SMALLHOLDER FARMERS' ADOPTION OF SOYBEAN PRODUCTION TECHNOLOGIES IN KONDALA DISTRICT, WEST WOLLEGA ZONE, OROMIA REGIONAL STATE OF ETHIOPIA

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Smallholder Farmers' Adoption of Soybean Production Technologies in Kondala District, West Wollega Zone, Oromia Regional State of Ethiopia

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We, the undersigned, member of the Board of Examiners of the final open defense by **Mulu Kaba**have read and evaluated his/her thesis entitled **"Smallholder Farmers' Adoption of Soybean Production Technologies in Kondala District, West Wallaga Zone, Oromia Regional State of Ethiopia"** and examined the candidate. This is therefore to certify that the thesis has been accept in partial fulfillment of the requirements for the degree Master of Science in Rural Development and Agricultural Extension

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DEDUCTION

This manuscript is dedicated to my wife for her unreserved eager to see my dream be true.

STATEMENT OF THE AUTHOR

First, I affirm that this thesis is the result of my authentic work and that all sources or materials used for this thesis have been accordingly acknowledged. This thesis is submitted in partial fulfillment of the requirements for M.Sc. degree at Jimma University and to be made available at the University's Library under the rules of the Library. I confidently declare that this thesis has not been submitted to any other institutions anywhere for the award of any academic degree. Brief citation from this thesis is allowable without special permission, provided that precise acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by 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 instances, however, permission must be obtained from the author.

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BILBILOGRAPHIC SKETCH

The author was born at Fargash kebele, Beghi district, (now days Kondala), west Wallaga zone of Oromia National Regional State from his father Kaba Talilla and his mother Shushe Yadata in March 1982. He started primary school (1-4) at Shoge and learned grade 5 at Geba-Dafino elementary school, 6 that Gunfi elementary school and 7-8 at Beghi junior and elementary school. After completion of primary school he joined senior secondary School and learned 9-12 at Assosa and completed high school education in 2002.After completion of high school, the author joined Chiro ATVET College nowadays (Oda Bultum University) and graduated with Diploma of Natural Resource Management on July 2,2005; and hired at Kondala district of agricultural and natural resource office. After the employment the author worked at different positions from kebele development agent to district higher agricultural expert. After eight years of experiences, the author joined Haramaya University to attend the BSC education with regular program and graduated with BSC in Rural Development and Agricultural Extension on March 4, 2016. After graduation the author then backed to Kondala district agricultural office and worked as extension team leader. The author again joined Jimma University in November 2018 to pursue a Master of Science (MSc) education in Rural Development and Agricultural Extension. The author is married and has two children.

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LISTS OF ABBRIVATIONS AND ACRONYMS

BARC	Bako Agricultural Research Center
CDI	Center for Development Innovation
CSA	Central Statistics Agency
DA	Development Agent
EIAR	Ethiopia Institute of Agricultural Research
FAO	Food and Agricultural Organization
FHH	Female House Holds
GIS	Geographical Information System
HYV	High Yield variety
IFC	International Financial Corporation
IMVs	Improved Maize Verities
ISPT	Improved Soybean Production Technologies
KDANRO	Kondala District Agriculture and Natural Resource Office
KDAO	Kondala District Administrative Office
KDEO	Kondala District Education Office
KDFEC	Kondala District Finance and Economic Corporation
KDFEPO	Kondala District Forest and Climatic Change Office
KDIAO	Kondala District Irrigation Authority
KDHO	Kondala District Health Office
KDRAO	Kondala District Road Authority Office
m.a.s.l.	meter above sea level
MARDCDDD	Ministry of Agriculture and Rural Development, Crop Development
MHH	Male House Holds
MoANR	Ministry of Agriculture and Natural Resources
PPS	Probability Proportional to Sample
SPSS	Statistical Package for Social Science
SSA	Sub Saharan Africa
UNDP	United Nations Development Program
URRAP	Urban Rural Road Access Project
ZLSAO	Zonal Labor and Social Affairs Office

