FARMERS' INNOVATIVENESS ON MAIZE PRODUCTION: IN LIMU SEKA DISTRICT, JIMMA ZONE OROMIA REGIONAL STATE, ETHIOPIA

M.Sc. THESIS

BY

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FARMERS' INNOVATIVENESS ON MAIZE PRODUCTION: IN LIMU SEKA DISTRICT, JIMMA ZONE, OROMIA REGIONAL STATE, ETHIOPIA

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Major advisor: Teferi Tolera (PhD, Ass. professor)

Co-advisor:

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I have incorporated the suggestion and modification given during the internal thesis defense and got the approval of my advisors. Hence, I hereby kindly request the department to allow me to submit my thesis for external defense.

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We, the thesis advisers, have verified that the student has incorporated the suggestions and modifications given during the internal thesis defense and the thesis is ready to be submitted. Hence, we recommend the thesis to be submitted for external defense.

Major Adviser: Teferi Tolera (PhD, Ass. professor) signature _____ Date 10/06/2020

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Decision/suggestion of Department Graduate Council (DGC)

Approved

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DEDICATIONS

This thesis manuscript is dedicated to my wife **Misgane Duguma Gutema,** who sacrificed much to bring me up to this level, until I finish the final work of M.Sc. thesis and my mother Workinesh Hailu, my lovely son Alazar Dawit and my daughter Bontu Dawit for their affection, love and devoted partnerships in the success of my life.

STATEMENT OF THE AUTHOR

First, I declare that this thesis is my work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillments of the requirements for M.Sc. degree at the Jimma University and is deposited at University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution for the award of any academic degree, diploma, or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of the source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instance however, permission must be obtained from the author.

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Place: Jimma University, Jimma, Ethiopia

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BIOGRAPHICAL SKETCH

The author was born in Dego Jiru kebele Jimma Zone in Oromia Regional state, in September 1986 GC. He attended his primary school in Dego Jiru and Atinago Elementary School. He attended his secondary school education at Limu Kosa Comprehensive High School. In October 2002 GC, he joined Assosa ATVET College and graduated with Diploma in Animal sciences in July 2005 GC. Soon after graduation he was employed by Limu Seka Woreda Agricultural and Rural Development office as field supervisor and served for 2 years. Then after, due to his high job performance, he signed as head of Agriculture and Natural resources and served for 4 years. Beside of his work, from 2007 -2010 he attended his BSc program in Rural Development from Yardsticks International College April 2010 GC. In the same office the author continues his work in different position up to 2018 GC he joined the School of Graduate Studies at Jimma University in order to attend M.Sc. program in Rural Development and Agricultural Extension specialization in Communication and Innovation. The author was married and a father of one son and one daughter.

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LIST OF ABRIVATIONS AND ACRONYMS

ADPLAC	Agricultural Development Partnership Linkage Advisory Counsel
ANO	Agricultural and Natural Resource Office
CASCAPE	Capacity building for Scaling up of evidence-based best practice in Agricultural Production in Ethiopia
CIP	International Potato Center
CSA	Central Statistics Agency
DA	Development Agent
EAFIF	East African Farmers Innovation Fair
EIAR	Ethiopian Institution of Agricultural Research
FAO	Food and Agriculture Organizations
FGD	Focus Group Discussion
GDP	Growth Domestic Product
GTP	Growth and Transformational Plan
HHs	Households
IS	Innovation System
JUCAVM	Jimma University College of Agriculture and Veterinary Medicine
JZANRO	Jimma Zone Agricultural and Natural Resources Office
MoA	Ministry of Agricultures
NGO	Non-Governmental Organizations
NIS	National Innovation System
NVS	Natural Vegetation Strips
PPS	Probability Proportional to Size
SD	Standard Deviation
SMS	Subject Mater Specialist
TLU	Total Livestock Unit
ToT	Transfer of Technology
TV	Training and Visit
WANRO	Woreda Agricultural and Natural Resources Office

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A**BSTRACTS**

Evidently, farmers' innovativeness is important for agriculture and overall economic development of one country, especially in today's rapidly changing social and ecological systems. Although, farmers have been considered as one of the key sources of innovation, many studies on agricultural innovations often continue to consider farmers as passive adopters of externally-driven technologies only. This thesis, in contrast, analyzes the innovativeness behavior among maize farmers in the study area. To this end the aim of this study was to analyze factors that affect farmers' innovativeness on maize production, to assess the degree of farmers' innovativeness, and to explore major challenges and opportunities of farmers' innovativeness on maize production system in the study area. A cross-sectional design was adopted, because the duration of data collection and other activities took place within a limited time in 2019 the production season. The study adopted multi-stage random sampling techniques to select 188 respondents from the study area. Interview schedule, focus group discussion and key informant interview were used to gather the relevant data. The data were analyzed using descriptive statistics, such as mean, standard deviations and frequency were used to summarize the data while, a binary logistic regression model was fitted to identify the most important variables that were influencing the farmers' innovativeness. Fourteen explanatory variables were used for the binary logistic model, out of which 7 were found to be positive and significantly affect farmers' innovativeness. These were age of household heads, educational level, farm experience, extension contact, livestock holdings, mass-media exposure and farm size of the households. The study reveals that the major challenge of farmers' innovativeness on maize production includes poor extension delivery system, weak linkage among various actors, poor maize grain marking system, prevalence of disease/pest and financial constraints. Generally, any development practitioners, government and policy makers who work on farmers' innovativeness should look into these factors in the process of assessing farmers' innovativeness to transform country's agriculture.

Key words: - Farmers' Innovativeness, Binary Logit Model

1. INTRODUCTION

1.1 Background of the study

Maize is the most widely grown and consumed staple crop in Africa with more than 300 million Africans depending on it as their main food source and it is the staple food for 24 million households in east and southern Africa and is annually planted over an area of 15.5 million hectares (Shiferaw, 2011). Majority of the African researchers was emphasis that to maize improvement practices to enhance grain yields is a priority for governments in the region because of the critical role the crop plays in ensuring food security (Milkias *et.al,* 2018).

Agriculture was the leading sector in Ethiopian economy contributing for 51% of the GDP in 2009/10 (WB, 2013). Within agriculture, cereals play a central role accounting for roughly 60% of rural employment, 80% of total cultivated land (Jayne *et al,* 2014). Among cereals maize is the most important crop in terms of production and contributes significantly to the economic and social development of Ethiopia (CSA, 2016). Maize cultivation is largely a smallholder phenomenon. The smallholder farmers that include about 80% of Ethiopia's population are both the primary producers and consumers of maize (Abate *et al*., 2015). About eight million smallholders were involved in maize production in 2018/19 compared to 6.2 million for teff and 5.1 million for sorghum making it critical to smallholder livelihoods in Ethiopia. In addition, its production accounts for 27% of the total cereal production in the country with the greatest production at 3.8 million tons compared to teff and sorghum at 2.7 million and 3.0 million tons respectively in 2018/19 (Alemaw *et al*.,2014).

Ethiopia's agricultural research system has given emphasis on knowledge/technology generation to be distributed through extension system. Innovation, the productive use of knowledge for desired social and economic benefits has not been the focus causing important research outputs to remain shelved and/or poor and patchy adoption of technologies of maize (Davis *et.al,* 2010) The government has been making significant investments to strengthen the agricultural research and extension system with the aim of reducing poverty through technological changes. However, there is an increasing recognition that the value of traditional agricultural science and technology investments, like research and extension, is not sufficient to enable agricultural innovation

(World Bank, 2006). The innovation systems concept emerged as a response to the limited success of conventional extension models that view innovation as a linear process driven by the supply of research and development (Hounkonnou *et al*, 2012). The framework is now being used to understand and strengthen innovation at national and sector levels. Innovation systems are very important determinants of technological change. Traditional methods of innovation that mainly focus on the structure of innovation systems have proven to be insufficient (Bergek, *et al*, 2015). This insufficiency has resulted in the development of new techniques of innovation systems focusing on a number of processes that are important for well performing innovation systems and consider farmers as active stakeholders in innovation system (Tigabu, *et al.*, 2015).

The farmers' innovativeness on maize production can be the process of using newly generated or already existing knowledge and associated with maize agronomy practices like weed management, crop rotation, plant spacing, disease/pest control mechanism, adoption of fertilizer and intercropping and postharvest handling mechanisms etc.(Boschma,2012).

According to Gebre, (2014), farmers are not passive receivers of the ideas of technologies generated under the research systems; rather they are active researchers and experimenters. It is widely recognized that farmers are very resourceful and regularly engaged in generating and testing new idea. According to Kibwana (2000) in developing country like Ethiopia, local innovation by farmers are essentially making major contributions to agricultural development and over all development of the country. As agricultural developments demands continual innovation and experimentation all farmers innovate and experiment in their struggle to make a living from the soil (Kibwana, 2000).

Likewise, farmers' innovativeness is not a new phenomenon for smallholder farmers in Ethiopia. Despite, the practice is found at it is beginning stage, in recent years. The attempts of outsiders and researchers to recognize and support the knowledge and experiences of farmers within a purpose of developing technology generations as well as building the confidence and capacity of others to experiment new ideas is significantly improving (Reij, C, 2014).

Limu Seka district is one of the potential maize growing areas in Jimma zone and due to this maize varieties which are released from research system have been promoted by extension

organizations to maximize productivities of the farmers'. Among those organizations, Jimma Agricultural Research institutions recommend seven superior improved maize varieties which are suitable to agro-ecology of the area have been popularized. These maize varieties include BH-540; BH-543; BH-660; BH-661; 30G19;P3812W(limmu) and pool 15C7,quality protein maize (QPM) through the approval of Ethiopian national seed industry and Ethiopian Institute of Agricultural Research (EIAR). But the current practice is simply transfer of research brought technology (TOT) rather than encouraging farmers' innovativeness even though few innovative farmers' are not following this linear approach because they are doing things in different ways (WARDO, 2018).

In summary, farmers' innovativeness on maize production is not yet assessed in the study area. This study is therefor, designed to provide primary information on the factors that influence farmers' innovativeness. It also addressed the major challenge and opportunities of farmers' innovativeness towards maize production in the study area.

1.2 Statements of the Problem

Ethiopia is one of the developing economies which has not realizing its full agricultural potential, as the sector is dominated by subsistence oriented, low input/low output and rain-fed farming systems (Beyene, *et al* , 2018). The country agricultural practice was also characterized by low production due to inadequate emphasis given to farmers' innovativeness and depends only promoting on research brought technology through existed extension model (World Bank, 2008). On the other hand, agriculture is still the main source of livelihood for the majority of the population mainly for peoples living in rural areas (Chamberlin *et. al*, 2012).

Studies have been shows that transforming agriculture strongly linked to the level of farmers' innovativeness (Ashenaf, 2010). In responding to social and ecological systems dynamics including rising population pressure and growing awareness of environmental degradation, farmers are looking for more productive ways to use the available resources without depleting them and they have to adjust rapidly to changing conditions (Ezezew, A.A., 2014). If agriculture is to be sustainable farmers must be capable of actively and continuously creating new local

knowledge and innovation which is favorable with their own conditions (Reij and Waters-Bayer, 2001).

In other words, evidently only innovative farmers can cope with social ad ecological dynamics induced challenges and therefore, farmers' innovativeness is becoming a very important characteristic to survive (Yishak *et al* 2011). Farmers' innovations do offer starting points for joint action by farmers and other stakeholders, including researchers, development agents and government authorities, to help farmers in their efforts to deal with changing conditions (Reij *et al.,* 2014). It is also critically important to note the farmers' innovativeness highly influenced by characteristics of farmers such as education level or knowledge and their ability to interpret the information they have accessed (Amsalu, 2008). This implies farmers' innovation needs to be assessed and integrated to the overall innovation system.

Farmers' innovativeness on maize production is not a new phenomenon for farmers in the study area. For them innovation was their day to day life because, they were conducting different experiments to living with the soli and also adding value on maize seed in order to maximize production and overcome the environmental challenge. But emphasis not given to the farmers' innovativeness in the district from the government due to the conventional approaches that transfer of research brought technology to farmers (Bedasso, 2008).

The maize agronomic practice that farmers participated to innovate like plant spacing, introducing of new maize crop varieties, weed management, fertilizer application, disease/pest control mechanisms and postharvest handling etc. But the problem is that farmers seldom record their accomplishments in writings, rarely write papers on their discoveries and do not attach their names and patents to their inventions (Amsalu, 2008).

Based on the general agricultural innovation framework several studies have been conducted so far in other parts of Ethiopia *e.g. (*Bedasso, 2008; Alene *et al.*, 2000; Ashenaf *et al*., 2010; Yishak *et al*., 2011; Yu *et al.,* 2011; Assefa *et al*., 2012; Reij *et al*., 2014). Accordingly, the study conducted by (Bedasso,2008) in the SNNP Alaba *distric*t identify social and cultural factors that affect farmers' innovativeness on the general agricultural activities and the study finding was come up with that farmers' innovativeness had a positive contribution to household income and

reduce rural poverty. However, the assessment lacks to address the effect of important variables like demographic, socio-economic and institutional variables that affect farmers' innovativeness on specific commodity of maize production. Because the focus of all authors were on farmers' innovativeness on general agricultural activities but not on the specific commodity, that way this study motivated to assess farmers' innovativeness on specific commodity on maize production. So this specific gap call for the study and motivated the researcher to conduct research in this area.

Therefore, this study was going to identify factors that affect farmers' innovativeness on maize production and by assessing the status of farmers' innovativeness and the type of maize agronomic practices those farmers was participated to innovate and the generous of innovations developed or redesigned by them. Thus, working on such problems is very essential due to lack of the in-depth research conducted in the rural households, on the above mentioned problem this study, tried to generate evidence based findings to fill the gap on the above reviewed by exploring of farmers' innovativeness on maize production in Jimma zone, Limu Seka Woreda, Oromia regional national state, Ethiopia.

1.3 Objectives of the Study

1.3.1 General objectives

The general objective of this study was to analysis farmers' innovativeness on maize production in Limu Seka district.

1.3.2 Specific objectives

1. To analysis factors that affect farmers' innovativeness on maize production in the study area.
2. To assess the degree of farmers' innovativeness on maize production in the study area.
3. To identify challenges and opportunities of farmers' innovativeness on maize production in the study area.

1.4 Research Question

The main research questions set to address the objectives that are mentioned above were:

- ✓ What are the possible factors that affecting farmers' innovativeness on maize production in the study area?
- ✓ What is the current status of farmers' innovativeness on maize production in the study area..?
- ✓ What are the challenge and opportunities of farmers' innovativeness on maize production in the study area..?

1.5 Significance of the Study

Farmers' innovativeness on maize production is crucial in designing future research and development strategies. This study will help policy makers to develop evidence based on existing evidence, researchers, extension workers and development practitioners by using this evidence may benefit smallholder farmers. Policy makers also will benefit from the research output since they require micro-level information to formulate policies and strategies so that this effort were appropriate in meeting smallholder farmers' need in particular and to bring change in agricultural innovation system in general. In additions, this research result will benefit development planners, other researchers and ultimately the farmers. Therefore, the studies were generating information on a diverse set of issues related to farmers' innovativeness on maize production in the Limu Seka district.

1.6 Scope and Limitation of the Study

The analysis of farmers' innovativeness on maize production in Limu Seka district is the first of its kind. The study focused on farmers' innovativeness' considering the size and diversity of Ethiopia this one-district-focused study results cannot be generalized farmers' innovativeness in the whole country. One of the limitations of this study was using cross-sectional data. Because the data were taken from one harvesting season from 188 respondents, but farmers' innovativeness was differ from time to time. On the other hands, the most limitations which

encountered during data collection were some household farmers were not willing to respond and others did not want to give the required information due to busy on their own seasonal job and same time and personal problem . While, the Woreda experts were not cooperating to give the relevant data because they are busy with government seasonal activities.

1.7 Organization of the Thesis

This thesis was organized into different sections. The first section introduces the background, statement the problem, significance of the study and the research objectives. The next section deals with review of literature which includes definition of basic concepts, theoretical and empirical reviews. Section three is about research methodology which includes the description of the study area, types of research design, data types, sample and sampling method, method of data collection and analysis. Data analysis, data interpretation and writing the major findings were included under section four. The last section contains the summary of the study, conclusion and recommendations.

2. LITERETURE REVIEW

In this chapter an attempt has been made to explain basic concepts. In addition, the topics were intended to critically review the literature of the past research work in relevance to present study objective, so that it contains theoretical and empirical reviews enables better understanding of the subject.

2.1 Theoretical Reviews of farmers' innovativeness

2.1.2 Definition and concepts of innovation

Innovation: the term innovation is confused with invention and technology adoption in general, particularly when it is written as innovations. Invention is a process of creating new knowledge, methods or a set of discovery. Innovation in contrast, encompasses the factors affecting demand for and use of knowledge in novel and useful ways for society (Bateson *et.al*, 2013).

According to Pardey, (2010) innovations are new ideas, methods, practices or techniques which provide the means of achieving sustained increases in farm productivity and income. Some innovations originate from agricultural research stations, others from farmers. As Leeuwis, (2013) put it innovation is not always the result of recent research.

Innovation is the process by which organizations master and implements the design and production of goods and services that are new to them irrespective of whether they are new to their competitors, their country or the world (Foster and Heeks, 2013). Innovations are new creations of social and economic significance involve a combination of technical, institutional and other sorts of changes are also a non-linear process of learning (Inigo and Albareda, 2016).

One of the crucial viewpoints about innovation system, compared to its conventional view is the fact that it is the work of multiple actors spatially distributed and with differential access to resources, knowledge and power. Moreover, it is related to technology adoption of some new invention process or discovery on the level of behavior, meaning and action. Hence, innovation involves new behavior, new habits and new interlocking patterns of roles or institutions (Henrich, *et al*, 2010).

Innovation system*:* The innovation systems approach emerged as a result of the increasing recognition that the ToT model which views innovation as a linear process driven by the supply of research and development has not fulfilled expectations in terms of developing locally adapted innovative practices (Röling, 2009a; World Bank, 2011).

The innovation systems can be defined as "comprising the organizations, enterprises and individuals that together demand and supply knowledge and technology, and the rules and mechanisms by which these different agents interact" (World Bank, 2006). The concept is applied in many disciplines and in agriculture it is commonly refer to as the agricultural innovation systems (AIS). The AIS is a recent concept that builds on two earlier innovation frameworks: national agricultural research systems (NARS) in the 1980s and agricultural knowledge and information systems (AKIS) in the 1990s (World Bank, 2006; Rajalahti, 2009).

The innovation systems approach acknowledges the role of education, research and extension in providing new knowledge and technology to the farmer but in addition, it recognizes the farmer as part of a complex network of heterogeneous agents who engage in innovation processes and also looks at the actions and interactions that link these agents to each other along with the formal and informal institutions and policy environments that influence these processes (Spielman, 2011). Hence, the approach argues for strengthening the interactions between actors of the innovation process. It emphasizes highly on building innovative capacity and acknowledges the important role of an enabling environment for innovation generation (Rajalahti, 2009).

2.1.3 The theoretical concepts of innovation

There are several definitions and classifications of innovation (for an overview, see Garcia and Cruickshank, *et.al,* 2010), and this is partly because research on innovation spans many disciplines. Nonetheless, innovation generally entails the implementation of new or significantly improved products, processes or methods (OECD, 2005).

