K. (2011). Determinants of adoption of improved maize technology in Damot Gale, Wolaita, Ethiopia. Raj Journal of Extension Education, 19, 1–9.
IFC. (2013). Working with Smallholders: A hand for Firms Building Sustainable Supply Chains. Washington D.C: International Finance Corporation, World Bank Group.
James Ouma, Eric Bett,and Patrick Mbataru., (2014). Does Adoption of Improved Maize Varieties Enhance Household Food Security in Maize growing Zones of Eastern Kenya? Jan-March 2015, 4(1): 221-228.
Julius Manda (2016). Econometric Analysis of Improved Maize Varieties and Sustainable Agricultural Practices (SAPs) in Eastern Zambia.
Medlin, B. D. (2001). The Factors that may Influence a Faculty Member's Decision to Adopt Electronic Technologies in Instruction. Thesis for Award of PhD Degree at Virginia Polytechnic Institute and State University, 186pp.
Milkias, D. and Abdulahi, A., (2018). Determinants of Agricultural Technology Adoption: The Case of Improved Highland Maize Varieties in Toke Kutaye District, Oromia Regional State, Ethiopia. Journal of Investment and Management, 7(4), pp.125-132.
Mmbando, F. E., &Baiyegunhi, L. J. (2016). Socio-economic and institutional factors influencing adoption of improved maize varieties in Hai District, Tanzania. Journal of Human Ecology, 53(1), 49–56.
Moshi, A., (1997). Economic impact of maize research in Tanzania. Southern African Centre for Cooperation in Agricultural and Natural Resources Research and Training: Gaborone, Botswana, pp. 15. Available at: http://libcatalog.cimmyt.org/download/cim/66519.pdf[Accessed on 11 April 2015].
Moti Jaleta, ChilotYirga, MenaleKassie, Hugo de Groote and Bekele Shiferaw (2013). Knowledge, Adoption and Use Intensity of Improved Maize Technologies in Ethiopia
Ojo, S. O., & Ogunyemi, A. I. (2014). Analysis of factors influencing the adoption of improved cassava production technology in Ekiti State, Nigeria.International Journal of Agricultural Sciences and Natural Resources, 1(3), 40–44.
Ray, G. L. (2001). Extension Communication and Management. Naya Prokash Publisher, Calcutta. 162pp.
Rogers, E. M. (2003). Diffusion of innovations. Journal of Educational Technology 5(2): 14 –23.
Smale, M., Byerlee, D., & Jayne, T. (2011). Maize revolutions inSub-Saharan Africa Policy Research Working Paper 5659.Washington, DC.The World Bank, Development Research Group, Agriculture and Rural Development Team. https://doi.org/10.1596/prwp
Solomon Tiruneh (2012). Impact of Improved Barley Scale Up/Out Program on Household Food Security in MeketDistrict, North Eastern Ethiopia M.Sc. thesis Haramaya University.
Tura, M., Aredo, D., Tsegaye, T., La Rovere, R., Kassie, G.T., Mwangi, W.M. and Mwabu, G., (2010). Adoption and continued use of improved maize seeds: Case study of Central Ethiopia. African Journal of Agricultural Research, 5(17), pp.2350-2358.
Yamane, Taro. (1967). Statistics: An Introductory Analysis, 2nd Ed., New York: Harper and Row. Zodpey, S P (2004): Sample size and power analysis in medical research, Indian J. Dermatol. Venereol.Leprol, 70 (2), 123-128.
Yenealem Kassa, Ranjan S. Kakrippai, Belaineh Legesse (2013). Determinants of Adoption of Improved Maize Varieties for Male Headed and Female Headed Households in West Harerghe Zone, Ethiopia. International Journal of Economic Behaviour and Organization. Vol. 1, No. 4, 2013, pp. 33-38. doi: 10.11648/j.ijebo.20130104.11