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ABSTRACT

Legume crops play great role in improving households' food security and generating income for smallholder farmers. However, the yield of the crop is limited due to lack of appropriate use of production technologies that boost up production. One way of transforming agriculture isusing improved agricultural production technologies, such as high yielding seed varieties and application of fertilizer at recommended rate. Soybean is an important legume crop which has high contents of protein, vitamins and minerals. The productivity of the soybean crop at national and particularly at study area was very low. To improve such low productivity, adoption of high yielding varieties with appropriate fertilizer application was very important. This study was tried to investigate the variation among farmers on the adoption and intensity of soybean production technology in the Kondala district. Two stages sampling procedure were followed to select the sample households for the study. Four rural kebeles were selected from ten soybean producing kebeles by using simple random sampling.Primary data collected from 185 sample selected households. Both key informant interview and focus group discussions were used to generate qualitative data. In addition, secondary data were collected from relevant sources. The data have been analyzed by descriptive statisticsand the Tobit model using Statistical Package for Social Science software. Qualitative data narration were used to triangulate survey responses. The result of the descriptive statistics showed that the majority of farmers 57.3% were adopters and the remaining 42.7% were non adopters. This study also identifies soybean production technologies such as recommended seeding rate, recommended fertilizer applications, land allocation and spacing among adopters and non-adopters and there was statistical significance difference in technology usage between adopters and non-adopters. Results of the Tobit model indicated that household ages, education level, farm experience, membership in cooperatives, access to agricultural inputs, participation in non-farm activities and frequency of extension contact were positively and significantly influenced the adoption and intensity use of soybean technologies. Whereas, distance from market center showed, negative relationship with the adoption and intensity of adoption of soybean production technology. The study also investigated opportunities and challenges that hamper adoption of the soybean production technology. The overall finding of the study underlined high importance of institutional support in the areas of extension; membership in cooperatives and market to enhance adoption of improved soybean production package. Therefore, policy and development interventions should give emphasis to improvement of such institutional support so as to achieve wider adoption which increased the productivity and income of smallholder farmers.

Key words: Adoption, Ethiopia, Intensity, Oromia, Soybean technologies, Tobit.

1. INTRODUCTION

1.1. Background

The majority of the world's extremely poor people (of about 74%) live in marginal areas rely on small scale agriculture (World Bank, 2017). To meet these worlds' consumption it needs to an increase production by 60% of its productivity per year (Hennicke *et al*., 2014). Adoption of improved agricultural technologies are important for getting higher earnings and lower poverty; improves nutritional status; lower staple food prices; increased employment opportunities as well as earning income for landless laborers (Kasirye, 2010). For most of developing world, agriculture also represents the largest employment sector for rural households and is a leading contributor to national income. It is essential for inclusive development because it produces food as well as economic wealth for many of the poorest people in developing world. Agriculture also allows to improved livelihoods through better health care, education, infrastructure improvements and greater investment in environmentally sound practices (Melesse, 2018).

The most common areas of technology development and promotion for crops include introducing of new varieties as well as soil fertility management; weed and pest management; irrigation and water management (Loevinsohn *et al*., 2013). The usage of new technology is important to raise output and reduces average cost of production which in turn results in real gains in farm income (Challa, 2013). Grain legumes are the second and the largest crops in Sub Saharan Africa and produced on about 160 million hectare annually (Graham and Vance, 2003). Similarly, in Ethiopia around 1.56 million hectare of land planted to grain legumes annually and more than 2.67 million tons of production was harvested (CSA, 2015). Soybean (Glycine max (L.) is one of the grain legume and a non-native and non-staple crop to its wide range of uses as food, feed, and industrial raw material (Mohamed *et al.,* 2018). It was originated from East Asia, and was first domesticated in China in the second century (Hymowitz, 2008). Currently, about 50 countries worldwide grow soybean (Boerma and Specht, 2004).

Since the value of soybean as a high-protein food source, the utilization and consumption of soybean-based foods are becoming popular in SSA (Joubert *et al*., 2013). Food products such as soy-ogi (fortifying maize with soybean), biscuits, soy flour, soy yogurt, and soymilk have been accepted by local people in many SSA countries (Dlamini e*t al.,* 2014). Together, with other African legumes, soybeans are a productivity-enhancing crop and potentially an economically beneficial choice, especially for small and medium scale producers (Gress hoff *et al*., 2015; Kerr *et al.*, 2007). The crop is the most important due to its good chemical compositions such as carbohydrate, minerals and other components including vitamins (Dixit *et al.* 2011). Owing to that in SSA effort has played a leading role in international level to improve the productivity of soybean of smallholder farmer's from 1.1 t ha^{-1} to the world average of 2.4 t ha^{-1} in the last four decades, in rising and disseminating well-adapted varieties (Dalia *et al.*, 2018).