In agriculture, it is well acknowledged that innovations could emerge from many sources including farmers, and these are normally referred to as farmers' innovations (Biggs and Clay, 1981; Röling, 2009b). Farmer innovation is sometimes termed farmer-driven or farmer-led innovation, grassroots innovation, local innovation, folk or farmer experiment, etc. (Saad, 2002). Similar to innovation, there is no generally agreed definition for a farmer innovation or a farmer

innovator. It is, however, different from the concept in the literature on adoption and diffusion of innovations in which adopters or the first group of adopters of introduced technologies is referred to as innovators (Rogers, 2011). Following Saad (2002) and Waters-Bayer et al. (2009), we define a farmer innovation to be a new or modified practice, technique or product that was developed by an individual farmer or a group of farmers without direct support from external agents or formal research. In our study, the term innovative behavior goes beyond the final outcome and encompasses activities of the innovation process such as experimentation. Innovation processes or activities may be new to farmers in one community, but not necessarily new to farmers in other communities (Saad, 2002; Waters-Bayer and Bayer, 2009).

These studies try to identify farmers' innovativeness on maize production in four specific categories. These are: (i) developing new techniques or practices related to maize production, (ii) adding value or modifying indigenous or traditional practices on maize production, (iii) modifying or adapting external techniques or practices to local conditions or farming systems, and (iv) informal experimentation related to maize cultivation (Joachim *et.al* 2015). Thus, innovator farmers are those farm households who have implemented any of these four categories of innovation-generating activities during the last 12 months prior to the survey. There are several factors that can trigger the implementation of these innovation-generating activities.

2.2The degree of farmers' innovativeness on maize production

The maize innovation process was understood narrowly and has since been influenced by the linear transfer-of-technology model where innovation was equated to the generation of maize-related technologies by scientists at research stations followed by their release, packaging and dissemination by extension agents. The learning and feedback mechanisms between the organizations involved in this process continue to be very loose. Moreover, the technologies are recommended without due to consideration of the diverse biophysical and socioeconomic situations of the end users. Consequently, it is not surprising to find reluctant farmers to adopt the technologies (Mengistu *et al,* 2010).

Maize innovation is not new phenomena for farmers for their innovation is their day to day life because there are conducting many experiments in order to overcome the environmental

challenge. The field that farmers are participating to innovate like tillage practices, time change in sowing, weed management, fertilizer application, disease and pest control mechanisms and postharvest handling etc. But the problem is that farmers seldom record their accomplishments in writings, rarely write papers on their discoveries and do not attach their names and patents to their inventions (Amsalu, 2008)

Farmers' innovativeness is not a recent development or phenomenon discusses the atmosphere of experimentation which characterized the Neolithic farmer since the earliest stages of agriculture. Farmers selected and domesticated all the major and minor food crops on which human kind survives today (Harris, D.R. and Hillman, 2014).

From recently conducted researches it is possible to count many farmers' innovativeness. In addition to the approval of the availability of farmer innovation, scientists are also said to learn about different technologies from farmers. As Chappell, (2011) explains, a work on diffused light storage of potato carried out at the International Potato Centre (CIP) scientists was first learned from Third World farmers.

In most countries of the third world, rural people's knowledge is an enormous and underutilized national resource. Padulosi, (2013) has written that the small farmer's expertise 'represents the single largest knowledge resource not yet mobilized in the development enterprise and 'we simply cannot afford to ignore it any longer'.

According to Reij and Waters-Bayer, (2014) there are many reasons for seeking to find out why farmers innovate. The answers can provide academic insight into the how and the why of development. From the practitioners' point of view, it can guide interventions to support Innovation by farmers.

2.2.1 Farmers' innovativeness

Farmers' innovativeness is the basis for evolution in agriculture and is essential for the development of local farming systems (Hellin *et al*, 2012). It is the process through which farmers adopt numerous technologies and practices to different conditions. It empowers farmers and lead to the creation of local or indigenous knowledge (Saad. 2001). Farmers' innovations are

argued to contribute to improved rural livelihoods and food security (Reij and Waters-Bayer, 2001; Saad, 2002). The importance of farmer innovation for agricultural and rural development and the growing recognition of the need for increased participation of farmers in agricultural research have stimulated interest in the subject in recent decades.

While there is a growing level of interest in farmer innovation, the literature provides no clear or consensus definition of the concept "farmer innovation". Different studies and research programme have used varied definitions. For instance Waters-Bayer *et al*. (2009, p.239) defined local farmer innovation as "the process through which individuals or groups within a given locality discover or develop and apply improved ways of managing the available resources building on and expanding the boundaries of their indigenous knowledge". Flynn, P.,(2017) regarded farmer innovation as "the process by which people in a given locality discover or develop new and better ways of doing things using locally available resources and on their own initiative without pressure or direct support from formal research or development agents". Waters-Bayer and Bayer (2014) added that farmer innovation includes modifying or adapting existing knowledge, which can be local or external initiatives. They further indicated that the innovations are new to a particular locality but not necessarily new to the world. To differentiate from traditional knowledge, Gebre Michael (2014) considered farmer innovation as something new that has been started within the lifetime of a farmer and not something inherited from parent or grandparents. Finally, Saad (2002, p.3) referred to "activities that farmers engage in independently of the formal research sector" as farmer innovation. The common element running through most of these definitions is that farmer innovation relates to experiment, adaptation and invention and not adoption of introduced technologies. Also, it is initiated by farmers and not external agents.

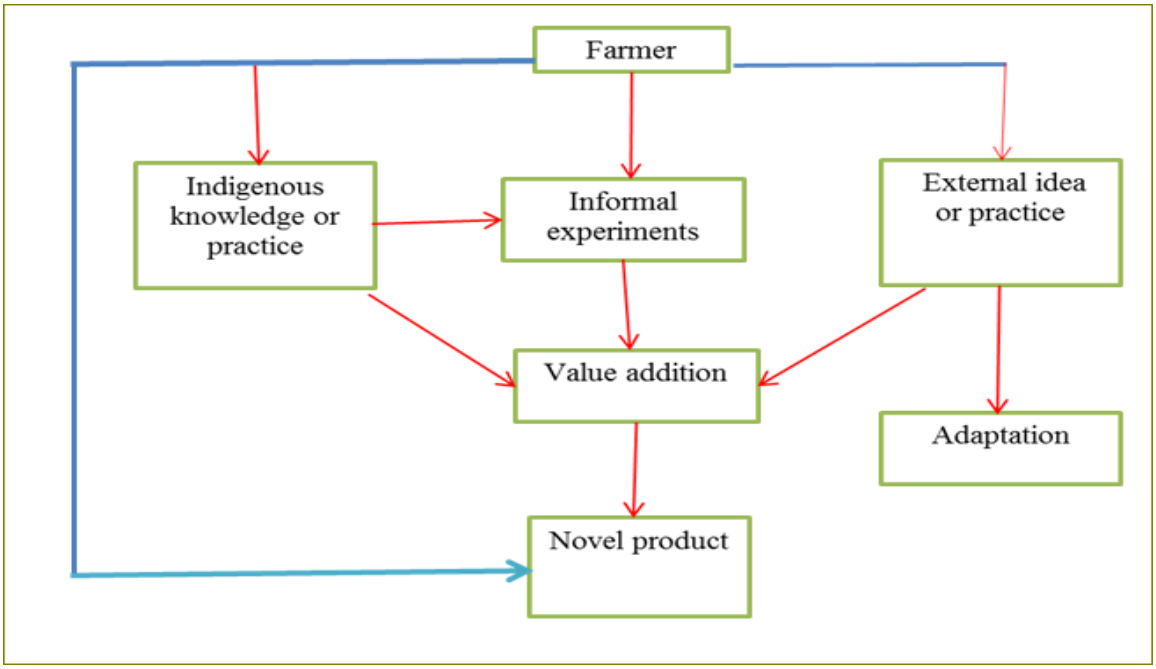

Figure 1: The process of farmers' innovativeness

Source: Adopted from Prolinnova-Ethiopia (2006), modified by author

Figure, 1 shows that the various feature of farmers' innovativeness. It shows that a farmers' innovativeness is someone who conducts informal experiments based on his own ideas is testing various indigenous features and or external ideas or practices is modifying and adapting technologies brought from outside to local conditions is improving or adding value to external and local practices to solve problems or has developed a novel product such as new technologies or better ways of carrying out farming activities (Kummer, 2011).

Thus, in this thesis farmers' innovativeness is defined as a new or modified practice, technique or product that was developed by stallholder farmers' without direct support from external agents or formal research. A key aspect of farmers' innovativeness process is experimentation, which involves the process of trying, testing, generating or evaluating a technique or practice by an innovator farmer (Saad *et al*, 2002).

Farmers' innovativeness in several domains to suit the complex and diverse farming systems of which are new for their local condition. Hence, these innovations can be considered as farming system innovations. Most of the farmers' innovations identified by previous studies are technical in nature with very few institutional innovations. Commonly observed topics of farmers'

innovations include new crop and variety, soil fertility, soil conservation, time of planting, planting methods, crop spacing and density, land preparation, intercropping, weed and pest management, animal husbandry and farm tools (Kummer 2011and Leitgeb *et al*., 2014).

2.3 Challenge and opportunities of farmers' innovativeness on maize production

Financial problems to use technologies: According to Abate *et al,* (2011) financial challenge was limited farmers' opportunities to use agricultural technologies to improve their lives. The use of technologies like fertilizers, selected seeds, breeds, and pesticides were limited due to lack of sufficient money to purchase the technologies. Moreover, the prices of technologies were high and unaffordable to farmers'. There was no subsidy for the use of these technologies. Farmers did not have good access to credit institutions. Additionally, farmers that had the capacity to purchase the technologies did not have sufficient knowledge and skills to use the technologies properly to get the maximum yield. Due to these, the yield of crops and animals were not as expected. All these problems hindered the linkage of farmers with researchers and critically reduced innovation in agriculture. The works of (IFAD, 2009; Abate *et al*., 2011) beautifully showed that financial availability to farmers critically affects the use of technologies to increase their output. Farmers that have enough money have high chance of adopting technologies to change their lives. Resource poor farmers have little opportunity to use modern technologies and this fundamentally hinders the linkage of farmers with re-searchers.

Poor extension system in the country: The research revealed that the existing extension system was one of the problems affecting the link-age of knowledge institutes with farmers to bring innovation in Ethiopian agriculture. This extension related factors affecting linkage included the linear model of technology development and transfer; pluralistic activities of development agents; loose linkage among various actors like researchers, extension workers (Lee, *et, al* 2011).

Problems of the pipeline extension model: The research conducted revealed that the extension system was the linear model in which researchers were engaged in the development of technology whereas its dissemination was left to extension workers and farmers were implementers of the technology (Wood hill *et al.,* 2011). This model separated farmers from working with researchers to bring innovation in agriculture. The model created gap between

farmers and researchers and limited the opportunity of farmers to get knowledge and skills on technology development and implementations from researchers. This linear model of extension system (Re-search-Extension-Farmer) limited the chance of researchers to engage farmers in the research process. In this model, agricultural office or the extension office was in between both researchers and farmers (Klerkx *et al*., 2012).

Weak linkage among various actors engaged in development

According to Belay, (2008) One of the reasons for the poor relationship between all actors was that researchers undermine extension workers for their academic status. Further-more, development workers did not get attractive incentives from researchers for the work that was not their obligations. This deteriorated the relation-ship of researchers with development workers. Due to pluralistic work of extension workers like engagement in tax collection from farmers for the government, farmers did not trust development workers. Even the relationship between extension workers and the government was not strong for productive development. Extension workers were busy with a number of activities but they did not get enough salary to support their family (Spielman D 2011). Development workers were assigned to the lower administrative levels in which they did not get access to modern facilities. Most of them were living in the rural areas. However, there were no incentives which encourage development workers (Davis, 2011).

2.4 The history of maize production in Ethiopia

Maize is the second most widely cultivated crop in Ethiopia and is grown under diverse agro-ecologies and socioeconomic conditions typically under rain-fed production. The maize agro-ecologies in Ethiopia can be broadly divided into six major categories including Moist and Semi-moist mid-altitudes (700–2000 m above sea level; 1000–1200 mm rainfall), Moist upper mid-altitudes (2000–2400 m >1200 mm), Dry mid-altitudes (1000–1600 m; 650–900 mm), Moist lower mid-altitudes (900–1500 m;900–1200 mm), Moist lowlands (<900 m, 900–1200 mm)and Dry lowlands (<1000 m, <700 mm)) (Abate *et al*, 2015). As presented in Table 1, the moist and semi-moist mid-altitude zones comprise the bulk of the national maize area in Ethiopia. These are mostly located in the SW and W Oromia and NW Amhara, parts of the Southern Nations Nationalities and Peoples Region (SNNPR) and Ben Shangul-Gumuz (BSG). Taken together the

Semi-moist and Moist ecologies cover about 75 % of the national maize production area whereas the dry ecologies cover the remaining 25 % (Abate and Shiferaw, 2015).

Smallholder farms account for more than 95 % of the total maize area and production in Ethiopia. The farmers use animal traction for land preparation and cultivation almost all production is rain fed, irrigated areas accounting for only about 1 % of the total. Smallholders across all 70 administrative units of Ethiopia which include 59 zones and 11 special Woreda 3, grow maize. The top five maize producing zones of Ethiopia according to the (CSA, 2011) data are West Gojjam, Jimma, East Welega, West Welega and East Gojjam. Most of these fall into the mid-altitude (1500–2000 masks) range. More than 9 million households more than for any other crop grow maize in Ethiopia (CSA, 2011–13 data). The annual rate of growth for the number of households cultivating maize grew at 3.5 % each year between 2004 and 2013, compared to 3.0 % for sorghum, 3.1 % for teff, 2.1 % for wheat, and 1.8 % for barley. At present as a sub-Saharan country, Ethiopia has the fifth largest area devoted to maize but is second only to South Africa in yield and third after South Africa and Nigeria in production (Sheahan *et.al,* 2014).

Maize currently occupies about 2 million ha with an average yield of upwards of 3 MT/ha. National maize yields have doubled from about 1.50 MT/ha during the early 1990s to 3.23 MT/ha in 2013. Analysis of FAO data revealed that a highly significant ($p<0.0001$) annual yield gain of 68 kg/ha was recorded for maize in Ethiopia for the period 1990 to 2013. Only South Africa exceeded this figure (119 kg/ ha/yr) in SSA whereas some countries such as Tanzania and Kenya registered negative growth. Ethiopia's figure is superior to Mexico (55 kg/ha/yr), China (55 kg/ha) and India (47 kg/ha/yr). Yield gains grew even faster (120 kg/ha/yr) between 2000 and 2013).

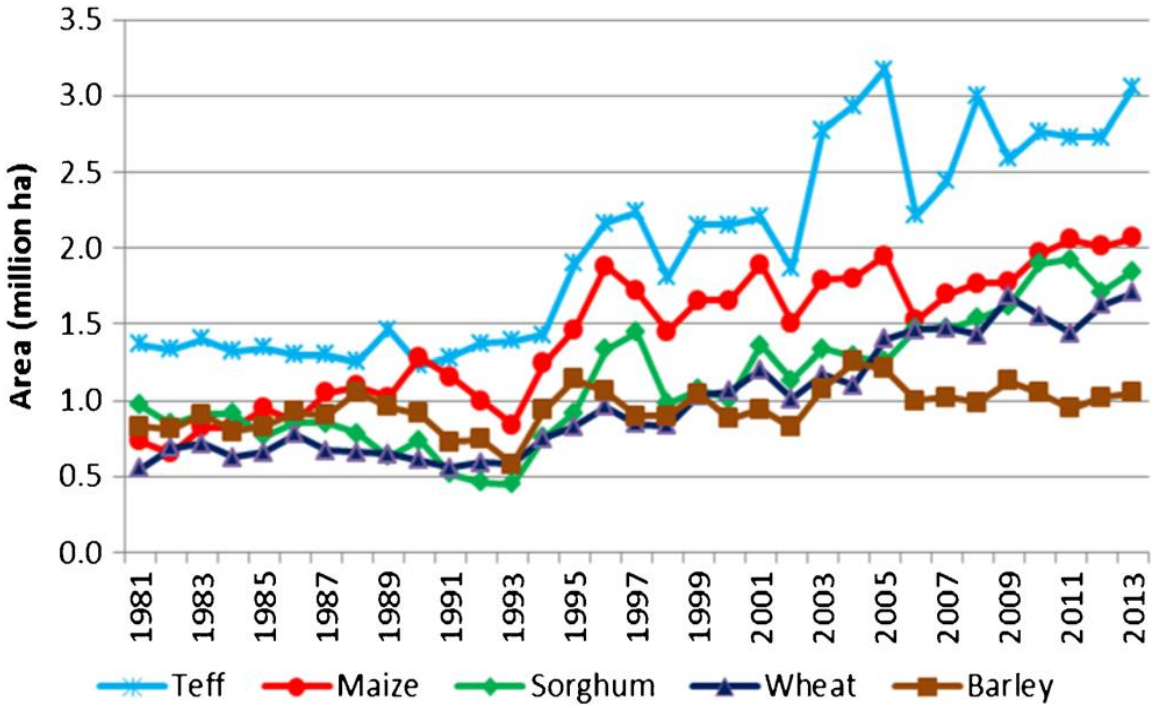

Figure 2: Area occupied by major cereals in Ethiopia, 1981–2013

Source: FAOSTAT, 2014

2.5 Empirical Review on Farmers' innovativeness

2.5.1 Review of empirical evidences on farmers innovativeness on maize production

A number of empirical studies have been conducted by different people and institutions on the agricultural innovation system both outside and inside Ethiopia. But, the studies are mainly conducted on agricultural innovation framework due to this fact the studies conducted on the specific area of crop like farmers' innovativeness on maize production are limited. As such, this section of the paper presentence the review of conducted on different contexts and geographical area. For ease of clarity for the purpose of presentation, the variables so far identified having relationship with farmers' innovativeness are categorized as personal and demographic variables, economic- related factors, socio-psychological factors and institutional factors.

Empirical study conducted by (Bedasso, 2008) on determinates of farmers' innovativeness from the result of binary logistic model shows that age is one of the demographic factors that is found to be useful to describe respondents innovativeness. In other words, the status of farmers'

innovativeness was affected by the age of the farmer. Accordingly, there are some study results which indicate the level of farmer's innovativeness to be lower among older and younger farmers and the pick in innovativeness to be found among farmers in the age bracket of 35-50 years (Bedasso *et al,* 2008). The result of (Amsalu *et al*, 2008) indicates that there is statistically significant mean age difference between innovator and non-innovator groups implying the presence of significant relationship of age with farmer's category.

Coming to gender effect, several that have been studies conducted in various countries of Africa it are stated that about three-quarters of the identified innovators are men (Reij and Waters-Bayer, 2001) . The same source substantiate that although, women often do a large share of the farm work, it is usually the men who are the household heads and represent the family in public, & are therefore most likely to take credit for any changes made on their farms. This may partly explain the lower percentage of female are participated innovation system identified (Reij and Waters-Bayer, 2001; Yohannes, 2001, in: Reij and Waters-Bayer, 2001).