Soybean was first introduced to Ethiopia in 1950's because of its nutritional value, multi-purpose use such as improving food security, soil fertility improvement and recovery of row material for oil industry, and wider adaptability in different cropping systems. It also plays major role and used as protein source for resource poor farmers of Ethiopia who cannot afford animal products (Kibiru, 2018).In Ethiopia, most people, especially members of the Ethiopian Orthodox Church, consume soybean oil which is free of animal products during their fasting period. Thus soy-based oil is used as dairy alternatives and serves as good option for these people while they are fasting (Shurtleff &Aoyagi 2009). Different research had been done on soybean at Ethiopian by Institutes of Agricultural Research (EIAR, Addis Ababa), for the past 70 years (Alemu, 2011). According to the Ministry of Agriculture (2013), till 2013G.C, more than twenty soybean varieties were released by Ethiopian Agricultural Research Institute (Getahun *&*Tefera, 2016; Mesfin. & Abush, 2018).

Currently, the cultivation of soybean in Ethiopia covered 36,636 hectares of land with 812, 355 tons of production per year (Hailu& Kaleb, 2014).There are favorable climatic and soil conditions for soybean production in south and western Ethiopia which is essential both for commercial purposes as well as for subsistence farming (Sopov, 2011).From Western and South Western of Ethiopia, Oromia and Benishangul Gumuz regions account for the major production of soybean in the country, 51% and 40% respectively (Bekabil, 2015).In Benishangul Gumuz, (Metekel, Assosa, and Kemashi) zone and in Amhara region (west Gojjam and Awi) zone. In Oromia region, the top- soybean producing zones are Illubabor, Horogudru Wollega, East and West Wallaga (Mehari, 2018). Despite the significance of soybean to address food and nutrition insecurity problems prevailing in the country, little people are known about the return to investment in soybean production to promote it as a profitable business to the local community. By using recommended soybean production technologies and improving best management practice, it is possible to increase the yields of soybean from 0.5 to 2.5 tons /ha in most parts of Africa (Getahun & Tefera, 2016). In most cases, when soybean yields exceed 1.2 ton /ha, farmers are likely to make profits but at less than 0.7tons/ha farmers may not be able to recoup the cost of production (Mutegi & Zingore, 2014).

Similarly, in Kondala district soybean production started before ten years by Hararghe farmers who settled in the district through settlement program in 2003G.C. The production gradually disseminated to the all low land kebeles. Later on the production was continued by SG-2000 project, in the district for the past five years (2011-2015) for enhancing technologies and practices that have been promoted to smallholder farmers by the public extension system. The total agricultural area of the district is more than 32,000 hector of which the ten kebeles for 40% of the cultivable land is suitable for soybean production (KDANRO, 2019 unpublished). According to the district agriculture and natural resource office, the farmers produce soybeans for cash crops, meal (wet), Nifro and it is used as rotational crop for soil fertility management. The farmers of the area produce soybean variety such as Wallo, Jalale and Gishima that were introduced by SG-2000 project (KDANRO, 2019).

In the study area, in the past five years, production and area cultivated under soybean has shown as an increased trend. One of the reasons for soybean production increase is policy measures taken by the government. In spite of the intervention made so far in the country, in general and the study area in particular, the improved soybean distributed and farmer's adoption and the adopters' number is difference. The study aims to analyze why some farmers have adopted and why others have not adopted soya bean production technology. Hence, this study was designed to investigate the factors affecting the adoption of soya beans and understand the challenges that producer experienced in the soybean production technology in the study area. The result of this study was built-in in contributing to the existing body of knowledge on soybean production technology which is slight different from the previous research. This study was, therefore, conducted to examine the determinants of adoption and intensity of adoption of improved soya bean production technologies with a purpose of generating information that help understand and evaluate the key challenges to the adoption of improved soya bean in the study areas and enhance informed decision making to improve adoption of soya bean, their production and thereby increasing productivity in the study areas.

1.2. Statements of the Problem

The agricultural policy of Ethiopia gives main concern for increasing food production and decreasing malnutrition problems through the promotion of improved production technologies among smallholder farmers in the national extension package (Urgessa, 2015). Low productivity characterizes Ethiopian agriculture. The average grain yield for various crops is only about one metric ton per hectare (Byerlee, Spielman and Alemu, 2007). Utilizing improved seed and chemical fertilizers are important technological devices in all crop based farming system and they are a key factors in determining the upper limit of yield (Morris, 2007). In Ethiopia, various recent empirical studies conducted to identify determinants of adoption of soybean production technologies. For example, Emana, (2010) and Abebe (2018), focused on factors influencing adoption of agricultural technologies.