Reij and Waters-Bayer, (2014) reveal that the education level of the household headed enhance the capacity of individual to obtain, and utilize information disseminated by different sources. This in turn strengthens their innovativeness. Based up on this premise, some studies indicate that farmers who are participated in innovation system are better educated (Reij and Waters-Bayer, 2001). There are also other studies which indicate the level of formal education not to be a determining factor with respect to farmers' creativity & propensity to experiment.

Tadesse, (2008) examined that farming experience was another important household related variable that has relationship with maize innovation system. Longer farming experience implies accumulated farming knowledge and skill, which has participated in innovation. Many studies supported this argument. For instance Melaku, (2005) and Yishak (2005) have reported farming experience had positive and significant relation with farmer's innovativeness. In the same line, Mahdi (2012) found the mean farming experience difference of farmers participated in innovation and none-participate is statistically significant. In contrary, Ebrahim, (2006) found that farming experience have negative relationship with farmers' innovativeness.

Likewise, many studies all over the world have shown that socio-economic variables influence farmers' innovativeness on maize production. In this study, economic variables such as total land holding, family labor, livestock holdings, farm size, participation in off/ non-farm activities and access to credit services are assumed to play a great role in determining the willingness and ability to invest of the farmers.

Reij and Waters-Bayer, (2001) investigated that most of farmers in sub-Saharan Africa derive 60-80 percent of their income from off/non-farming activities. But, according to some studies it was found that most of the innovators devote most of their working time to farming (Bryceson, 2015). They are often in their fields, digging pits, constructing bunds, planting and protecting trees, caring for their livestock, producing compost and so on. This all result shows that most of farmers who are participating in innovation system can produce enough from their land and therefore need not seek non-farm sources of income.

Bedasso, (2008) explained that land size of the households perhaps the single most important resource, as it is a base for any economic activity especially in rural and agricultural sector. Farm size influences farmers' innovativeness and to use new technologies. A farmer who has relatively had large size of farm land will not hesitate to try new ways of doing agricultural activities. This will motivated to participated farmers in innovation system. The result of (Amsalu, 2018), shows that average land holding for non-innovator group was 1.865ha while that of the innovator group was 2.952ha. The results of the t-test show that there is statistically significant relationship between farm size and innovator category of the respondents.

A study conducted by Bedasso (2008) in Alaba special woreda on determinates of farmers innovativeness revealed that livestock holding were an important indicator of household's wealth position. Similar to owners of large farm, owners of large number of livestock are often rich, and have access to more resources, including information and can better afford risk. It was thus, assumed to be positively associated with farmers' innovativeness.

The study conducted by (Debelo, 2015) on determinants of farmers' innovativeness indicates that livestock holding of the respondents ranges from 0.13 to59.97 TLU so the result showed that TLU was significance relationship among innovator category. This indicates that, there exists a

variation among the respondents in the size of livestock owned. The average livestock holding of the farmers is 8.644 TLU with Standard Deviation of 7.927. Further in depth analysis of the results show that, the average livestock size owned by innovators and non-innovators is 10.777 and 4.379 respectively indicating that, innovators have relatively large livestock size than non-innovators.

Mekonnen *et al,* (2012) examine that in his study credit utilization were economic variable that farmers need to get to improve production and productivity is credit service (credit utilization). Capital and risk constraints are key factors that limit farmers that participated in innovation system to produce high value crops by small scale farming practice (Minyahel, 2012). In line with this, study conducted by different authors such as Taha (2007) also found that the use of credit had positive and significant influence on farmers' innovativeness.

In his study, Bedasso, (2008) indicated factor that influence farmers' innovativeness in his study extension contacts play a great role in raising awareness about technology including agricultural innovation system. By doing so the increased awareness would enhance farmers' innovativeness. When such contacts are for promotion of farmer involving in innovation system, the possibilities of farmers to be influenced to innovate is multiplied in the same way if the frequency of contact by extension agent is more the innovativeness will be increased with the same proportion. The result of (Debelo, 2015) Chi-square test result shows a significant relationship between extension contact with extension agents and innovator categories. The significance in relationship between extension contact with extension agents and the innovator categories shows dynamics of changing from innovator to that of not participated in innovation and vice versa, as the frequency changes.

Amsalu *et al,* .(2011) stated in his study that mass media plays a great role in creating awareness about agricultural innovations or technologies in shortest time possible over large area of coverage. The information about new agricultural technologies or innovations, disseminated by mass media will motivate farmers to use the same or it will encourage them to generate appropriate innovation which is suitable for their specific situation. It will also help to disseminate, and raise awareness about, farmers' innovativeness and to influence policy that favors farmer innovation. The study conducted by Ngwenya, (2018) showed that there is a

significant relationship between mass media exposure and farmers innovativeness. Accordingly, innovator farmers are most often listen Radio while compared to that of non-innovators. This relationship signifies that if farmers are most frequently listening to radio they can get relevant information on different agricultural practices in different areas and various technologies generated by researchers and farmers that essentially assist their innovativeness.

2.6 Conceptual Framework of the Study

Depending on the statement of problems and review of literature the following conceptual framework were discussed here below. The identification of factors that would be affecting farmers' innovativeness on maize production was subject to the application of a research framework.

The conceptual framework of this study is based on the assumption that a number of factors that influences farmers' innovativeness namely, personal and demographic, institutional, wealth-related and socio-physiological variables. The conceptual framework of this study was developed based on the theoretical model of agricultural innovation discussed in the literature review parts. As clearly illustrated in the following diagram the four categories of variables are explanatory and dependent variables. Hence, the conceptual framework presented in Figure 2 shows the most importance variables expected to influence farmers' innovativeness on maize production is presented as follows.

In summary, all the above and other factors discussed above are interwoven and inter-related with each other and influences farmers innovativeness in maize production system. The relationships among different factors with innovativeness are illustrated by the following analytical framework (Fig, 3).

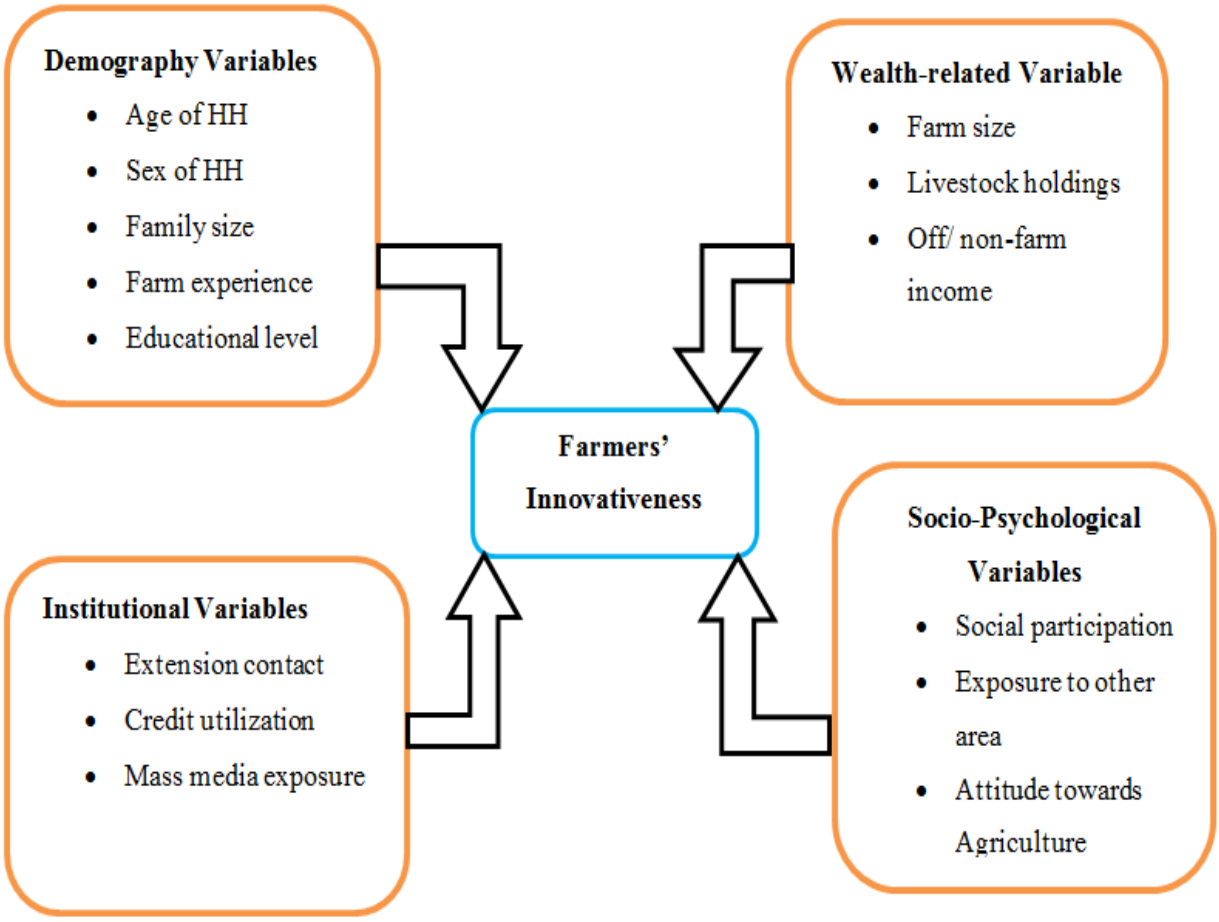

Figure 3: Conceptual frame work of the study

Source: Own compilation based on literature, 2019

3. RESEARCH METHODOLOGY

This section describes the research design and methodological steps followed for this particular study including description of the study area, research design and sampling techniques, data collection instruments and method of data analysis.

3.1 General Description of the Study area

Location: The study was conducted in Limu Seka district which is situated 109 km far from Jimma town. It is bounded by Illu Ababbor zoneYanfa *district* in the south west, Limu kosa in the south west, Nono Benja *district* in the north and Chora Botor *district* in the east. According to the Limu Seka district WAO office, the district covers an area of approximately 1,694 km^2 and divided into 38 rural *kebeles* and 2 town administrations.

The agro-ecology was characterized by 13% highland and 55% mid-highland and 32% lowland. The altitude of the *district* is between 1,400 and 2,200 meters above sea level (masl). In the district 10,241 hectares (ha) are currently covered by forest and bush, while 38,874 ha were used for crop production. There are two distinct seasons in Limu Seka: the rainy season starting in late March and ending in October and the dry season occurring during November to early March. The rainfall is often in excess of 1,800 mm per annum. Limu Seka *district* has 173,884 cattle, 14,357 sheep, 47,909 goats and 5,600 mules. The varied topography includes hills, undulating landscape and plains. Moderately dense vegetation coverage includes forests, bushes, scrublands and grasslands. Natural resources such as stone, sand, charcoal, timber and wild animals are also found here (WANRO, 2018).

The *district* potential for agriculture is estimated to be around 42,704 ha of land. In terms of cereal crops, maize covers 21,538 ha and sorghum covers 1,266 ha. Coffee is the major cash crop produced by the majority of farmers as the main source of income and covers more than 12,964 ha of land. The *district* has more than 3,427 ha of land under irrigation, 109 ha of which is irrigated by modern motor pump technology. Moreover, 80% of the population in the *woreda* is Muslim followed by 18% Orthodox Christians and 2% Protestant Christians.

Land use: The total land area of Limu Seka district was 1,694 km^2 and divided into 38 rural *Kebeles* of which 48,337ha (75%) is considered suitable for agriculture. The main land use types of the woreda include arable land, grazing land, forest; potentially cultivable and uncultivable land others (Table 1). As a result of suitable of ecological of the woreda majority of farmers were cultivated coffee production and other cereal crops like maize and teff. For the-seek of coffee production farmers cultivated forest for this reason erosion is minimized and soil fertility is increased and grasslands, natural resources such as wild animals are also found (WANRO, 2018).

Table 1: Land use patterns of Limu Seka Woreda

Land Use	Area Coverage (ha)
Arable land	1,158
Gazing land	3,600
Forest	13,200
Potentially cultivable land	45,250
Uncultivable land	8,130
Others	3,500
Total	74,838 (ha)

Source: Limu Seka ANRO, 2018

Climate: Agro ecology of the woreda was classified as highland, mid-highland and lowland accounting for 13%, 55% and 32% respectively. The altitude of the woreda is between 1,400-2,200 meters above sea level (masl) in the district. The annual rainfall varies from 857 to 1,085mm while the annual mean temperature also varies from 170c to 200c with mean value of 180c. There are two distinct seasons in Limu Seka the rainy season starting in late March and ending in October and the dry season occurring during November to early March. The rainfall is often in excess of 1,800 mm per annum. The varied topography includes hills undulating landscape and plains. Moderately dense vegetation coverage includes forests, bushes, scrublands and grasslands natural resource also found (WANRO, 2018).

Population: According to the recent district population reports (2007/08) the total number of rural households in 76 peasant associations in the woreda was 35,719. Out of these 26,698 (75%) were men and 9,021 (25%) were women households. The total population of the woreda was189, 463 out of which 93,594 (49.3%) were male and 95,869 (50.6%) were female. Economically active population of the woreda (15-55 years of age) is estimated at about 102,176 people out of whom 55,668 are male and 46,508 were female (WANRO, 2018).

Major crops: Coffee, Maize, teff, wheat and sorghum are the dominant crops. Coffee is grown on more than 75% of the cultivable land in the woreda which means 23,246 ha of while all the other crops account for the remaining 50% of the area. All most because of the regularity of rainfall all production of cereal crops are very well and hence the woreda is known as surplus producers' woreda (WANRO, 2018).

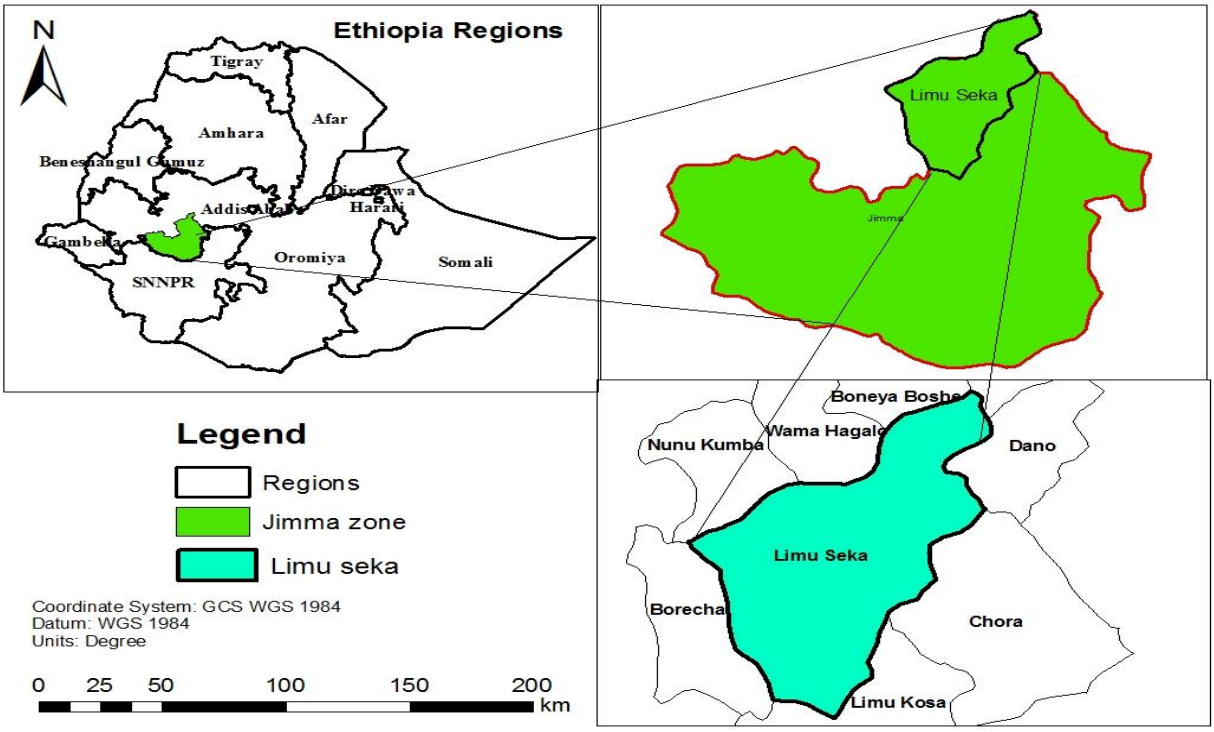

Figure 4: Map and location of Limu Seka district

Sources: GIS, (2019)

3.2 Research Design

The research design of this particular study was cross- sectional survey with both qualitative and quantitative components. This was due to the data for this research was collected once cropping season only. A cross-sectional survey collects data to make inferences about a population of interest (universe) at one point in time.

3.3 Sampling Procedure and Sample Size

The study was followed multi-stage sampling procedures to select representative sample households. In the first stage of sampling procedure, *Limu Seka Woreda* was selected purposively among rural woredas in *Jimma zone* based on large cultivated land under maize production (JZANRO, 2018). In the second stage, four *kebeles* were randomly selected from 20 maize producing *kebeles* of the *district* since all of them have relatively the same maize production potential. Then at the third stage, the farmers in each randomly selected *kebeles* were stratified into innovator and non-innovator based on the guideline of East African farmer innovation Fair (EAFIF, 2013). Households those were categorized under the innovator stratum were those of farmers fulfilled minimum of five criteria seated by (EAFIF, 2013). In the fourth stage, based on the above mentioned guideline the numbers of innovative farmers were few in number, therefore, all innovative farmers were selected purposively and non-innovative farmers were selected randomly. Finally, one hundred nine (109) innovative farmers and seventy nine (79) non innovator farmers were selected using purposive sampling and simple random sampling respectively. Population proportion to size was used to select non innovative farmers.

The sample size for the study was determined by the formula of (Yamane, 1967) to minimize the availability of error and bias during sample determination selection for the study. The formula for sample determination at 7% confidence interval is described as follows:

$$n = \frac{N}{1+N(e)^2} \quad \text{..... (1)}$$

$$n = \frac{2480}{1+2480(0.07)^2} = 188$$

Where n is the sample size for the study N is the total households of the four selected target *kebele* which is 2,480, *e* is the margin of error, or which is 0.07 in this study, 1 is the probability of the event occurring. The sample size of non-innovative farmers of each kebeles was determined based on their proportion to the total share of households residing in each *kebeles*.

PPS= ni/Ni=79/2371= 0.033319

Table 2: Sample size distributions in the sample rural kebeles

List of Kebeles	Total Household's			Sampled Household's		
	Innovators	Non-Innovators	Total	Innovators	Non -Innovators	Total
Molle	28	617	645	28	21	49
Yedo	30	618	648	30	21	51
Dego	26	597	623	26	20	46
Omo kaka	25	539	564	25	18	43
Total	**109**	**2371**	**2480**	**109**	**79**	**188**

Source: own survey, 2019

According to Eastern African Farmer Innovation Fair (EAFIF) (28–29 May, 2013) guideline set to select innovative farmers in Ethiopia must fulfill the criteria listed below:

- Farmers who have developed innovations on their own initiative (not imposed and externally driven).
- Farmers who are trying to add value to existing practices through creative engagement and experimentation and with a passion to seek changes.
- Farmers who have (co-) developed low-external input innovations that are relevant for small-scale agriculture and natural resource management (ecologically, socially and economically sound) and bring returns in the long run in terms of increased income, reduced drudgery, saving labour etc;
- Farmers who have interacted with other innovation actors (researchers, extension staff, university staff etc) in joint experimentation and innovation (Participatory Innovation Development).
- Farmers who have experience diversified and integrated farming operations to increase their income.

- Farmers who have developed new ways of doing things that have substantially changed (or have the potential to change) their agricultural and NRM practices and the lives of their families and neighbors (locally appropriate innovation) or innovations that can be applied more widely it the country, i.e. innovations that are “best bets” for recognition, dissemination (scaling out) or scaling up.
- Farmers whose innovative activities have influenced a large number of other farmers, e.g. they have mobilized others to innovate to maximize their livelihood.
- Farmers who have developed innovations that can impress others through physical exhibits or visual documentation.
- Farmers who are ready and willing to take part in the fair and scale of operations
- Farmers who are fully participated on adoption new technology in their farm filed
- Farmers who are role player in community development agricultural practice or others

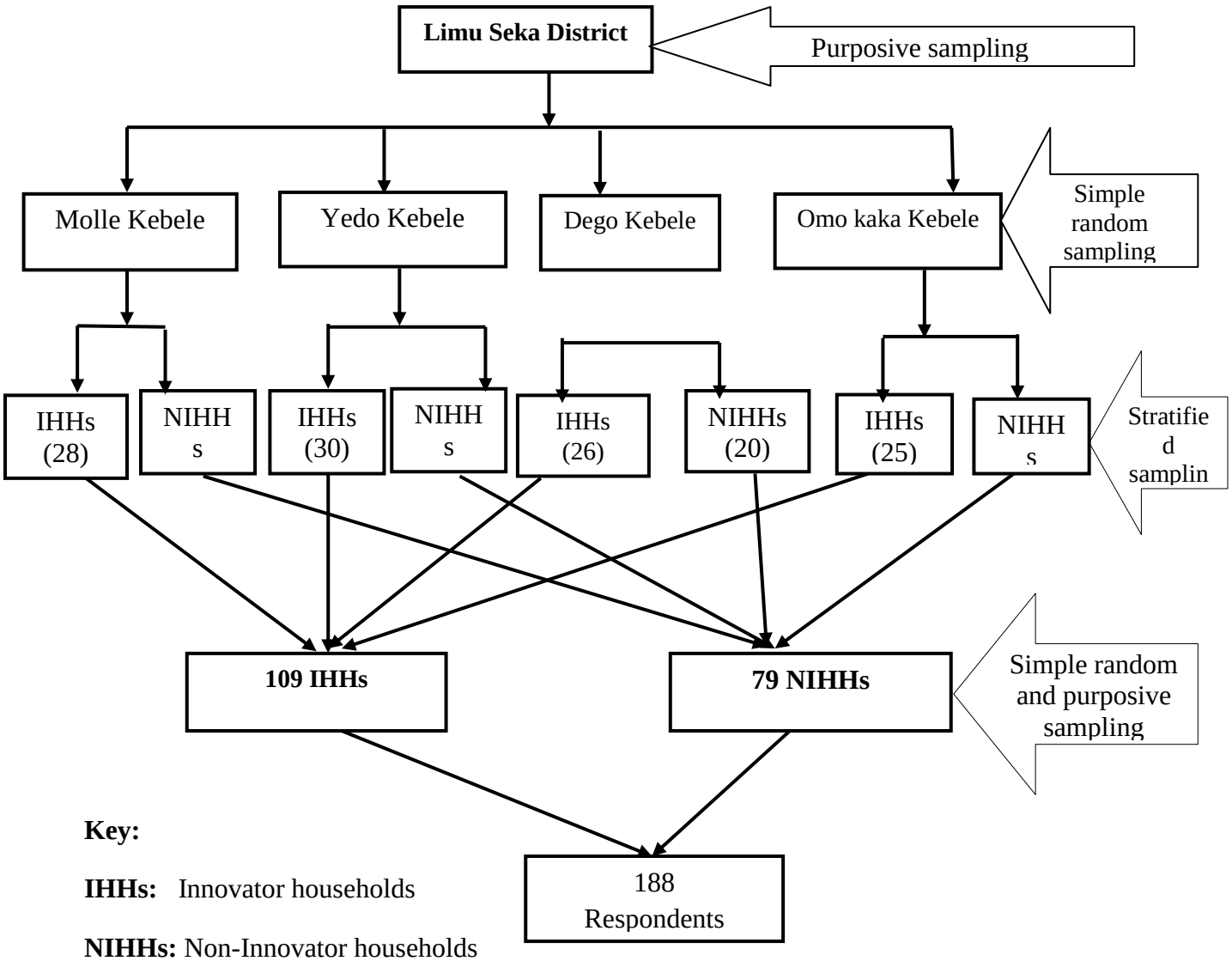

Figure 5: Framework of sampling procedures

Source: Own sketch, 2019

3.4 Types of Data and Data Sources

Both quantitative and qualitative data were collected from primary and secondary sources. Primary data were collected from respondents, while, secondary data were reviewed and organized from various documents both published and unpublished materials which were relevant to the study. In addition, data on existing of farmers' innovativeness was also collected from zonal and district agricultural office. Secondary data was collected from published and unpublished documents such as articles, journals, and reports of zonal and district agricultural and natural resource office.

3.5 Method of Data Collection

Primary data were collected through various data collection instruments such as a household's survey, Focus group discussion and key informant interview.

Household Survey

To generate quantitative and qualitative information at the household level, semi-structured questionnaire was used and data were collected through interview schedules. The household survey covered personal data, household resources, educational status, income issues and production related to maize innovation. The interview schedules were first prepared in English and later translated into the local language (Afan Oromo) so that the respondents can easily understand the questions. The questionnaire was first prepared and pre-tested on 8 households to check and make some correction. Two enumerators were employed in each kebele based on their ability of local language and experiences in data collection. Training was provided to the enumerators on the content of the questionnaire and procedure to follow while conducting interviews with respondents.

Focus Group Discussions

The participants for focus group discussion members were purposively selected with the collaboration of development agents and *Kebele* leaders based on the information they have about on farmers' innovativeness on maize production. The focus group discussions (FGD) were held to supplement the individual respondent's interview. One focus group discussions at each study kebeles were conducted and each focus group comprised eight individuals. Each group of the FGD contains 4 innovator farmers and 4 non-innovator farmers. The discussion was aimed to get additional supportive qualitative evidence on the current status of farmers' innovativeness addition to the information obtain from the survey. Accordingly, with the help of well-prepared checklists discussions were conducted with all members of the focus group discussion.

Key Informant Interview

The primary data collected from sample households need to be further enriched with additional information gathered through key informants. Thus, intensive interview was conducted with key informants. Thus, two (2) subject matter specialists of agriculture and natural resource office, one researcher from Ethiopian Institute of Agricultural Research Jimma center (EIAR), two (2) development agents (DA) and five (5) model farmers from kebele, totally ten (10) key informants were interviewed for this study.

3.4.1 Methods of Data Analysis

Quantitative data were analyzed by using descriptive and inferential statistical tools. Mean, percentage and standard deviation were used to analyze qualitative data, while chi-square and t-test were also applied to test the statistical significance of the dummy and continuous independent variables respectively. The t- test was used to examine the mean difference between innovator farmers from that of non-innovator farmers with respect to certain continuous variables. The binary logistic regression model was used to identify factors that influencing farmers' innovativeness on maize production. The qualitative data collected using focus group discussion and key informant interview was interpreted by narrative explanation to supplement

quantitative data. Finally, after data was collected, data editing and coding was completed and analyzed by using (SPSS ver.20).

3.4.2 Econometrics Model Specification

Binary logistic regression model was a proper model when the dependent variable as dummy one consisting of two, 0 and 1; logistic regression model can be properly used (Tathdil, 2002). Thus, the employed regression model was a binary logistic regression model, where dependent the variable is Y and the independent is X. Therefore to identify the major factors are that influencing farmers' innovativeness, binary logistic regression was used. In order to explain the model, the following logistic distribution function was used (Gujarati, 2009).

$$Pi = \in (Y=1/Xi) = \frac{1}{1+e^{-(\beta 1+\beta 2xi)}} \text{...} \quad (1)$$

In the logistic distribution equation, *Pi* is the independent variable; *X*i is the data that is the possibility of a preference by an individual (option of having 1 and 0 values). When β 1+β2*Xi* in Equation 1 is replaced by *Zi*, Equation 2 is obtained:

$$Pi = \frac{1}{1+e^{-Zi}} \text{..} \quad (2)$$

Z i is between - ∞ and + ∞, and *P i* is between 1 and 0.When *P i* shows the possibility of innovator and non-innovator of maize production is 1- *P i*. Then, the possibility of non-innovator farmer can be explained as in Equation 3 as follows:

$$1 - Pi = \frac{1}{1+e^{Zi}} \text{..} \quad (3)$$

Equation 4 is obtained by dividing the innovator by non-innovator:

$$\frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{-Zi}} = e^{Zi} \text{..} \quad (4)$$

When the natural logarithm of both sides of the equation is written, Equation 1 is obtained

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = Zi = \beta 1 + \beta 2Xi \text{..} \quad (5)$$

Thus, non-linear logistic regression model is liberalized based on both its parameters and variables. "*L*" is called "logit" and models such as this called "logit models" (Gujarati, 2003). In these situations, Equation 1 is used for proper transformations:

$$Pi = \in (Y = \frac{1}{Xi} = \frac{1}{1+e-(\beta 1+\beta 2X1+\beta 3X2+\cdots+\beta kXk)} \ldots\ldots (6)$$

Odds and odds ratio are significant terms in logit model. Odds are defined as the ratio of the number of events that occurred to number of events that did not occur. “Odds ratio” on the other hand, is the ratio of two odds, in other words, the ratio of likelihood to another. In Equation 4, two probabilities, the innovator and non-innovator probability of an event are proportioned and this is the odds of proportion. It is important to understand that possibility, odds, and logit concepts, are three different ways of explaining the same thing (Menard, 2002).

$$Zi = \beta o + \varepsilon \beta iX + Ui \ldots\ldots (7)$$

3.5 Definitions of Variables and Working Hypothesis

3.5.1 Dependent Variables

Dependent variable is variable which are affected by independent variable for this study farmers’ innovativeness was treated as a dependent dichotomous variable that take the value of 1 if farmers are innovator and 0 otherwise. Thus data were collected from both innovator and non-innovators farmers, in order to analyze factors that affect farmers innovativeness on maize production.

Table 3: Definition of dependent variables and unit of measurement

Variables name	Description	Unit/Type
Farmers Innovativeness(FI)	Respondents category; 1 = if Innovator 2 = if Non-innovator	Dummy

Source own survey, 2019

3.5.2 Independent or explanatory variables

It is hypothesized that farmers’ innovativeness is influenced by a set of independent variables. Based on the review of previous literature research findings and considering the information from an informal survey among the large number of factors which were expected to influence the farmers’ innovativeness 14 potential explanatory variables were considered for this study. These are presented as follows.

Demographic & personal factors

Sex of household head: Sex refers to biological differentiation of the household head. It is dummy variable 1 if male, 0 otherwise. Male-headed household farmers were culturally having a better chance of exposing to different agricultural information source when compared with women headed household this may enable them to innovativeness (Yaekob, 2010). Therefore, it is hypothesized that sex of the household head to influence the farmers innovativeness on maize production negatively.

Age of the household head: It is a continuous variable and measured in number of years from birth. Age of the household head is an important factor that would help to explain farmers' innovativeness on maize production. According to Assefa and Gezahegn, (2010) as the farmers' increases in age, they become conservative, and their ability to perform various farm operations diminishes. Therefore, it was hypothesized that age of households was negatively influenced farmers' innovativeness on maize production.

Family size of the household: It is a continuous variable measured in terms of adult equivalent with the availability of active and productive family member in the household. Availability of family labor is likely to enabling the farmers to be more productive. A household with larger number of workers more likely profitable and enhancing to agricultural innovation and it was expected to influence farmers' innovativeness positively (Hassen, 2014). Hence, this variable was hypothesized to have a positive relationship with farmers' innovativeness on maize production.

Education level of the household: This refers to the level of education of the respondent in formal schooling. It is a continuous variable and measured in number of years he /she gained formal school during the time of data collection. Educational qualification significantly contributed to farmers' innovativeness (Reij and Waters-Bayer, 2014). Therefore, it was hypothesized that, the level of education attained by the household head would influence farmers' innovativeness positively.

Farming experience: It is continues variable measure the number of years spent in farming by the respondent. Experience is enabling farmers to have better knowledge which in turn may be

the basis for innovativeness (Tewodrose, 2016). Hence, farming experience is expected to affect the farmers' innovativeness on maize production positively.

Socio-Psychological factors

Social participation: It is a dummy variable reflects on the degree of involvement of the respondents in existing formal and non-formal organizations like Idir, Iqub, PAs, marketing cooperatives Unions, school councils. Those farmers who frequently participate in those social organization(s) exercise leadership and venerable to new ideas this may lead them to be innovative. They have an opportunity to get information on various improved agricultural practices which in turn may be the basis for innovativeness. (Teshome *et.al*, 2019) Therefore, social participation was hypothesized that positively related with farmers' innovativeness on maize production.

Mass-media exposure: This is variable measured that as a composite score in ordinal scale. It is measured in such a way that a person who has access to all the three media (Radio, TV and printed materials). Access here is defined as ownership of the media and having time and the ability to use it. Mass media play a great role in creating awareness about farmers' innovativeness in the shortest time possible over a large area of coverage (Yishak, 2005). This will motivate farmers to innovate. Therefore, mass-media exposure also expected to influence farmers' innovativeness positively.

Attitude towards agriculture: It is operationally defined as the degree of positive or negative opinion of farmers towards agriculture as well as innovativeness and it was measured by a 5 Likert-scale type in which the result for each respondent was obtained by scoring procedure. Positive attitude towards agriculture is one of the factors which could speed up the innovativeness (Tadesse, 2008). Therefore, It was hypothesized that favorable attitude towards agriculture influences farmers' innovativeness positively.

Exposure to other areas: According to some studies farmers that participated in innovation have better exposure to external areas. They pick up ideas while in other parts of the country outside their own PAs, or abroad (Reij and Waters-Bayer, 2014). Therefore, it is hypothesized

that exposure to other areas influences farmers' innovativeness on maize production positively. It was used as a dummy variable (1 if exposed, 0 otherwise).

Economic-related factors

Farm size of the households: It is a continuous variable measured in hectare that the size of total land owned by the respondent at the time of data collection. Farm size of the households expected to affect farmers' innovativeness. Owners of large farms are often rich have access to more resources, including information and can better afford failed experiments (Richardson-Ngwenya, 2018).Therefore, it is expected that farm size and farmers' innovativeness are positively related.

Livestock holding: It is a continuous variable measured in TLU; where those who possess a flock of TLU are expected to participate on maize innovation better than they have not. Livestock holding is an important indicator of wealth status for the farm community. It is an important source of cash, manure, draft power and food for the agricultural community. The presence of tropical livestock unit can solve the liquidity problem that farm households face while intending to purchase and agricultural technology (Debelo, 2015). Hence, livestock holding was hypothesized to positively affect farmers' innovativeness.

Off/non-farm income: It is a continuous variable and measured by the average amount of income earned from off farms per annum in E.T.B Majority of farm families derive their livelihoods not only from crop and livestock production but also from a range of activities outside of agriculture. According to some studies, it was found that the innovators devote most of their working time to farming. It appears that the more innovative farmers can produce enough of their land and therefore need not seek off/non-farm sources of income (Reij and Waters-Bayer, 2014). Therefore, in this study it is hypothesized that participation in off/non-farm activities affects farmers' innovativeness negatively.

Institutional factors

Access to credit: It is dummy variable; representing 1 if the household had credit access and 0 otherwise. Credit access reduces liquidity problems that household could face while intending to

purchase agricultural inputs and hence paves the way for timely application of inputs thereby increase the overall productivity and farm income. Since farmers with access to credit are more capable in accumulating capital than their counterparts who do not have access, these farmers had the capacity to innovate (Anik and Salam, 2015). Hence, this variable was hypothesized to have a positive relationship with farmers' innovativeness.

Extension contact: Extension contact is an institutional factor which includes any support from government and non-government organizations are stimulating households in any farm activities. It is continues variable that measured trough frequency of farmers' visited by extension agents in one year. In extension contact farmers may get information that helps them to involve in maize innovation.

Information through extension service can play a vital role in increasing skills and agricultural production, improving analytical power of a person and decision-making capacity for looking new venture (Hilton *et al*., 2016; Husain *et al*., 2016 and Schreinemachers *et al*., 2016). Therefore, the research hypothesis that contact with extension agent or development agent was expected to influence farmers' innovativeness positively.

Table 4: Definitions of independent variables and units of measurement

Independent Variables	Type of variables	Measurement	Expected sign
Age of the HHs	Continuous	Year	-ve
Sex of the HHs	Dummy	1= if male otherwise= 0	+ve
Family size of the HH	Continuous	AER	+ve
Education level	Continuous	Year of schooling	+ve
Farm experience	Continuous	Year of farming	+ve
Access to credit	Dummy	1= if access otherwise = 0	+ve
Extension contact	Continuous	Frequency of Ex, contact	+ve
Mass Media exposure	Dummy	Frequency of TV and Radio listening	+ve
Off/non-farm income	Continuous	ETB	-ve
Livestock holdings	Continuous	TLU/continuous	+ve
Farm size of the HHs	Continuous	Hectare	+ve
Social participation	Dummy	1= if participate otherwise=0	+ve
Exposure to other area	Dummy	1= if yes otherwise = 0	+ve
Attitude towards agriculture	Categorical	Score(+) 1 for positive 2, for neutral, 3 for negative (Tadese,2008)	+ve

Sources: Own computations, 2019

4. RESULT AND DISCUSSIONS

The focus of this section is on the analysis and interpretation of the major findings of the study in different categories. This study was based on cross-sectional data obtained from 188 household headed in, which 109 were innovator farmers' households head and 79 were non-innovators farmers' household head. The first section presents the background information of all the respondents. The section devoted to discussing the relationships between explanatory variables and results of the econometric analysis of factors affecting farmers' innovativeness were discussed. The third section, presents the status of farmers' innovativeness on maize production in the study area. The fourth section discuses some challenges and opportunities of farmers' innovativeness in maize production system in the study area. Finally, in the fifth section, summary, conclusion and recommendations of the total findings were discussed.

4.1.1 General characteristics of sample respondents in the study area

Before going in-depth investigation of the influence of various explanatory variables on dependent variables, the general characteristics of sample respondents which included in the interview schedule were discussed in this section using descriptive statistics as shown in Table 4. Accordingly, 30.4% of the respondents were found in the age category of 28-44 years. Likewise, 45.7% were found in the age of 45-64 years. As depicted in the Table 4, about 10.6% the respondents were found in the age of greater than 65 years old.