Most of adoption studies done in Africa as well as in Ethiopia focus on adoption decision of farmers and reported that location specific socio-cultural, institutional, infrastructure, demographic and communication variables significantly affect technology adoption behavior of farmers (Gelgo *et al*.,2016; Belay &Beyene 2016; Dachito &Alemu, 2017; Zemedu *et al*., 2017).While some studies in the past have attempted to access the factors behind the adoption behavior of farmers, but the adoption and diffusion of these technologies has not been satisfactorily and comprehensively assessed even at national and regional level (Dachito, & Alemu, 2017). According to global agricultural information net work 2019 report, in Ethiopia soybeans contribute nearly 10 percent to the country's total oil seed production and accountfor only 4 percent of area planted to oil seeds (Gale *et al*.,2019). Studies by Galmessa (2018) & Miruts (2016), reported that location specific socio-cultural, institutional, infrastructure, demographic and communication variables significantly affect technology adoption behavior of farmers. But they don't consider other constraints related to production such as biological (natural) and marketing constraints. A study done by Uematsu and Mishra

(2010) reported that formal education has negatively influence the adoption of genetically modified crops.

Kariyasa and Dewi (2011) and Samie*et al.*, (2009) also found that extensive of land holdings had no significant effect on adoption of agricultural technology. The other gap related to previous research was some studieswere failed to see intensity of adoption by taking only the index of land cultivated, by forgetting other technological variables such as fertilizer and improved seed (Ashenafi & Oliyad, 2020).

Kondala district is also one of the western parts of Oromia and has suitable climatic condition for soybean production. Among the 32 kebeles' of the district, 10 kebeles have favorable climatic and soil condition for production of soybean (KDANRO, 2018). Even though, farmers of the district have such favorable condition on soybean production, the practices are not known by all farm households and till now there was variation among farmers. In the study area, most of the farmers use improved varieties of soybean but less productivity and production from a given hector which was 12 quintal (KDANRO, 2018). No published empirical evidence exists in the district regarding adoption of any crop including soybean production. Hence this study focuses on the possible inter-relationships between the various practices and intensity of adoption of a package of technologies rather than a single commodity or technologies which includes seeds of high-yielding varieties, inorganic fertilizers, and land allocation. By considering those gaps and issues, this study was tried to investigate why some farmers adopt full package of the technologies and others adopt partially or not adopt at all and why productivity was less than national average. The study also identified the constraints and option for adoption decision. Thus, this study was instrumental in identifying, analyzing, and understanding demographic and socioeconomic characteristics of the sample households to inform policy decisions regarding adoption of soybean technology in Kondala district.

1. 3. Research Questions

- What are the factors that affect farmers' adoption of soybean production in the study area?

- What are the factors that influence the intensity of adoption of improved soybean technologies in the study areas?
- What are opportunities and challenges of soybean production in the study area?

1.4. Objectives of the Study

1.4.1. General objective

The general objective of the study was to analyze smallholder farmers' adoption of soybean production technologies in the study area.

1.4.2. Specific objectives

i. To analyze factors affecting adoption decision of recommended soybean production technologies in the study area;
ii. To analyze the intensity of adoption of soybean technologies by farmers in the study area;
iii. To assess opportunities and challenges of soybean production technologies in the study area.

1.5. Significance of the Study

This study was undertaken in Kondala district which is found in west Wollega zone Oromia region. There was no empirical evidence published on the adoption status of soybean production technologies and its effect on farm income of smallholders, and intensity soybean produce in the study area. Hence, this study was conveyed information on adoption soybean production technologies. It also pointed out the main factors that influence the adoption of soybean technology at farm household level. It was also help to understand why farmers continue and use full package or adopt one or two of soybean production technologies among the given packages, and what are the challenges to cultivate the full technology of soybean production. The knowledge gained was therefore, help on informing the researchers and extension agents on how to promote the use of agricultural technologies to the optimal level for high production potential.