Coming to the sex of the respondents, 92.1% of the respondents were male and only 7.9% were female. Regarding marital status, out of the total respondents, 97.3% of them were married and 2.7% of the respondents were found to be single respectively. Coming to the family size, which was expressed in adult equivalent ratio indicated in the Table 4 below show that 22.3% of the respondent's family size exists between the interval of 0-7.9 in AER; 31.2% were between 0-2.6, 46.2% were between 2.7-5.2 and 22% were between 5.3-7.9. The education level of respondents exists in the interval of 0-10 and most of the respondents get primary education as it was observed in Table 4 below. The year of schooling of 36.4% of the respondents ranges between the interval of 0-4 grade, 35.5% were between 5-8grade and 7.4% were between 9-10 grade respectively.

Table 5: general characteristics of sample respondents

Variables	Characteristics of sampled respondents		
		Frequency	Percentage
Age of the HHs	28-44 (low)	57	30.4
	45-64 (medium)	86	45.7
	> 65 (high)	45	23.9
Total	25-65 (overall)	188	100
Sex of HHs	Male	173	92.1
	Female	15	7.9
Total	-	188	100
	0-2.6	59	31.3
Family size of HHs (AER)	2.7-5.2	87	46.2
	5.3-7.9	42	22.3
Total	0.-7.9	188	100
	0-4	108	57.4
Education level of HHs	5-8	66	35.2
	9-10	14	7.4
Total		188	100
	Married	183	97.3
Marital status	Single	5	2.7
Total	-	188	100

Source own survey, 2019

4.2 Factors that affect farmers' innovativeness on maize production

It is well known that there are several factors which are influencing farmers' innovativeness on maize production. Earlier studies group those factors under different major categories depending on the purpose and variables of the study. In order to understand the influence of existing personal and demographic, socio-psychological, economic-related and institutional factors that affect farmers' innovativeness on maize production were discussed and disused under the following sub-sections.

4.2.1 Result of descriptive dummy variables

Sex of household head: The studies conducted in other country of Africa stated that most of identified innovators farmers were men (Reij and Waters-Bayer, 2014). Although, women's often do a large share of the farm work it is usually the men who are the household heads and represent the family in public and most likely to take credit for any change made on their farms.

This may partly explain the lower percentage of female innovators identified (Reij and Waters-Bayer, 2014 and Yohannes, 2001) this holds true the present study also.

According to the data accommodated on Figure, 6 out of the total sampled respondents, 92.25% were male and 8.86% of the was females respectively. The result further illustrated that the female number of sampled household head was very small than that of male households.

The result revealed that male innovator farmers' households had greater percentage than female headed households. The chi- square value ($\chi 2$= 0.743; p=0.704) shows that there was no statistically significant between sex and both category of farmers.

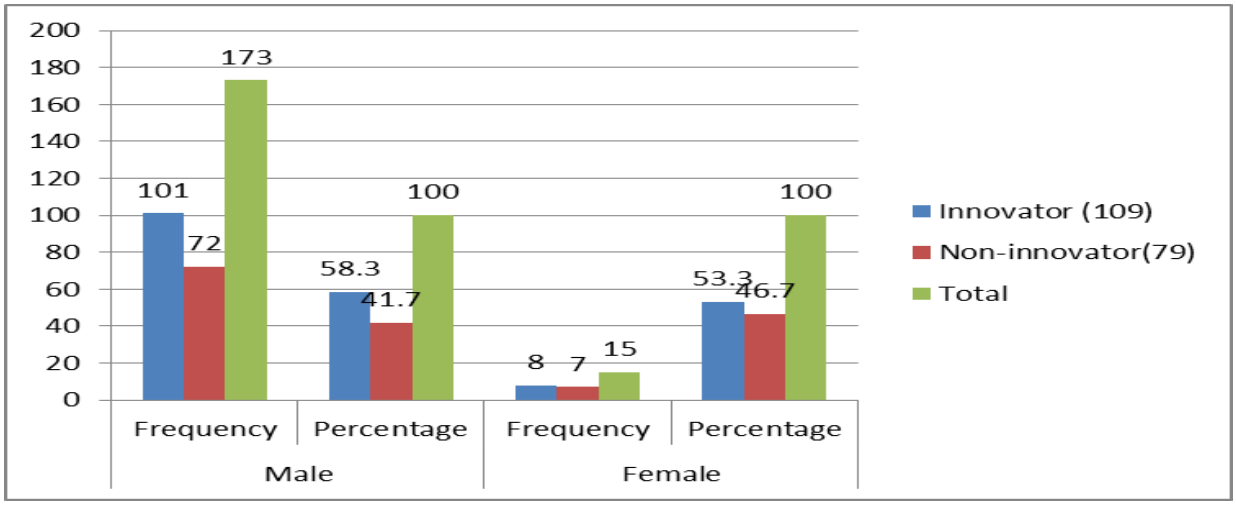

Figure 6: Sex of respondents among innovator category

Source: own survey, 2019

Social participation: Involvement in social organization is expected to influence the innovativeness behavior of the farmers. It links the individual to larger society and exposes him to a variety of ideas. This exposure makes him positively predisposed towards innovative ideas and practices.

Social participation is determined by many factors and in turn it influenced the innovativeness of the farmers. These opportunities would create suitable conditions for farmers that may enable them to develop leadership experience. While, they are practicing leadership in the community

they would have opportunities to get diverse information on various aspects of agricultural technology which in turn may be the basis for enrichment of innovativeness.

The result of categorical analysis situated in Table, 6 shows that among total sampled households 55.4% had participated in social organizations while, 44.2% farmers were not participating in any of social organization. Among households who participated in social organization innovators accounted about 67.9% and while, about 32.1% were not participating in any social organization. Similarly, from non-innovator categories about 39.3% of respondents were participated in social organization while, 60.7% not participate in social organization like edir, equb, members of religious and cooperatives to share their own value and experience (Appendix table, 4).

The chi-square result shows that, social participation was found to be a statistically significant relationship with the farmers' innovativeness on maize production (x^2=15.606; p=0.00) at 1% probability level. The result in line with Hamado Sawadogo and his colleagues conducts in Burkina Faso (Sawadogo *et al,* 2001).

Attitude towards agriculture: Individual attitude towards agriculture were determining the measure to be taken by the individual to improve the same. A person having a positive attitude towards innovativeness may take any possible measure to bring information. A man of negative attitude towards agriculture will do the opposite. The positive minded person who tries to get new information and ask which would make him capable of taken the appropriate measure for the farmers' innovativeness.

The categorical analysis presented in Table, 6 shows that among the total respondents, about 60.6% of had positive, 22.9% were neutral and also 16.5 of them had negative attitude towards agriculture respectively. Accordingly, out of both categories the innovator farmers found to be 73.3% positive, 19.3% neutral and 7.4% of negative attitude towards agriculture. While, the non-innovators category 43.3% of positive, 27.8 of neutral and 29.2% of the respondents had negative attitude towards agriculture.

The chi-square was computed to see the relationship between the respondent's attitudes towards agriculture. The result shows that there is a significant relationship between respondents' attitude

with innovator category at 1% probability level (x^2=21.606; p=0.000). This implies the innovator farmers have the highest average score; from that of non-innovator respondents have a positive attitude towards agriculture.

Exposure to other area: The result of categorical analysis presented in Table, 6 shows that out of the total interviewed respondents, about 30.8% were exposure to other areas while, 69.2% of them are not getting the opportunity. Accordingly, among both categories about 24.7% of innovator were getting the chance to expose other area while, 75.3 of them were not exposed to another area. Similarly, among that of a non-innovator about 39.3% of them expose to other area and the remaining 60.7% were not exposed to other areas.

The chi-square test indicates that the relationship between innovator category and exposure to other area statistically significant at 10% probability level (x^2 4.937; p=0.085). Accordingly, the exposure of innovator farmers seen to be very high when compared to that of non-innovator farmers'.

Credit utilization: Credit services are an important source of finance for the poor farmers to buy inputs for agricultural production and ultimately to adopt new technologies. The result of the survey in Table, 6 shows that, out of the total sample respondents, about 71.3% had got credit service from district credit service delivering institutions to run their agricultural production accordingly. On the other hands, about 28.2% of the total sample households were not credit recipients while, 76.1% of innovator and 64.6% of non-innovator sample household had credit utilized during the survey year. The remaining about 23.9% of innovators and 35.4% non-innovators had not access to credit service.

The chi-square analysis result ($x^2$6.129; p=0.00) revealed that the difference between the two categories with respect to this variable was found to statistically significant at 1% probability level. The descriptive analysis witnessed that innovators are larger in population in credit utilization than non-innovator farmers. However, in this study credit utilization had encouraged farmers' innovativeness.

Table 6: Results of descriptive dummy variables and innovator category

Variables		Innovator(109)		Non-innovator (79)		Total sampled HHs (188)		x^2
		N	%	N	%	N	%	
Exposure to other area	Yes	27	24.7	31	39.3	58	30.8	4.937*
	No	82	75.3	48	60.7	130	69.2	
Access to credit	Yes	83	76.1	54	64.6	137	71.3	6.129***
	No	26	23.9	28	35.4	54	28.7	
Social participation	Yes	74	67.9	31	39.3	104	55.8	15.608***
	No	35	32.1	48	60.7	83	44.2	
Attitude towards agriculture	Positive	80	73.3	34	43.0	114	60.6	21.606***
	Neutral	21	19.3	22	27.8	43	22.9	
	Negative	8	7.4	23	29.2	31	16.5	

*Source: own survey, 2018. ***, *'means significant at 1%, and 10% probability level*

Mass media exposure: Mass media plays a great role in increasing awareness about agricultural innovation system or technology in shortest possible over a large area of coverage. The information bout new agricultural technologies which are disseminated by mass media will motivate farmers to use the same or it will encourage them to generate appropriate innovation which is suitable for their particular situation. It will also help to disseminate and raise awareness about farmers' innovativeness. Hence, mass media exposure was treated with respect to Radio listening, TV watching, and new paper reading. The survey result of mass media exposure of sampled respondents is provided in the Table, 6 below.

Radio was the most widely used tools that has about 80% of transmission cove in Ethiopia and owned by about 50% of the country populations (UNDP, 2012). It is used to spread knowledge and information in all aspects of production managements, post-harvest management and marketing. Even though most of innovator farmers who are frequently listen the agriculture program which transmitted through radio the life style of them are changed and also productive on their production season. So the frequency of farmers' radio listening was discussed in the following table below.

The categorical analysis presented in Table, 7 was among the total resoponbets73.9% of the respondents were access to mass-media and about 26.1% of the respondents have been never accessed to media like Radio, TV and printing media. It is encountered that about 53.2% of innovators and 48.2% of non-innovator farmers were listening to radio every day. On the other hands, among both categories about 36.6%, 35.4% of innovator and non-innovator farmers were rarely listened to the radio respectively. Likewise, about 8.3% and 13.9% of innovators and non-innovator farmers also access to the radio listening once a week.

The survey results further exposed that, among the total respondents there were no respondents watching TV every day. Furthermore, about 22.34% and 27.65% of the respondents are watching TV once in a week and rarely respectively. To the contrary, about 50% of respondents were never watching the program transmitted through television. The chi-square result ($x^2$28.5, p=000) shows mass-media exposure was found to be positively related with farmers' innovativeness and statistically significant at 1% probability level.

Table 7: Relationship mass-media exposure and innovator category

Variables		Innovator (109)		Non-innovator(79)		Total sampled HHs (188)		x^2
		N	%	N	%	N	%	
Mass media	Yes	97	88.07	42	54.16	139	73.9	
exposure	No	12	11.1	37	46.83	49	26.1	28.5***
Radio	Never	2	1.9	2	2.5	4	2.1	
listening	Rarely	40	36.6	28	35.4	68	36.1	
	Once a week	9	8.3	11	13.9	20	10.7	
	Every day	58	53.2	38	48.2	96	51.1	
TV	Never	52	47.7	42	53.2	94	50.8	
watching	Rarely	30	27.5	22	27.8	52	27.6	
	Once a week	27	24.7	15	19	42	22.3	
	Every day	00	00	00	00	00	00	

Source: own survey, 2019. , ***, *Significance at1% Probability level*

4.2.2 Result of descriptive continuous variables

Age of household head: Age is one of the demographic factors that is useful to describe respondents and provide clue about the age structure of the sample and the population. The degree of farmers' innovativeness found to be affected by age of the farmer. Accordingly, the results of some study indicates that the degree of innovativeness to be lower among older and younger farmers and the pick innovativeness to be found among farmers in the age range of 35-50 years (Reij and Waters-Bayer, 2014).

The result in Table, 8 reveals that, the mean age of total respondents was found to be 43.70 with a standard deviation of 10.37. The minimum and maximum age of the respondents was 28 and 70 respectively which is at the same time shows that, the variation in the range of respondents' age. Likewise, the mean age of innovator was about 44.09 and 43.15 for non-innovator with a standard deviation of 10.26 and 10.37 respectively. To check a significant mean age difference between innovator and non-innovators t-tests statistics were run. Therefore, the t-test result shows that there was no significant difference in ages of both sampled household's.

Family size of household head: Families often work very closely together to build up their farm. Moreover, most innovator farmers will need support from the rest of the family as new techniques may require extra labor, divert resources and involved some risk and therefore at least in some case requires consultations within the family (Reij and Waters-Bayer, 2014).

According to the result accommodated in Table, 8 the total means of family size of the sampled respondents were 5.09 persons with SD of 2.17. The minimum and the maximum family size of the total sampled household is 1 and 9, respectively. The mean family size of the sampled innovator farmer was about 4.88 persons and the non-innovators are 5.30 with a standard deviation of 2.21 and 2.11 respectively. The t-value witness that (t-value= -1.38; p=0.193) family size of the respondents was found to be not significant mean difference between both categories. This result suggested that availability of high household size is an important factor influencing in farmers innovativeness on maize production. The result of this study is in agreement with the results of (Amsalu, 2008, Yohannes, 2001), community assessment of local innovators in northern Ethiopia.

Educational level of household head: Education improves the capacity of an individual to obtain and utilize information disseminated by different sources. This turns strengthen farmers' innovativeness. Based upon this premise some studies indicate that innovators are better educated (Waters-Bayer, 2014 and Nasr *et al.,* 2017).

Based on assessment results postulated in Table, 8 the means of schooling both innovator and non-innovator sampled respondents were about 2.37 with SD of 2.33, respectively. The mean schooling of innovative farmers was about 3.00 with a standard deviation of 2.43 while, the non-innovator was 1.49 with a standard deviation of 1.866. The result of t-test shows that means year of schooling of sampled respondents had significant difference among both categories (t-value=4.83; p=0.00) and statistically significant at 1 % probability level. The finding of this study is in agreement with the study indicated by Ashenaf (2010) in his study; of comparative analysis of maize-livestock innovation system.

Farm experience of household head: Farm experience is one of the household features, which a farmer acquired in his life by undertaking farming activities. Farmers can observe success and failure in his innovative activities. Therefore, this could help them to weight between the performance of modern and a traditional technology and to develop more confidence to take risk related to farming. This is because as farm experience increases the degree of farmers' innovativeness also increases.

According to the survey result in a table, 8 shows that, the means farm experience of the total sampled respondents had about 25.53 with a standard deviation of 10.28 years of experience. The finding of this study further shows that, mean farm experience of innovator was about 27.12 with (SD=8.05) while, mean farm experience of non-innovator were 23.33 (SD=12.47) years respectively. Likewise, the study has further identified about 20% of the respondents have less than 10 years farm experience whereas, around 80.5% of respondents had 20-40 years'. This result indicated that innovator farmers had more farm experience than non-innovator farmers. To check a significant mean difference in the farm experience between innovators and non-innovators t-test statistics was run. The result of t-test (t-value=2.37; P=0.012) witnessed that there was statistically significant mean difference between innovator and non-innovator in terms of farm experience at 5% probability level.

Extension contact: According to table 8, the average mean of frequency of extension contact that farmers made with development agent per month in the study area were 2.01.with a standard deviation of 0.98. It was observed that the mean extension contact of innovative farmers was about 2.34 with a standard deviation of 8.05 while, mean of non-innovator farmers that made extension contact with the agricultural development agent was 1.55 times per month with the standard deviation of 0.93 times respectively,. T-test (t=5.8; p=0.00) was run to see the statistical mean difference of both category. Therefore, there was a mean difference regarding to frequency of extension contact among both innovator category and statistically significant at 1% probability level.

Livestock holding in (TLU): In rural context livestock holdings is an important indicator of households' wealth passion. Similarly, to owners of large farm owners of large numbers of livestock are often rich and have access to more resources including information and can better afford the risk. It was thus assumed to be positively associated with farmers' innovativeness.

Livestock is an important source of income and draught power for cultivation and one of the main cash sources to purchase production inputs for farmers. In the study area livestock production constitutes important elements of the farming system of the community. The result accommodated in Table, 8 shows that, the total means of livestock holdings of the sampled households were about 3.47 TLU with a standard deviation of 2.25. Among both categories' innovator farmers found to own more livestock than that of non-innovator farmers. It was observed the mean livestock holding of innovator farmers' were about 4.14 TLU with a standard deviation of 2.65 while, the mean non-innovator farmers' had 2.54 with a standard deviation of 2.13. The t-value result (t=value 6.02, p=0.00) indicated that, there was mean difference in livestock holdings and innovator categories and statistically significant at 1% probability level.

Farm size of household head: Land is perhaps the single most important resource as it is a base for any economic activities especially in the rural agricultural sector. Farm size influenced farmer's decision to use or generate new technologies a farmer who has relatively a large size of the farmland will not be indecisive for farmers' innovativeness. But it will motivate the maize innovator farmers.

The result stated in Table, 8 shows that the total means of farm size of the sampled respondents were about, 1.94 with a standard deviation of 1.14ha and the maximum land holding by the sampled respondents were 7.5ha, while, the minimum is 0.23ha. The mean farm size of non-innovator groups was about 1.41ha with SD of 0.94 while, the mean of the innovator groups were 2.32ha with SD of 1.12. The finding of the study (t-value=6. 02; p=0.00) shows that there were a mean difference between farm size and innovator category and statistically significant at 1% probability level. This result in line with finding of (Amsalu, 2008, Yohannes, 2001) in their study entitled determinants of farmers' innovativeness.

Off/non-farm income: In most of African countries the majority of farmers derived their livelihood not only from agricultural activities but also from a range of activities outside agriculture that off/ non-farm activities. According to Bryceson (2015) farmers in sub-Saharan Africa drive 60-80 percent of their income obtained from off/non-farm income. But some studies indicated that most of innovator farmers devoted majority of their working time to farming. They are often in the fields, digging, pits planting of maize, weeding, doing disease/pest controls mechanisms and harvesting. It appears that the more innovative farmers can generated their income from both off/non-farm activities due to this reason the innovators farmers' annual income are better than non-innovator.

Participation of off/non-farm activities had insignificant relation with farmers' innovativeness on maize production. Participation in non-farm and off-farm activities gives the same result. The only difference is the mean income from these actives. As Table, 8 indicated that, the average annual off/non-farm income sample household head in per year were about 6813.0, ETB with standard deviation 5193.7. On average, the off/non-farm income of innovator farmers' were about 8463.81ETB with standard deviation 7911.5 while, the non-innovator farmers' had 5162.2, ETB with standard deviation 2476.05. The result of (t-test=0.37) result indicates that there was no mean difference between off/non-farm income and innovator category. The probable reason might be most of the innovators farmers in the study area were depended on crop production as well as animal and animal products. This implies most of the farmers in the district relay on on-farm income rather than non/off-farm activities.

Table 8: The results of descriptive statistics of sampled households (continuous variables)

Variables	Innovator(109)		Non-innovator(79)		Overall	t=value
	Mean	SD	Mean	SD	Mean	
Age of HHs	44.09	10.26	43.15	10.56	43.70	0.612NS
Family size	4.88	2.21	5.30	1.11	5.09	-1.31NS
Educational level	3.00	2.43	1.49	1.86	2.37	4.83***
Farm experience	27.12	8.05	23.33	12.47	25.53	2.37**
Frequency of Ext, contact	2.34	0.88	1.55	0.93	2.01	5.87***
Livestock holding	4.14	2.65	2.54	1.13	3.47	4.56***
Farm size	2.32	1.12	1.41	0.94	1.94	6.02***
Off/non-farm income	8463.81	7911.1	5162.2	2476.05	6813.0	0.37NS

*, ** and *** means significant at 10%, 5% and 1% probability levels, respectively; NS, Non-significant
Source: Field survey (2019)

4.2.3 Summary of descriptive variables

Before passing to the econometric part of analysis, it is important to summarize the results of descriptive statistics. In this study respondents were treated in two categories. The differences between innovators and non-innovators were assessed using t-test and chi-square test statistics for the continuous and dummy/categorized variables, respectively. The mean and SD were used to discriminate the categories for continuous variable. Out of 14 explanatory variables hypothesized only three variables like sex of households, family size and off/non-farm income were did not show significance variation with dependent variable. The remaining 11 of them explanatory variables were (educational level of households, age, farm size, mass-media exposure to other area, extension contact, social participation, farm experience, attitude towards agriculture and access to credit) showed a significance association with farmers' innovativeness on maize production.

4.2.4 Results of the econometrics model

The previous section dealt mainly with a description of the sample population and test of the existence of an association between the dependent and explanatory variables to identify factors affecting farmers' innovativeness on maize production. Identification of these factors alone is not enough unless the relative influence of each factor is known for priority based intervention. In this section, the binary logistics econometric model was used to see the relative influence of different personal and demographic, socio-psychological, institutional and economic-related variables that influence farmers' innovativeness.

Before running the binary logit model all the hypothesized explanatory variables were checked for the existence of multi-colinearity problem. VIF (variance inflation factor) was used for testing the association between the hypothesized continuous variables .The VIF values displayed in the show that all continuous explanatory variables have no serious multi-colinearity problem. Similarly, the contingency coefficient test was used to ascertain the degree of association among dummy variables.

The values of contingency coefficient range between 0 and 1, with zero indicating no association between the variables and values close to 1 indicating a high degree of association. The association is said to be high when the value is greater than 0.75. The values of the contingency coefficients were also low (Appendix table, 6).

Finally, all hypothesized explanatory variables were included in the Binary logistic analysis. These variables were selected on the basis of theoretical explanations, personal observations and the results of the survey studies. To determine the best subset of explanatory variables that are good predictors of the dependent variable, the logistic regressions were estimated using the method of maximum likelihood estimation, which is available in the statistical software program (SPSS version 20). All the above-mentioned variables were entered in a single step.

The logit model results used to study factors influencing farmers' innovativeness on maize production shown in table 8. The various goodness of fit measures state that the model fits that data well. The likelihood ratio test statistics exceed the chi-square critical values with 17 degree

of freedom at less than 1% probability levels indicating that the hypothesis that all the coefficients, except the intercept are equal to zero is rejected. The value of Pearson chi-square test shows the overall goodness of fit of the model at less than 1% Probability level.

Another measure of goodness of fit is based on a method that classifies the predicted value of the dependent variable, farmers' innovativeness, as 1 if innovator and 0 otherwise. This classification is the result of cross-classifying the outcome variable, y, with a dichotomous variable whose values are derived from the estimated logistic probabilities. In this approach, estimated probabilities are used to predict group membership. They say that, if the model predicts group membership accurately according to some criteria, then this is thought to provide evidence that the model fits.

Age of the household head: Age of the respondents was hypothesized that, it has a negative relationship with the dependent variable. The result of the model shows that, age has negatively affected the dependent variable at 10% significance level. Other thing held constant, the odds ratio in favor of farmers' innovative increase by a factor of 0.94. One year increase in age of household would cause the level of farmers innovativeness decrease. The possible justification is that as the household get old might reduce trust towards new technology including maize innovation. Hence, also elder farmers tend to be risk averse and may avoid innovations in an attempt to avoid risk associated with the initiative, because some of the technologies to be used, sunk costs have to be incurred .The result of the study is in line with the study of, petrous *et al*, (2010), Teshome, (2011) and Tewodrose, (2016) reported that younger farmers more likely to innovated.

Education level: The model result also reported that household head education level was found to be positively and significantly related with farmers' innovativeness at 1% probability level. This indicates the educated farmers were more access to information capable to interpret and analyze the information and become aware of new technology from that of non-educated farmers and this awareness enhancing them for innovativeness. In other words, other things held constant, the odds ratio in favor of the farmers innovativeness increase by a factor of 1.407 as education level increase by one grade. This result was in consistent with (Lavison, 2013;

Bayissa, 2014; Leake and Adam, 2015) reported that having education increases the probability of farmers to participate on agricultural innovation.

Farm experience: In this study farm experience of the household head was found to be positively related with farmers' innovativeness on maize production and statistically significant at 5% probability level. This indicates that respondents with higher farm experience are more likely to be innovative farmers than respondents with low farm experience. The implication is that having the cumulative experience on farming will enable farmers to have better knowledge about agricultural activities and to understand its requirements to develop which in turn may be the basis for innovativeness. Other things kept same; as farm experience increase by one year, the odds ratio in favor of farmers' innovativeness increase by a factor of 1.088. This study finding is in line with the findings of (Nielsen, 2001; Waters-Bayer, 2014 and Nasr *et al.,* 2017) which acknowledge significant association between farm experience and innovativeness.

Extension contact: As hypothesized frequency of farmers, extension contact with agricultural extension agents had positive and significant influence with farmers' innovativeness at 1% probability level. The result of the model shows that other things held constant the odds ratio in favor of farmers' innovativeness increase by a factor of 1.750 as the frequency of extension contact increases by one unit (one day). The possible justification is that frequent contacts, create awareness and build the necessary knowledge for using the improved new technologies and enhancing the exposure of innovativeness. Previous study by (yaregal 2011; Kudi *et al*. 2011 and Idrisa *et al*., 2012) also argued that farmers with more information through frequent contacts with extension agents are more likely to participating in agricultural innovation system.

Livestock holdings: The positively significant result of the model, at probability level of 1%, witnessed that respondents with large number of livestock are more likely to be innovative farmers than respondents with small number of livestock. The implication is that owners of large livestock are often rich, have access to more resources including information and can better afford risk. In addition, to this livestock husbandry practices have a stronger integration with cropping activities with mutual benefit. Thus, investment in livestock will be paralleled by changes in cropping practices and vice versa. Other things held constant, the odds ratio, in favor of farmers' innovativeness, increases by a factor of 1.361 as the number of livestock owned

increases by one TLU unit. This result is in consistent with the findings of (waters-Bayer *et al* and Amsalu, 2008).

Farm size: Farm size was hypothesized to influence farmers' innovativeness positively. From the result of these findings, farm size was found to be statistically significantly and positively related with farmers' innovativeness at 1% probability level. This indicates that household those who have large farm size are more likely to be innovative farmers than households who have less farm lands. The result in (Table 10) shows as farm size of the household increase by one unit the farmers' innovativeness increases by a factor of 2.454. This implies that households who have large cultivated farm size are more likely to be innovative farmers while compared with farmers who have a small land size. The result is in line with prior expectations and with the finding of (Yohannes, 2001; Amsalu, 2008) having large farm size increase the level of farmers' innovativeness.

Mass-media exposure: Mass-media plays a great role in creating awareness about new technology with regard to framers' innovativeness. It was treated with respect to two type of medium the access to listening Radio and Watching TV. According to the result of the model indicated that access to mass-media exposure was found to be positively and significantly influence farmers' innovativeness on maize production at less than 1% probability level.

This result witness that as farmer exposure to the mass-media more frequently is more likely to be innovators than farmers who access less frequency. Other things held constant, as odds ratio in favor of farmers' innovativeness increase by a factor of 8.281 and the level of farmers' access to several media will also increase. This result was in line with the finding of (Reij and Waters-Bayere, 2014; Nasr *et al.*, 2017) in their study on "A bridge between local innovation, development and research: the regional radio of Gafsa, Tunisia".

Table 9 : Results of binary logistic regression

Variables	Coef.	Odds Ratio	Z	P>z
Age of the HHs	-.0515327	0.9497725	-1.74*	0.081
Sex of the HHs	.6322508	1.881841	0.74^{NS}	0.457
Family size	-.1013256	.9036388	-1.03 ^{NS}	0.305
Education levels	.3415437	1.407118	3.05***	0.002
Attitude towards agriculture	.4278874	1.534013	1.00 ^{NS}	0.318
Farm experience	.0843491	1.088009	2.82***	0.005
Extension contact	.5596993	1.750146	2.36**	0.018
Livestock holding	.3089012	1.361928	3.20***	0.001
Social participation	.2589754	1.295602	0.55 ^{NS}	0.580
Off/non-farm income	-.0674297	.9347935	-0.15 ^{NS}	0.880
Credit utilization	.0648969	1.067049	0.14 ^{NS}	0.887
Exposure to other area	-.081186	.9220221	-0.17 ^{NS}	0.863
Farm size of the HHs	.8979374	2.454535	3.74***	0.000
Mass media exposure	2.114	8.281301	4.18***	0.000
Constant	.000089	0023406	-3.63	0.000

Pseudo R^2 = 0.4268	Log likelihood = -72.5
LR chi^2 (14) = 107.97	Number of observed = 188
Prob > chi^2 = 0.0000	

Source: model output, 2019,*, ***and****, is significant level at 10%, 5%and 1% respectively; HH: Household; NS: not significant.*

4.2 The Degree of Farmers' Innovativeness on Maize Production

These studies try to identify the degree of farmers' innovativeness on maize production in four specific categories. These are: (i) developing new techniques or practices related to maize production, (ii) adding value or modifying indigenous or traditional maize agronomic practices, (iii) introduce or adapting external techniques in to local conditions of farming systems, and (iv) informal experimentation related to maize cultivation (Joachim *et.al* 2015). Thus, innovator farmers are those farm households who have implemented any of these four categories of innovation-generating activities during the last 12 months prior to the survey

To support quantitative data which were obtained from household survey regarding to the existed status of farmers' innovativeness on maize production, FDG and key informant interviews were conducted with DAs, SMS, progressive farmers and local leaders. Then after, multiple type of maize agronomic practices were assembled together based on the above four criteria of innovativeness to see the degree of farmers involvement on those best agronomic practices. On the other hands, free option was given to the respondents to choice their alternatives among the listed maize agronomic practices to see the percentage and frequency of farmers' innovativeness in each maize agronomic practice. The results were presented in Table, 10 below.

Table 10: Maize agronomic practice in which farmers have participated and innovated (Multiple Response)

Agronomic practices	Frequency (109)		Percentage (%)	
	Yes	No	Yes	No
Introducing new crop varieties	53	56	48.6	51.4
Plant spacing	59	50	54.1	45.9
Crop rotation	98	11	89.9	10.1
Weed control	99	10	90.8	9.2
Experimentation	58	51	53.2	46.8
Disease and pest control	63	46	57.8	42.2
Post-harvest handling	64	45	58.7	41.3

Source: Own survey, 2019

4.2.1. The types of maize agronomic practice in which farmers innovated

Table 10, above revealed the agronomic practices of innovative sampled households, such as introducing new crop varieties, applying plant spacing, crop rotation, weed management, conducting experimentation, disease and pest control and post-harvest handling practices. Among the total innovator sampled households (48.6%) were involved in introducing new crop varieties in the study area. On the other hand, 54.1% of the respondents were involved in plant spacing. Regarding the farmers' innovativeness related to crop rotation were 89.9%, about 90.8% of innovative farmers were categorized weed control practices. Likewise, about 53.2% innovator farmers' involved in plant experimentation. Similarly, 57.8% of the respondents participated on disease/pest control mechanisms and 58.7% were also involved post-harvest handling into their own farm. The finding of this study was in line with the result of Amsalu *et al* (2008) who found that, crop production practices as the most common farmer's innovativeness in the Southern Nations Nationalities and Peoples (SNNP).

Introduce new maize crop varieties in to the local area: One of the features of innovative farmers' to ask their friends and to detect their surroundings attentively hoping to get new ideas, new ways of doing things, etc. when continuously doing this, they were finding some new ideas or new ways of doing things and felt like to try to find whether it's suitable to their specific situation or to see if relevant to solve their specific problem.

The survey result presented in table 10, shows that among total innovator farmers interviewed, 48.6% of them introduced new varieties of maize crop brought to other areas which are suitable to the agro-ecological and adapted to their farms. Accordingly, different varieties of maize crop such as "orme maize" are introduced by many farmers. Among those farmer Ato Tijane was one of innovator farmer in the Limu Seka district and *Yedo kebele* once upon a time he went to west Welega zone to visit his wife's family and he have seen the local varieties of maize, which was called "*Orome*" the maize as very productive and it takes three cobs per stalk, then after he took the seed and brought to his existing areas. Now many farmers even from the neighboring PAs have taken the seed from him and have grown in their fields.

Plant spacing: The data presented in table 10, indicted that 51.1% of innovative farmers were participated and innovated with regards to plant spacing. Among those farmers Ato Mustafa Jebal was one of innovative farmers who live in *Murkuz Kebele.* As the district agricultural and natural office reported that he was one of active and innovative farmers to receive new agricultural technology and adopt on his farm due to this he is recognized at the regional level in medallion premium. Accordingly, once up the time he wants to review his farming practices in order to determine which methods are working and which are not then after, he develops new maize sowing practice to obtain maximum maize production. When growing maize he found that the planting method which is recommended by the development agent -25cm between plants with one plant per station was not as efficient in large farmland as in as smaller pilots. As he reported in large areas the 25cm spacing worked well in the first few rows of his field, but in the middle was light scarce the maize was thinner and of poorly quality. Then after he developed new ways of plant spacing and he decided to try planting his maize at 30cm apart with one plant per station instead of the recommended 25cm. Finally, Ato Mustafa using this method found that there is more space and light for the maize plants and his maize was healthier and more productive. Within 25cm spacing the plant produced 1-2 cobs per stalk (through the second cob would be very small and often poorly developed) but within 30cm spacing he gets 2-3 good quality cobs per stalk and increases in yield achieved though the increased spacing to compensate the reduced plant population and also this right spacing ensure good crop growth, make it easier to weed and reduces the spread of pests and diseases.

***Crop rotation*:** Crop rotation is a practice of growing different crop one after another on the same piece of land season after season or year after year. It is available traditional practice in the study area which plays an important role in maintaining ecological stability and improving agricultural productivity. Data is obtained from the survey in table 10, shows that 89.9% of innovative farmers participated and innovated in crop rotation in the study area.

The rotational cropping system implemented by farmer Jamal Abba Bulgu is one of the maize agronomy practice that are recommended by farmers Ato Jamal who living in Mole *kebele* he uses maize, a leguminous crop like (Noug) *Niger seed* and *Teff* as a rotational crop. In the first year he plants *Teff*, in the second year he sows a (Noug) Niger seed and in the third year he plants maize. As a result of this best agronomy practice and innovativeness Ato Jamal could

increase his yield of maize crop and at the same time sustaining the soil fertility of the farm know a time farmers in his neighbor follow this practice and maximized their productivities.

***Weed management practice*:** Clear observation in the table 10, reveal among the total innovator farmers interviewed, 90.9% of the farmers' participated and innovated regarding to best weed management practice Ato Nura Regasa was one of the innovative farmers who live in *Yedo kebele* after good preparation of land he sow a maize with chemical fertilizer as the same date of plating according to the recommendation of development agents. But a week after the weed is growing very fast equal to the maize seed and computing food and nutrient with maize. The innovator farmer who observed the enhanced growth of the weed for the time being he decided to separate fertilizer application and sowing date of maize seed. Accordingly, he applied fertilizer to his field on the first ploughing date in the following fifteen days in which he left his field untouched then the weed got a time to grow. Then after fifteenth days the farmer ploughed-in the grown weed. This time was not sufficient enough for the weed to produce seed. On the same date he planted his maize seed. As a result of this new way of farm management, he controlled the growth of the weed in his field and increases the maize production respectively.

Experimentations: Most of the innovator farmers conduct experimentation in order to ensure food security at family level and overcome environmental challenge. But some of them conduct experimentation to see the significance of the difference in performance between researches recommended technologies and local counterparts. The (table, 10) indicated that 53.2% of farmers' innovativeness were conducting experimentation among those farmers Ato Reduwn Yesuf one of innovative farmers who are living in *Molle kebeles* once he received improved maize varieties seed from the nearest primary cooperative office. According to the recommendation development agent, he had to use chemical fertilizers and compost were the types of fertilizer he wanted to experiment to see the difference in production of the maize. On 0.175hr of lands he sowed, some amount of the maize seed with compost. On the other hands, he sowed the remaining seed on 0.25hr of land with chemical fertilizers. He did not change the recommended seed rate. When the result was seen the maize seed sown with compost compared to that of maize sown with the chemical fertilizers had good yield and the individual seed size

and structure were preferable. Even though, the yield and other characteristics of the maize sown with compost was good rather than chemical fertilizer.

Disease/pest control practices: One of the very challenging things for farmers in the study area is maize crop failure due to disease/ pest. In order to overcome these problem farmers was conducted different cultural practices by using their indigenous knowledge. The results of the survey presented in table, 10 reveal that 57.7% of farmers' innovativeness was concentrated in the area of disease control mechanisms. Among those farmers Ato Fita A/Gojam was one innovative farmer who lives in *Dego kebele* one day when he visit his maize farm it attacked by cutworms and the maize become dried. As he reported he tells the situation to extension agents, but no solution at that time. Then after he found another option he collect a wood which are called in Affan Oromo "*Bakanisa*" then smoked all around the farm during at night time for three days. Finally, when he observed his farm in the next days the cutworms become dead due to the smoke and the maize crop was re-generated and given good yield. Even though, farmers in the neighbors are taking his best practice from this innovator farmer and save their maize farm from such worms.

4.2.1 Farmers' reason for innovativeness

There are many stimuli that motivating or trigger that farmers' innovativeness. Population pressure limited natural resources bass appears to be an important for innovating and inverting on maize crop production. (Waters-Bayer *et al*, 2001).

During data collection to know the motivational factor of farmers' innovativeness asked the question why you innovative and participated on maize production. As already presented in the (Figure, 7) about 39.44% of the innovator farmers were triggered to innovate to improve food security of the households. The results of the survey further show that the reason to innovate for 38.3% of the innovator farmers was to increase household income. Observation elsewhere of innovations also triggered 4.5% of the respondents and similarly, 11.1% of them were multiple reasons of as motivational factor to innovate. Furthermore, 6.5% of the respondents were reported that they are influenced by extension agents to innovate.