1.6. Scope and Limitations of the Study

The study was conducted in Kondala district of west Wollega zone, Oromia regional state. This study was limited to assessing factors that affect adoption soybean production technology (new varieties of soybean, fertilizer application, land allocation and agronomic practices). One of the main constraints for this study was lack of enough and full information at district because of unavailability of organized data and unwillingness of the respondents at

peasant association level in giving reliable information. The study was focused only on smallholder farmers found in four rural kebeles that were adopters and non-adopters of soybean producers using technologies. In addition, the study was confined to only one district in terms of area coverage. Both qualitative and quantitative data were employed in this study. Both descriptive & inferential statistics and tobit econometrics model were used for analysis. As far as concerned peace and security is important for undertaking the research, peace and security problem of the area particularly the district was limited the study to carry out. The study was also limited due to lack of detail knowledge on software skill to analyze data.The limitation was overcome through made agreement with those anti-government and the limitation of soft ware was overcome through peer group discussion.

1.7. Organization of the Thesis

The first chapter introduced the background, statement of the problem, objectives, scope and limitation of the study. Chapter two presents literature review focusing on basic concepts of technology adoption, technology adoption decision theories, empherical evidences and findings that are used to identify knowledge gap in, soybean research and production technologies in Ethiopia and analytical framework. Chapter three presents research methodology, which includes description the study area, sampling procedure, methods of data collection and data analysis. In chapter four results and discussions through descriptive statistics and model output were presented. Finally, chapter five concludes the study and presents policy recommendations.

2. LITRATURE REVIEW

2.1. Definitions and Concepts of Basic Terminologies

An innovation: it is an idea, behavior, or object that is perceived as new by its audience (Almobarraz, 2007).An innovation system (IS) is a "set of all individual and organizational actors that are relevant to innovation in a particular sector or issue, their interactions and governing institutions" (Amankwah *et al.,* 2012). The goal of an innovation system is to develop, diffuse and implement innovations (Hekkert *et al.,* 2007). Innovation expands in a society through a time process since some persons adopt quickly, some do not. The time period between the times a novelty is accepted by the first person and the last person is referred as expansion of innovation (Littler & Melanthiou, 2006**).**

Technology: The term "technology" has been defined by different scholars in a variety of ways. It can be described as the integration of people, knowledge, tools and systems with the objective to improve people's lives and the means and methods of producing goods and services (Porter, 1985). Betz (2003) also defined as the means of creating new tools serving humans and their environment. It is also new to a particular place or group of farmers.

Agricultural Technology: includes both the component and process of agricultural production process like production of plant, animal breeding (including biotechnology), and introduction of new crop varieties, mechanization services, infrastructural development and other inputs(Matunhu, 2011). They also constitute the introduction and use of hybrids, the greenhouse technology, genetically modified food, chemical fertilizers, insecticides, tractors and the application of other scientific knowledge.

Diffusion is the communication process through which an innovation travels or spreads through certain channels from a person, an organization, or any unit of adoption to another within a social system over time while, communication is "a process in which participants create and share information with one another in order to reach a mutual understanding" (Rogers 2003).

Adoption: According to Lin (2011), adoption is the profitability of agricultural enterprises. By the other side it is an integration of an innovation into farmers' normal farming activities over an extended period (Feder *et al*., 1985). Adoption of a new technology is the "process by which an innovation is communicated through certain channels over time among the members of the social system" (Rogers 1983). Van den Ban and Hawkins (1996) also define technology adoption as changes that take place within the minds of an individual with regard to an innovation from the moment that he/she first becomes aware of the innovation to the final decision to continuously use it or not. By other hand it refers to a decision to make full application of an innovation as the best course of action (Rogers, 2003).

Adoption decision: According to Loevinsohn *et al*., (2013), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the range of conditions and circumstances.

Perception: it is the process that organizes and interprets by our sensory in order to give meaning about the environment. It is the set of processes by which an individual become aware of and interprets information about the environment (Atkinson & Adolphs 2005). Van den Ban and Hawkins (2004) defined perception as a process by which we receive information or stimuli from our environment and transform it into psychological awareness.

Intensity of adoption: which refers to the number of technologies practiced by the same farmer and the rate of adoption is defined as the percentage of farmers who have adopted a given technology (Negash, 2007). The number of hectares planted with improved seed (also tested as the percentage of each farm planted to improved seed) or the amount of input applied per hectare will be referred to as the intensity of adoption of the respective technologies The intensity of adoption of different technologies is measured by a variable that represents the breadth of technology use within a particular stage of production (Kenneth *et al.*, 2006).