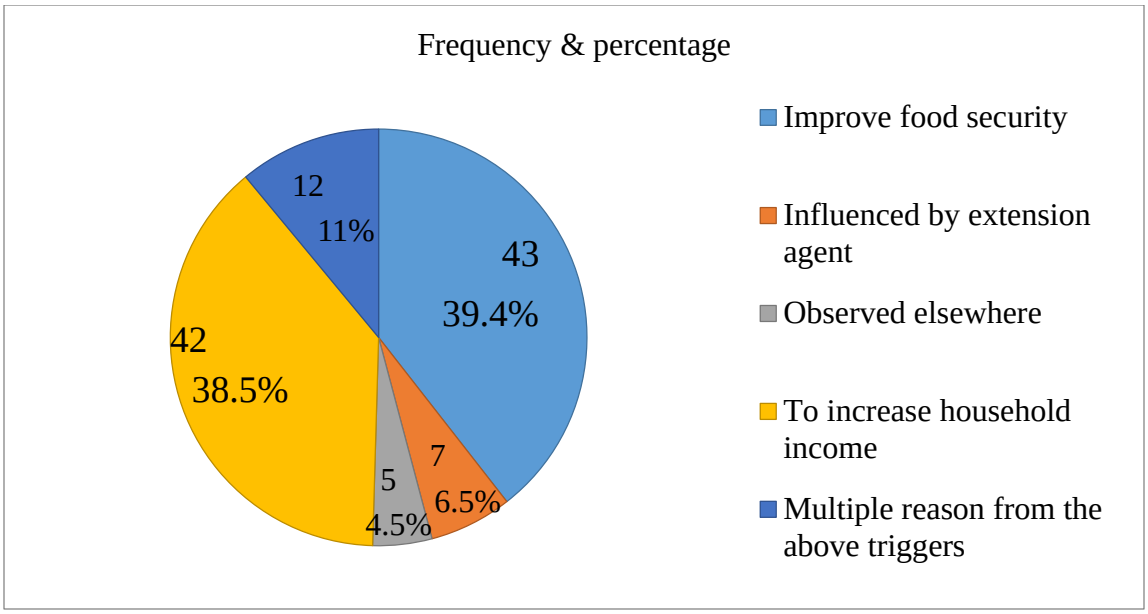

Figure 7: Motivation to innovate as expressed by the respondent

Source: Own survey, 2019

4.3 Challenge and Opportunities of Farmers' Innovativeness on Maize Production

In this sub-section the major challenges of farmers' innovativeness in the study area were identified and discussed. In order to prioritize the major challenges focus group discussions and key informant interviews were conducted in all sampled *kebeles* with innovative farmers, SMS, extension agents and local leaders. So all the findings of the qualitative data were further discussed blows.

4.3.1 Major challenges of farmers' innovativeness

The major challenges which arose during data collection by the respondents were listed and also ranked by using the systematic ranking index. Among those challenges which are mentioned at the time of discussion: poor extension delivery system, weak linkage among various actors, prevalence of disease/pest on maize production, financial shortage to use technology , high price inputs and the maize grain marketing system were ranked one another . In ranking index all respondents were equal chance to rank their alternative uses because respondents might have a chance of choosing two and more alternatives. Figure, 8 below shows that the ranking index scores of challenges of farmers' innovativeness on maize production in the study area.

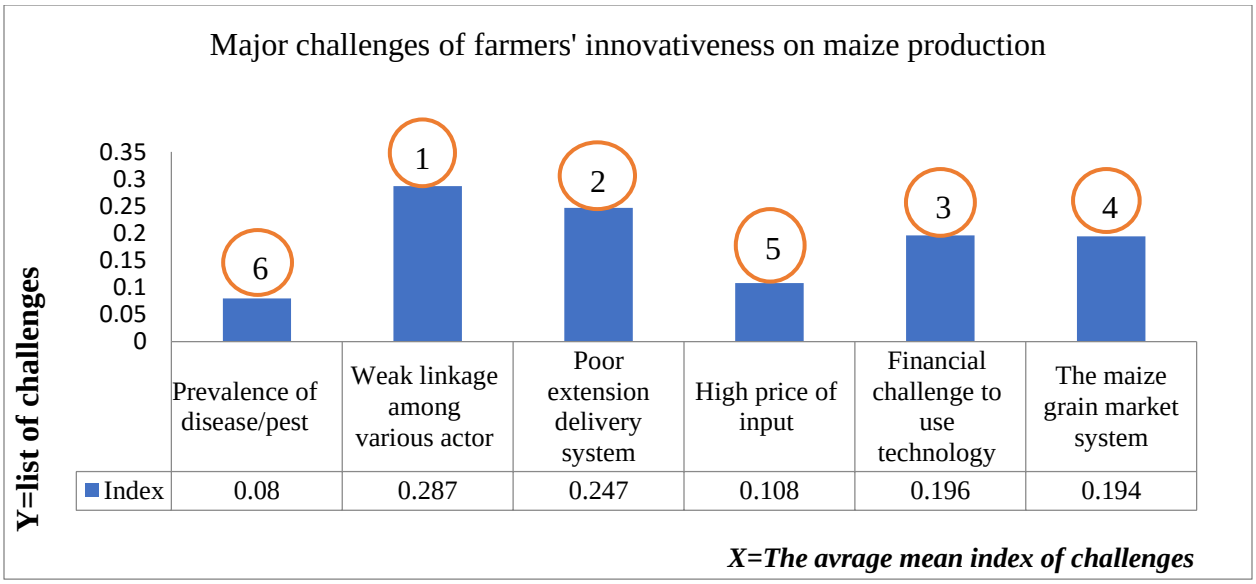

Figure 8 : Major challenges of farmers' innovativeness

Source: Own survey, 2019

The raking index which are presented in Figure, 8 above shows that, weak linkage among various actors was 1st challenge with the mean index score of (0.287), poor extension delivery system, was 2nd with mean index (0.247), financial challenge was 3rd with the mean index of (0.196), the maize grain marketing system was 4th with the index of (0.194), high price of input was 5th with the mean index of (0.108), and prevalence of disease/pest was 6th score with the mean index of with (0.08). Finally, the overall challenge of farmers' innovativeness in the study area were ranked and discussed one by one properly under the following sub-sections.

4.3.2 Weak linkage among various actors

The result of study in (Figure, 8) and (Appendix table, 3) indicated that the challenges of farmers' innovativeness in the study area with poor relationship between the different actors working in agricultural development were not strong and it was 1st ranked with the mean index of (0.287) this weak linkage were among different actor like researchers, development agents, SMS, NGOs, input suppliers and farmers.

According to result obtained from FGD one of the reasons for the poor relationship among actors were there is no, defined goal and responsibilities between all actors, that researchers undermine extension workers for their academic status as well reluctant on their jobs to work together with

researchers on the behalf of farmers question. On the other hands, extension workers did not get attractive incentives from government and also they have not their obligations to collaborate with researchers as well as other actors and no shared goals to work for single objectives.

The data obtained from key informant interview revealed that coordination and communication for effective and efficient use of the scarce resource among the different actors was weak. Specially, coordination among knowledge institutes and agricultural offices were poorly harmonized. Agricultural research institutes, universities, district agricultural extension team and NGOs etc., were placed under different umbrellas. This placement under different ministries created problems in designing research plans and had brought inefficient use of resources and resulted in duplication of efforts hindering effective linkage among such actors. The government was established agricultural development partnership linkage advisory council (ADPLAC) to come up and work together for a common goal on behalf of farmers' question. But the ADPLAC also face a number of challenges, like financial constraints, there is no official office of chair-man and chair- man also come from other office due to this challenge most of the members of the ADPLAC they see the job as additional task. Among many key informants, one of the 31 years old male experts, from district agricultural and natural office interviewed told me about the week linkage of actors that engaged in the development process as follows:

"The working relationship between research institutes and agricultural offices is not good and attractive to work together towards a common goal to bring food security. There is complexity among the two offices. People who are working in re-search are more educated than the people who are working in the agricultural offices. But people who are working in agricultural offices are politician and have more political power than researchers. Most of the researchers are not politicians and they do not have the interest to be accountable for these politicians. So there are complexity in terms of academic status and political power. When researchers ask agricultural officers for support they do not give positive responses in most of the cases. When the research institutes call them for a meeting they do not often come to share our vision. This lack of coordination has created a gap between all actors, including our office."

The above quote was the frequently raised notion among researchers, extension workers and agricultural officers. The linkage among key actors engaged in agricultural development to bring

innovation in agriculture was poor and resulted unproductivity's among farmers' innovativeness in the district.

4.3.3 Poor extension delivery system

The result obtained from FGD presented in (figure, 8) revealed that, the extension delivery system was ranked 2nd challenges by the respondents with a mean index of (0.247). The current extension approach of the district was tied by a number of obstacles like old approach of the linear model of technology transfer, pluralistic activities of development agents and loose of several actors that participated in maize production at different levels.

The finding of the key informant interview revealed that the linear model in which researchers were engaged in the development of technology were its dissemination was left to extension workers and farmers were implements of the technology. This model neglected farmers' innovativeness only allows researchers to bring innovation in agriculture. The model created a gap between farmers, researchers and extension workers and limited the opportunity for farmers to get knowledge and skills on technology development and implementations from researchers. This linear model of extension system limited the chance of researchers to engage farmers' innovativeness on maize production. In this model, agricultural office or the extension office was in between both researchers and farmers. Among key informant interviewed, one of 35 years old male key informant an expert and researcher from research center told me, the major challenges hindering the linkage of researchers with farmers was the linear model of technology development and transfer that placed extension office in between researchers and farmers. He stated the challenge of the existence of agricultural office between the developers and users of the technologies as follows:

"Researchers do not have a direct structure to work with farmers. Farmers are told not to give any information and work with anyone unless they come through the government structures starting from the district agricultural office to the village level. Getting permission from this office is not simple. People who are working at different government offices are bureaucratic and they kill re-searchers' time. Some times when we go to the agricultural office for permission, it is difficult to get the concerned body since they have spent most of their time on meeting. Most of the time, I prefer not to go to this office for permission. Even sometimes, they do not show

willingness where the researchers need to conduct the research. Agricultural officers tell us to go somewhere they need. The existences of agricultural offices at different levels create obstacles for the researcher to work where and when the researcher needs to work with farmers."

The above quote was mostly shared by most researchers, agricultural officers, extension workers and farmers in the study areas. Researchers were engaged mostly in technology development that had little relevance to farmers need. The development workers were given a number of activities from the government besides technology transfer to farmers for implementation. They were engaged in non-extension activities like tax collection, teaching the ruling party politics and organizing farmers. Extension workers were busy with government assignment and they did not have sufficient time to properly support and motivated farmers' innovativeness through the frequent extension delivery system. There was high attention diffusion of development workers since they were engaged in both extension and non-extension activities. Moreover, development workers got low payment and there were no incentive systems to encourage them.

4.3.4 Financial challenge to use technology

The research findings show that the financial problems that limited farmers' opportunities to use agricultural technologies to improve their lives. The use of technologies like fertilizers, improved seeds, breeds, and pesticides were limited due to lack of sufficient money to purchase the technologies. Moreover, the prices of technologies were high and unaffordable to farmers'. There was no subsidy for the use of these technologies. Farmers did not have good access to credit institutions in the study areas. Additionally, farmers that had the capacity to purchase the technologies did not have sufficient knowledge and skills to use the technologies properly to get the maximum yield. Due to this, challenges the yield on maize production decrease year to year. All these challenge hindered the poor linkage of innovative farmers with input suppliers critically reduced the motivation of farmers' innovativeness in maize production.

The works of (Abate *et al.*, 2011) beautifully showed that financial availability to farmers critically affects the use of technologies to increase their output. Farmers that have enough money have a high chance of adopting technologies to change their lives. Resource poor farmers have little opportunity to use modern technologies and this fundamentally discourages the

farmers' innovativeness. In line with this, one of 50 years old male farmer live in the district who's included in the key informant interviews stated as follows:

"*The credit system which was delivered to the farmers, though rural micro finance had a high interest rate, request to pay debit in the dry season and down payment in order of importance During the FGD discussion members of the group say to us, we asked to pay before the selling price of the grain rises coupled with the stated high price of input creates serious and shocking problems to the farmers which forced them to sale their livestock (including oxen) and other belongings."*

The above quoted was mostly shared by development agents SMS and elders in the study area. This all challenges are affected farmers' innovativeness to success in their engagements in agricultural innovation.

4.3.5 The maize grain marketing system

The survey result in (figure,8) shows that the market system of the district ranked as the 4th challenge with the raking index of (0.194) this obviously indicated that most of the farmers in the district suffer from absence of the market in the near. The growth of stallholder farming can help the rural households to raise their incomes and reducing the cost of food expenditure (Salami, 2010). The production of maize by households may not be for the aim of household consumption requirement only. The maize grain market is characterized by seasonal and yearly price fluctuations. Right after the harvest season maize grain prices are lower because of a relatively large supply. However, data obtained from FGD shows that farmers are obliged to sell grains at an early time after the harvest due to storage problems and early request for tax and debt payments. Market information and transport problems are also limiting factors to farmers for not selling at a better price. As maize is the most susceptible of the cereals to post harvest loss research and extension support in terms of generating and disseminating affordable storage technologies could play an important role in assisting farmers to store grains. The study also reviles that also the maize marketing system of the area is also challenged by transportation problems as a result of poor road networks. The predominantly used means of grain transport to market are pack animals and human beings. This affects the volume of grain that can be transported to market in search of better prices. Farmers' Cooperatives buy maize from their

members at a 10 % premium price and sell to Cooperative Unions after storing for some time. However, this practice does not favor those farmers who are not members of the Cooperatives. Even those who are members do not have a sense of ownership to their cooperatives as a result of lack of transparency, and the irregularity and usually absence of dividend sharing.

Farmers were may wish to raise their income by selling maize production in the available markets. Data obtained from the focus group discussion show that most of maize producer farmers in the study area were complaining about the fluctuation of the nearest markets. The study revealed that there was no uniform price for maize grain since farmers sold their production (maize) in low price. One of the key informants tells to as one bag (approximately 100 kg) of maize was sold at price of the range from 450-500 ETB in the district capital markets. Even this local price was no covering their costs of production like fertilizers, maize seed and labor costs. During FGD question raised to participants what are the main challenge of the maize grain market system. Among the respondent one the progressive male farmer 55 years old who live in the district told the major challenges as follows*:*

"The main challenge was the fluctuation of the nearest market as they reported most of the time there are no rules and regulation in marketing system the traders and brokers are decided the market as it is without the interference of local governments so since there no alternatives we are obligated to sell our maize production in low price". The other thing was a transportation problem in the district due to poor road network most of the farmers obligated to sale their maize production on local market the price of local mare also very low".

The above quote was the challenge which innovative farmers faced in the district. As many of the respondents agree with this statement the challenge was still unsolved and discouraged most of them to participate in maize production.

4.3.6 Prevalence of disease and pests

During the discussion with FDGs most farmers the area was specified the problem of disease and pest infestation on maize production at the first level. Farmers are identified a wide range of field insects, corn borer, cutworm corn leaf aphids and weevils are a common insects which affects

their maize production across all agro-ecology of the districts. Stem borers can be particularly problematic in spring and summer plantings when temperatures and insect reproduction rates are high. Grain weevils and rodents were the primary cause of post-harvest storage loses in the study area which is raised by many innovative farmers.

Maize production of the area also faced a number of challenges; most of the respondents during FGD reported that due to the favorability of the environment of the area more than disease causing three types of virus. Disease, identifying by innovative farmers, SMS, development agents and zonal agronomist is like a *sugarcane mosaic virus* (MCMV) is one of the major virus which have affected the maize production in the area. This virus was transmitted by several species of aphids it affects at early stage and makes the plant color radish and stating that reduce the production. The other very serious disease which is raised by many farmers during the FGD discussion are *Maize Lethal Necrotic Disease* (MLND) this viral disease was seen in the last three years ago. The zonal Agricultural and Natural Resources offices report show that this disease are combined infection from two types of virus: maize chlorotic mottle virus (MCMV) infected plant is short, the shows chlorotic and die at about flowing stage. The farmers try out by manual and cultural method to prevent those all disease, but due to the nature of fast spreading of the disease impossible to overcome the problem within a short period of time so it damaged large hectares of maize farm in the districts. One of 47 years old male farmer respondents who participated in FGD reported that:

"In order to control this disease/pest properly the chemical is not provided on time by the government also if it found is not recommended by the development agent because due to its effects on environmental pollution. So the farmers obligated to clear out the affected plant from their farm by hands this may take a time and disease have got enough time to speeding and damage all the production".

4.3.7 Opportunities of farmers' innovativeness in the study area

In the study area, numerous opportunities are there for maize innovator farmers. Due to these farmers in the district enough producers of maize grain and self-secure in household food security.

The district have favorable ecology of maize production: Agro-ecology of the district were favorable for crop production and gain maximum rainfall throughout the year this may create good opportunities for farmers in the district to cultivate at least three times a year and to maintain food security of the households.

Availability of knowledge sources institutions: There are different knowledge source institution nearest to the district among those Jimma Agricultural Research institutions are supported the entire district around the Jimma zone including, Limu Seka district by conducting different research which can resolve the current unfruitfulness of the farmers. Among those findings, the institutions were released seven superior improved maize varieties which are suitable to agro-ecology of the area and more productive like, BH-540; BH-543; BH-660; BH-661; 30G19;P3812W(limmu) and pool 15C7,quality protein maize (QPM) through the approval of Ethiopian national seed industry and Ethiopian institute of agricultural research (EIAR). The institution also conducting soil PH- laboratory test in order to minimize the acidity of the soil and disseminated limes in the district for incremental of the fertility of the soil.

Availability of different NGOs: The qualitative data acquired from agricultural and natural resource office show that Jimma university college of agriculture and veterinary medicine reinforced farmers in the district by offering capacity building training for development agent, SMS and model farmers. This capacity building training creates awareness and enhances farmers' innovativeness towards maize production. The JUCAVM support the district through the project (CASCAPE) Capacity building for scaling up of evidence based best practices in agricultural production in Ethiopia this may create a number of opportunities for farmers in the district by introducing different technology like bio-fertilizer, improved soya bean varieties and establishing an experience sharing program, farmers filed day, through scaling up best practices to increase the knowledge of farmers towards new technology. Even though, the majority of the

farmers benefited from this program and increase their food security of households and ensuring environmental sustainability. The other important thing the district had agricultural growth program /AGP/ fund through this project the district were rehabilitated and equipped farmers training center FTC and constructed road network and reducing unemployment. This opportunity helped farmers access to markets, health center and agricultural technology at the nearest.

Availability of enough experts: Data acquired from the district agriculture and natural resource office shows that there are 40, development agent and 20 subject matter specialist (SMS) were employed in all rural kebele of the district this means one or two DAs are available in each *kebele* and they are advising the farmers to increase their productivity through existed extension approach.

The initiative of government to access all kebeles through road network: The local government was working on better infrastructure facilities to address all the district kebeles through effective road network. This initiation may create for farmers' market opportunity to transport easily their maize crop in the district market in order to fetch better price.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The agricultural development actors will be able to make important contribution only for farmers' innovativeness if their roles are well redefined. With their changed role they will be able to appreciate farmers' knowledge and creativity capacities and they are preparing themselves to work together with farmers on the basis of equal partnership in their fields on questions that farmers are trying to investigate themselves.

The study was conducted to understand the status farmers' innovativeness on maize production Jimma Zone Limu in Seka district Oromia Regional Sate. The objectives of this were to analyze factors that affect farmers' innovativeness on maize production, to assess the degree of farmers' innovativeness on maize production and to explore the challenges and opportunities of farmers' innovativeness on maize production in the study area.

In the present investigation primary date were collected from 188 purposively and randomly selected household headed through personal interview by well-trained enumerators though pre-tested interview schedule, FGD and key informant interview. The secondary data were collected from literature, journal and numerous concerned district and zonal sources supplement the data obtained from the survey.

Data were analyzed and presented quantitatively using different statistical tools such as percentage, frequency, Chi-square test (for dummy/discrete variables) and (t-test or continuous variable). The binary logistic model was used to estimate the effect of hypothesized independent variables on the dependent variable.

The result is obtained from FGD and key informant interview showed that the farmers' innovativeness on maize production of the district faced a number of challenges like the prevalence of disease/pest, the maize grain marketing system, weak linkage among actors, financial shortage and poor extension delivery system etc. Specially, the linkage among various actors involved in agricultural sector like researcher, development agent, input supplier, universities and district office of agriculture were very weak. The initiation of the government to

strengthen those actors to work a common goal also unsatisfactory and also attention were not given to enhance the capacity of farmers'. Thus, only farmers obligated to go with the conventional approach that adoption of research brought technology on their farm. So this all mention challenge needs policy issue in order to ensure food security of the district.

The descriptive statistics analysis shows that from the total 14 variables 11 of them shows statistically significant difference among both categories that innovators and non-innovators at 1% and 5% and 10% probability level. The descriptive analysis further shows that household's personal and demographic factors, age, farm experience and education level were found to be significantly related to farmers' innovativeness on maize production.

The data analysis also showed that, household's economic related variables are the other important factors which influence farmers' innovativeness on maize production. The overall farm size, livestock holdings were found to have a positive and significant relationship with farmers' innovativeness on maize production.

With regards to household's socio-psychological variables, the non-innovator groups were moderately better participation in social organization as compared to innovator group. These indicated that social participation was found to have positive and significantly related with farmers' innovativeness on maize production.

The data confirmed that, regarding to frequency of extension contact among both category the innovator groups have comparatively high frequency of extension contact with extension agent. In addition, the participation of both categories of farmers to different extension events was very nice. Thus, showed that frequency of extension contact with extension agent was found to have positively and significantly relationship with farmers' innovativeness.

The result of the binary logit model indicated that among the total of 14 explanatory variables were included in the model and 7 variables were found a statistically significant difference in both categories with farmers' innovativeness at 1%, 5% and 10% probability level. Accordingly, age, of the household's, education level, farm experience, farm size, livestock holding and mass-media exposure had positive and significant influence with farmers' innovativeness. Contrary to

this, family size of respondents, sex, attitude towards agriculture, social participation, access to credit, off/non-farm and exposed to other area, had shown negative and not significant relationship with farmers' innovativeness on maize production.

5.2 Conclusion

Generally the findings of the study exposed that there is a positive and significant relationship between farmers' innovativeness on maize production, age of household head, education level, farm experience, extension contact, livestock holdings, farm size and mass-media exposure. To exploit the district crop production potentially were fully achieved by capacitating of farmers competence towards innovativeness through suitable measurements of in this finding.

Therefore, taking measurements to strengthen the innovative capacity of farmers needs appropriate intervention for attending agricultural transformation in Ethiopia. The measure may particularly focus on the above mentioned factors which should positively and significantly affect the farmers' innovativeness on maize production.

On the other hands, this study reveals that the major challenges and opportunities of farmers' innovativeness on maize production like weak linkage among various actors, poor extension delivery system, financial constraints, pest/disease and the maize grain marketing system are identified during FGD discussion, so it is expected from the government provide good infrastructure as well as a favorable market system through good extension approach for farmers in the district.

5.3 Recommendation

Based on the empirical finding of the study the following recommendations are suggested to consider in the future intervention strategies which are aimed to promote farmers' innovativeness.

- The study dictated that farmers' innovativeness on maize production of the district faced a number of challenges, like weak linkage among various actors, maize marketing system, and poor extension delivery system. Due to this major challenge maize production was

declined year by year. So the local governments work on a better road networking and affordable post-harvest technologies to prevent disease/pests and also should create a favorable environment to involve private sectors agro-processing of maize grown in order to help farmers fetch better grain price.

- Age of household head had a negative and significant effect on farmers' innovativeness on maize production. Therefore, stakeholders in the study area, including the district offices of agriculture and agricultural experts need to arrange experience sharing and provision of short-term training programs so as to create awareness among older farmers.
- Education was found to be positive and significant influence farmers' innovativeness. The diffusion of technology thus, needed to be facilitated through educating farmers to be used as contact farmers so that they can use the available inputs more efficiently under the existing technology. Besides, the district office of education needs to strengthen adult education programmers to change farmers' attitudes towards new technologies.
- Farm experience increases probability of farmers' innovativeness on maize production. This indicates that as farm experience get increases the household acquires new information, know the benefits of new technologies and develop confidence to use improved technologies. Thus, concerned bodies need to give emphasis to involve farmers to exercise and use new technologies through demonstration, training and field days. Besides, development agents, local leaders and other participants should create the room for experience sharing among farmers regarding the importance of innovativeness.
- Frequency of extension contact has positively and significantly influenced farmers' innovativeness. Thus, the extension system operating in the areas and elsewhere, need to be strengthened further to increase the flow of information for rural development. Participatory community based approaches involving all stakeholders and actors in planning and implementation are necessary in order to create a higher ownership attitude. So it is expected from the government clear messages should be included regarding to agricultural innovation system in the normal extension packages.
- The livestock owned has a significant positive impact on farmers' innovativeness on maize production. This study indicated the large number of livestock owned more access to technology as well as information regarding to innovation. Therefore, it is expected from the government to strengthening the existing livestock production system through

providing improved health services, better livestock feed (forage), targeted credit and adopting agro-ecologically based high-yielding breeds and disseminating artificial insemination in the areas.

- Farm size also positive and significantly influence farmers' innovativeness. The result of the model revealed that most of innovative farmers had large farm size from that of non-innovator farmers this may help them to conduct different experiments in order to maximize maize productivity. Therefore, the local government and NGO should be emphasized on farmers with large farm size through facilitating opportunity to access more land in the form of land renting and contracting.
- As seen on the above model result mass media exposure has a positive and significant relationship with farmer's innovativeness on maize production system. Based up on this reality the government should take an appropriate measure to establish relevant mass media and increase their accessibility by the farmers.

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7. APPENDIXES

7.1 List of Table in the Appendixes

Appendix Table 1: Conversion Factors used to compute man equivalent (Labor force)

Age group(year)	Male	Female
Less than 10	0.0	0.0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
Greater than 50	0.7	0.5

Source: Stork, *et al..*, 1991

Appendix Table 2: Conversion factor used to estimated tropical livestock units

Animal category	TTLU	Animal category	TTLU
Calf	0.25	Donkey (young)	0.35
Weaned calf	0.34	Sheep and Goat (adult)	0.13
Heifer	0.75	Sheep and Goat (young)	0.06
Cow and Ox	1.00	Chicken	0.013
Horse	1.10		
Donkey (adult)	0.70		

Source: Stork, *et al*., 1991

Appendix Table 3: Major challenges of farmers' innovativeness on maize production

List of challenge	Rank of respondents						Total	Index	Rank
	1st	2nd	3rd	4th	5th	6th			
High price for input	12	32	5	12	0	0	61	0.080	6
Week coordination among various actors	56	45	34	0	17	22	218	0.287	1
poor extension adversary system	44	55	13	12	34	13	187	0.247	2
Prevalence of disease/pest	30	15	0	0	0	13	82	0.108	5
Financial problem	34	25	17	42	18	0	149	0.196	3
The maize grain market system	55	43	18	17	23	9	147	0.194	4
Total	216	125	83	83	92	57	757	1	

Source: own survey data, 2019

Appendix table 4: Social participation and innovator category

Variables		Innovator(109)		Non-innovator(79)		Total sampled HHs (188)		x^2
		N	%	N	%	N	%	
Part.in social organization	Yes	74	67.9	31	39.3	104	55.8	15.608***
	No	35	32.1	48	60.7	83	44.2	
IDIR	Member	83	76.1	63	79.7	146	77.7	
	Committee	16	14.7	10	12.7	26	13.8	
	Leader	10	9.2	6	7.6	16	8.5	
IQUB	Member	27	24.7	9	11.3	36	19.2	
	Committee	-	-	-	-	-	-	
	Leader	2	1.8	0	0	2	2	
RELEGOUSE	Member	88	80.8	72	91.2	160	85.1	
	Committee	16	14.6	3	3.7	19	10.2	
	Leader	5	4.6	4	5.1	9	4.7	

Source own survey, 2019

Appendix table 5: Results of Binary logistic regression model

FPOMIS	Odds Ratio	Std. Err.	Z	P>z	[95% Conf.	Interval]
AGEHH	0.9497725	.0280485	-1.74	0.081	.8963593	1.006369
SEX	1.881841	1.600358	0.74	0.457	.3553883	9.964671
FAMILYSZ	.9036388	.0892536	-1.03	0.305	.7445958	1.096653
EDULEVEL	1.407118	.1576201	3.05	0.002	1.129749	1.752585
ATT	1.534013	.6579739	1.00	0.318	.6618035	3.555734
FARMEXP	1.088009	.0325149	2.82	0.005	1.026111	1.15364
EXTCONT	1.750146	.4153063	2.36	0.018	1.099223	2.786524
TLU	1.361928	.1314266	3.20	0.001	1.127231	1.645491
PARTICIPAT	1.295602	.6056069	0.55	0.580	.5183129	3.238554
NONFA	.9347935	.4182483	-0.15	0.880	.3889272	2.246793
CREDIT	1.067049	.4874953	0.14	0.887	.4358147	2.612564
EXPOSTOOTHER	.9220221	.4324317	-0.17	0.863	.3677264	2.311841
LANDH	2.454535	.5894513	3.74	0.000	1.533045	3.929918
MASMEXP	8.281301	4.193103	4.18	0.000	3.069774	22.34039
Constant	.0023406	.0039048	-3.63	0.000	.000089	.0615715

Total number of observed	= 188			
		LR chi2(14)	=	107.97
		Prob > chi2	=	0.0000
Log likelihood	= -72.511575	Pseudo R2	=	0.4268

Source: own survey, 2019

Appendix table 6: Contingency coefficient for dummy variables included in the binary logit model

Variables	SEX	PARTICT	EXTCONT	CREDIT	EXPOSTR	MASMEXP	ATT
SEX	1.0000						
PARTICIPAT	-0.0675	1.0000					
EXTCONT	-0.0552	0.0740	1.0000				
CREDIT	-0.0641	-0.1329	0.0581	1.0000			
EXPOSTOOTHER	0.0692	0.1080	-0.0930	-0.1019	1.0000		
MASMEXP	0.0005	-0.0241	0.2061	-0.0988	-0.0671	1.0000	
ATT	-0.0134	0.0358	0.1135	-0.0132	-0.0373	0.0128	1.0000

Source: model result, 2019

Appendix table 7: Multi-colinearity test for continuous variables included in binary logit model

Variables	VIF
Age of the households	1.74
Farm experience	1.70
Farm size	1.16
Education level of the households	1.09
Livestock ownership	1.05
Off/Non-farm income	1.03
Family size of the households	1.01
Mean VIF	1.26

Source: model result, 2019

7.2 Appendix II

Interview schedules

Jimma University College of Agriculture and Veterinary Medicine Department of Rural Development and Agricultural Extension/specialized in Innovation and Communication/

I. Demographic Variables

1. Name of HH----------Zone----------Woreda----------Kebele ----------
2. Age (AGEHH) _____ year
3. The respondents sex (RSPSEX) 1) male 2) female
4. Marital status 1) single 2) married 3) Divorced 4) window
5. Respondents educational level _____ grade
6. How money family members do you have? (FAMILYSZ) Male------female ---- total---
7. List total family member do you have in the table below?

No	Name of family	Relation with HHs	sex	Age	AE	Education level
1						
2						
3						
4						
5						
6						

AE: Adult Equivalent, (to be calculated by the researcher).

7. How long have you been engaged in farming? **(Farm experience**) (FARMEXP)_____ Years

8**.** Do you **participate in off/non-farm income? (PRTNFA)** 1) Yes, 2) No

9. If yes**, (**tick) the type of non-farm activities you participate?

Off/non-farm income in ETB Birr in a year					Total income
Weaving	Pottery	Blacksmithing,	Carpentry,	Shopping	

II. Socio-Psychological variables

10**. Social Participation (PARTOG):** Do you participate in social organizations?

1) Yes, 2) No

11**.** If yes, in which of the following formal & informal organization(s) do you participate?

(Tick the response in the corresponding cell)

organization	Ordinary member	Committee member	Leader	Frequency of participation		
				Never (0)	Sometimes(1)	Always(2)
Idir						
Equb						
Religious group						
Cooperative						
PA council						
School council						

Leader: Chairperson of the organization, Chairperson of any committee etc.

12. Mass-media Exposure (MASMEXP)

13**.** How frequently you access and utilize these media the last years?

14. do you have Radio yes_____ No _____

(Tick the response in the corresponding cell)

Mass media	Frequency of access to these media				Frequency of utilities		
	Daily(3)	Often(2)	Sometimes(1)	Never(4)	Always(2)	Sometimes(1)	Never(0)
Radio							
Television							
Print media							
Mobile							

15. Which radio programme(s) do you listen?

1) Educational 2) Agricultural 3) Entertainment 4) any other (specify)

16 Which TV programme(s) do you watch?

1) Educational 2) Agricultural 3) Entertainment 4) any other (specify)

Attitude towards agricultural innovation (ATTAG)

17**.** To what extent do you agree on the following statement?

(Tick the response in the corresponding cell) attitude toward agricultural innovation

Statement	Degree of agreement					Compile		
	Strongly agree(1)	Agree(3)	Neutral (3)	Disagree (4)	Strongly disagree(5)	Positive	Neutral	Negative
The farmers should tray farming in the way his parent did -								
I enjoy training new ideas +								
I want to change my way of life for betterment even if little risk involved+								
The farmers fortune is in the hands of almighty God -								
I am reluctant about adapting new ways of doing things -								
I challenged by ambiguities and unsolved problem +								

- **The status of farmers' innovativeness on maize production**

18) In which of maize agronomic practices you have participate and innovate

(Tick your response under Yes or No in the corresponding cell)

	Agronomic practices	1=Yes	0=No
1	Crop rotation		
2	Experimentation		
3	Weed control		
4	Post-harvest handling		
5	Disease and pest control		
6	Plant spacing		
7	Introducing new crop varieties		

18) To what extent you participate on maize innovation

19) Did other persons (farmers) try/adopt your innovation 1) Yes, 2) No

19) What is the impact of your participation on maize innovation on yield?

1) Production increase 2) No change in production 3) Decrease in production

20) If there is no change in production or it decreases production what **added value** did your innovation brought to you?

1) Decreased drudgery of farm work

2) Suitable to farm condition when compared to other similar technologies

3) Motivated researchers

4) motivated extension workers

6) other (specify)

21) What motivated you to start participating on maize innovation?

1) Own creativity 2) Influenced by extension agent

3) Observed the innovation elsewhere 4) To provide food for home consumption

5) To increase household income 6) Land pressure

7) Labor Shortage 8) Others

22. Exposure to other areas (EXPOAREAS) Degree of contact with other areas

23. Have you ever been to other places? 1) Yes 2) No

24. If yes, where?

1) Market places 5) Other zones,

2) Woreda capital 6) Other regions,

3) Other PAs 7) Abroad,

4) Other woreda 8) Other (specify)

III. Economic Variable

26. Livestock Owen (TLU)

Livestock number	Type of Livestock										
	Cows	Oxen	sheep	Goat	poultry	donkey	butter	milk	egg	honey	other
Total in number											
Sold last year											
Price											

Land holding (LANDH)

26 Land size of the respondent _____h/r

27. from where you get the land

1) Government 2) Inherited from family 3) Rented

28. Household's **annual farm income** from sale of crops **2010/2011** E.C in quintals

Type of crop	Total production last year in quintal	Amount of consumption	Amount of sols a year	Price per quintal	Total price	Remarks
Maize						
sorghum						
Teff						
Coffee						
Wheat						
Barley						
Fruit						
Others						

IV Institutional Variables

29. Credit (CREADIT)

30. Do you get credit service? 1. Yes 2. No

31. If yes, for what purposes do use it? 1. Input (fertilizer and maize seeds) purchase 2. Improved livestock purchase 3. Purchase of farm machinery 4 others (specify) _____

32. What are the problems you face in the credit system you are exposed to? 1. High interest rate 2. Require collateral 3. Request to pay debt earlier in the dry season 4. Any other (specify)_____

33. Do you use maize production inputs (fertilizer, seeds, herbicides…)? 1. Yes 2. No

34. If yes, where do you get the inputs from? 1. Cooperatives 2. Private suppliers 3. NGOs 4. Other (specify) _____

35. How do you purchase the inputs? 1. on cash 2. On credit?

36. If on credit, where do you get the credit? 1. Cooperatives 2. Microfinance organizations

3. NGOs 4.Bank 5. Other (specify) _____

37. How do you describe the loan arrangement? 1. Smooth 2. Fairly smooth 3. Problematic

38. Extension Contact (CONTEXTA)

39 Do DAs/extension agents visit your maize farm during the growing season? 1. Yes 2. No

40. If yes, how many times do you contact with agricultural Extension agent in last cropping season year/month_____

41. Do you use research-generated technologies proposed or suggested by extension agents? 1) Yes 2) No

42.If yes what technologies and how or in what manner?

1) Improved maize varieties 2) Fertilizers 3) Improved livestock breed

II. Major challenges and opportunities of farmers' innovativeness

No	Major challenges	Rank									
		1	2	3	4	5	6	7	8	Index	Rank
1	Poor extension deliver services										
2	The credit system										
3	The maize grain marketing system										
4	Week linkage among various actor										
5	Prevalence of disease/pest										
6	Financial problem										
7	Lang pressure										
8											
	Total										

7.3 APPENDIX III- Checklist

CHECK LIST for focus group discussion /FGD/

1. What are the major challenges you face on maize innovativeness in your area?
2. Is the government giving attention for farmer's innovativeness?
3. Do get improve maize varieties on a time?
4. How frequently do Das gives advice to farmer in a year..?
5. Do you participate on training and field day visit..?
6. Is there any institution that encourages farmers' innovativeness?
7. What is the expectation from different organization related to farmers' innovativeness?
8. What are the suggestions to overcome those challenges for the futures?
9. What is the benefit you gained from innovativeness?

QUESTION FOR KEY INFORMANTS/ DAs, SMS, local leaders and model farmers /

1. what is your prospect about farmers innovativeness on maize production
2. what is your plan to scale up farmers' innovativeness throughout the district
3. what are the challenge you face on innovativeness of maize production
4. what are your suggestions to cop up this challenges
5. what are the possible strategies to improve the status of farmers' innovativeness
6. How you elaborated the linkage among actors in the study area
7. Do you share your experience to the other farmers

Thank you very much