2.2. Theoretical Framework of Innovation, Diffusion and Adoption of Agricultural Technologies and Its Process

Since Rogers' classic work on adoption, paradigms for explaining adoption decisions have revolved around three basic models: the innovation-diffusion model, the technology characteristics user's context model, and the economic constraints model. The innovation diffusion model is based directly off of the work of Rogers. The underlying assumption of the innovation-diffusion model is that the technology is technically and culturally appropriate, but the problem of adoption is one of asymmetric information and very high search cost (Feder *et al.,* 1985). The second paradigm, the adopters' perception paradigm, suggests that the perceived attributes of the technology condition adoption behavior of farmers. This means that, even with full farm household information, farmers may subjectively evaluate technology differently than scientists (Dragon,S.&Place, N.T.,2005). Therefore understanding farmers' perceptions of a given technology is crucial in the generation and diffusion of new technologies and farm household information dissemination. The economic constraint model argue that input fixity in the short run, such as access to credit, land, labor or other critical inputs limits production flexibility and conditions for technology adoption decisions.

Adoption usually starts with the recognition that a need exists and moves to searching for solutions, then to the initial decision to attempt the adoption of a solution and finally to the actual decision to attempt to proceed with the implementation of the solution (Damanpour & Schneider 2006; Wisdom, *et al.,* 2014).They characterized in the adoption process: pre-adoption (e.g., awareness of innovation), peri-adoption(e.g. continuous access to innovation information), and established adoption (e.g., adopters' commitment to the adoption decision). There is little information about de-adoption (Gallivan, 2001; Frambach & Schillewaert, 2002). Finally, just as the decision to adopt is a process, how the adoption proceeds is better characterized in terms of level, rate, or degree of adoption (Mendel *et al*., 2008).

Feder *et al*., (1985) also classified adoption as an individual (farm level) adoption and aggregate adoption. Adoption at the individual farmers' level is defined as the degree of use of new technology in long run equilibrium when the farmer has full information about the new technology and its' potential. In the context of aggregate adoption behavior, diffusion is defined as the spread of new technology within a region. This implies that aggregate adoption is measured by the aggregate level of specific new technology with a given geographical area or within the given population (Feder *et al.,* 1985).There are six basic requirements that must be satisfied in choice of agricultural technology for smallholder farmers (Suri, 2011).(Knowledge, persuasion, decision, implementation, confirmation and adoption).Thus farmer may consider feasibility criteria's which includes technical feasibility economic feasibility, social acceptability, infrastructural compatibility and complexity.

The use of agricultural innovations by farmers can be understood from the perspective of diffusion of innovations whereby innovations generated by agricultural research are passed to farmers through extension agents (Johnsen *et al.*, 2009). Thus, in this process agricultural research is the source of innovation or change and farmers are its recipients. Moreover, farmer's rationality is either adoption or rejection of innovation, which are seen as the outcome of an innovation-decision process. Innovation-Decision process describes a model for how an individual makes a choice to adopt or reject a technology. The innovation-decision process categorized in to two elements. The first one is an attitude toward the innovation, to a decision to adopt or reject, of the new idea to specified technology. The second element of the diffusion of innovations process is communication channels.

For Rogers (2003), mass media and interpersonal communication arethe two communication channels. While mass media channels include a mass medium such as TV, radio, or newspaper, interpersonal channels consist of a two-way communication between two or more individuals. Dasgupta (2001) noted that an individual may decide to discontinue the use of an innovation for a variety of personal, institutional, and social reasons one of which might be the availability of another practice that is better in satisfying farmers' needs. On the other hand, "diffusion is a very social process that involves interpersonal communication relationships" (Rogers, 2010). Thus, interpersonal channels are more powerful to create or change strong attitudes held by an individual. In interpersonal channels, the communication may have a characteristic of homophile, that is, "the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like," but the diffusion of innovations requires at least some degree of heterophile, which is "the degree to which two or more individuals who interact are different in certain attributes (Rogers, 2003).

Adoption is viewed as a variable representing behavioral changes like changes in knowledge, understanding and ability to apply technological information, changes in feeling behavior such as interest, attitude, aspiration, and values (Chiu *et al*., 2007). Technological change in agriculture comprises of introduction of high yielding variety of seeds, fertilizers, plant protection measures and irrigation. These changes in agricultural sector enhance the productivity per unit of land and bring about rapid increase in production (Tariku *et al*., 2018). Agricultural technologies are the factors of production which have undergone some form of amendment from their original state with the intent of enhancing farm household's performance (Rehman *et al*., 2016). They constitute the introduction and use of hybrids, the greenhouse technology, genetically modified food, chemical fertilizers, insecticides, tractors and the application of other scientific knowledge (Derso *et al.*, 2011). Consequently, just as the decision to adopt is a process, how the adoption proceeds is better characterized in terms of level, rate, or degree of adoption (Mendel *et al*., 2008).

The impact related to adoption is closer to implementing and estimating a complete set of risks (Barham, *et al*., 2014). The better the process of adoption can be understood; the more likely adoption challenges can be addressed thus leading to initial implementation. For Rogers, "a technology is a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome". It is composed of two parts, hardware and software. While hardware is "the tool that embodies the technology in the form of a material or physical object," software is "the information base for the tool" (Rogers, 2003). Since software (as a technological innovation) has a low level of observablity, its rate of adoption is quite slow. Rogers (2003) also explained adoption process is a decision of the full use of an innovation as the best course of action available and rejection is a decision not to adopt an innovation. Depending on the support for adoption of the innovation and the attitude of the individual, later rejection or discontinuance happens. Discontinuance may occur in two ways. First, the individual rejects the innovation to adopt a better innovation replacing it. This type of discontinuance decision is called replacement discontinuance. The other type of discontinuance decision is disenchantment /dissatisfaction/discontinuance.

There are four elements in Rogers' model of the innovation diffusion process. First, there is the *innovation*; second, there are *communication channels*. Communication is the process by which participants create and share information with one another in order to reach a mutual understanding. Third, there is the *elementof time*. The individual's decision process consists of a series of stages, from knowledge about the innovation to confirmation of its use. Then, there are differences in the relative innovativeness of individuals. For example, some individuals are "innovators" who are the first to adopt, and some are the last to adopt. Finally, there are differences in rates of adoption of different innovations. The fourth element in the diffusion process is a *social system*, that is, a set of inter-related units that are engaged in joint problem solving to accomplish a common goal (Peres *et al*., 2010). There are two major drivers of successful changing prices for agricultural products are shown to be agricultural technology in developing countries: the first one is the availability and affordability of technologies; and second one is farmer expectations that adoption will remain profitable both which determine the extent to which farmers are risk averse (Carletto *et al*., 2007).

Process of agricultural technology transfer is done through two basic stages. The first one is the transfer and dissemination of agricultural technology to farmers and the second one is to convince farmers to adopt these technologies on their farms (Friederichsen *et al.*, 2013). The decision to adopt a new technology involves five stages including: knowledge (awareness); persuasion, potentially by gaining sufficient information on the characteristics, benefits, and costs of a new technology; decision; implementation; and confirmation. To better understand the role anew technology plays, there is a need for an understanding of the adoption decision process and the important factors that could affect adoption of the technology. The adoption process starts with getting information (awareness) about the new technology, whether through media advertisement, extension agents, or social networks. This is followed by a careful review of the perceived attributes of the technology and the potential benefits and costs of acquiring the technology.After examining the characteristics and weighing the benefits, costs, and trade-offs associated with the new technology, the decision to either adopt or reject the technology, the most critical stage, is made.

Some factors including opposition, the time of introducing the technology, location of introduction, or social networks, in which the opinions of technical leaders drive adoption in most cases, could activate rejection. There could be continuing dejections of a technology over time or a decision to adopt later. If at first the potential adopter develops interest in the new technology, he or she will put it into practice, potentially with the help of experts to reduce uncertainty about the full effects of the technology. At this stage, there could be continued evaluation of the technology to ensure that it meets expectations (Ugochukwu &Phillips, 2018).This could lead to reinvention, a modification of the technology to suit individual needs. It should be noted that from the knowledge stage through implementation, the potential adopter continuously seeks more information about the technology and therefore incurs transaction costs. Adoption decisions made prior to the implementation stage of the adoption decision process could be driven by subjective judgments. After implementation and reinvention, the implementer seeks factual evidence, considering attributes of the technology (objective judgments), to support his/her adoption decision. If the implementer is satisfied, he/she would objectively adopt the technology (Ugochukwu &Phillips 2018). The process shown in figure describes the steps and/or process an individual, a farmer, a firm, or a group passes through in making a technology adoption decision.

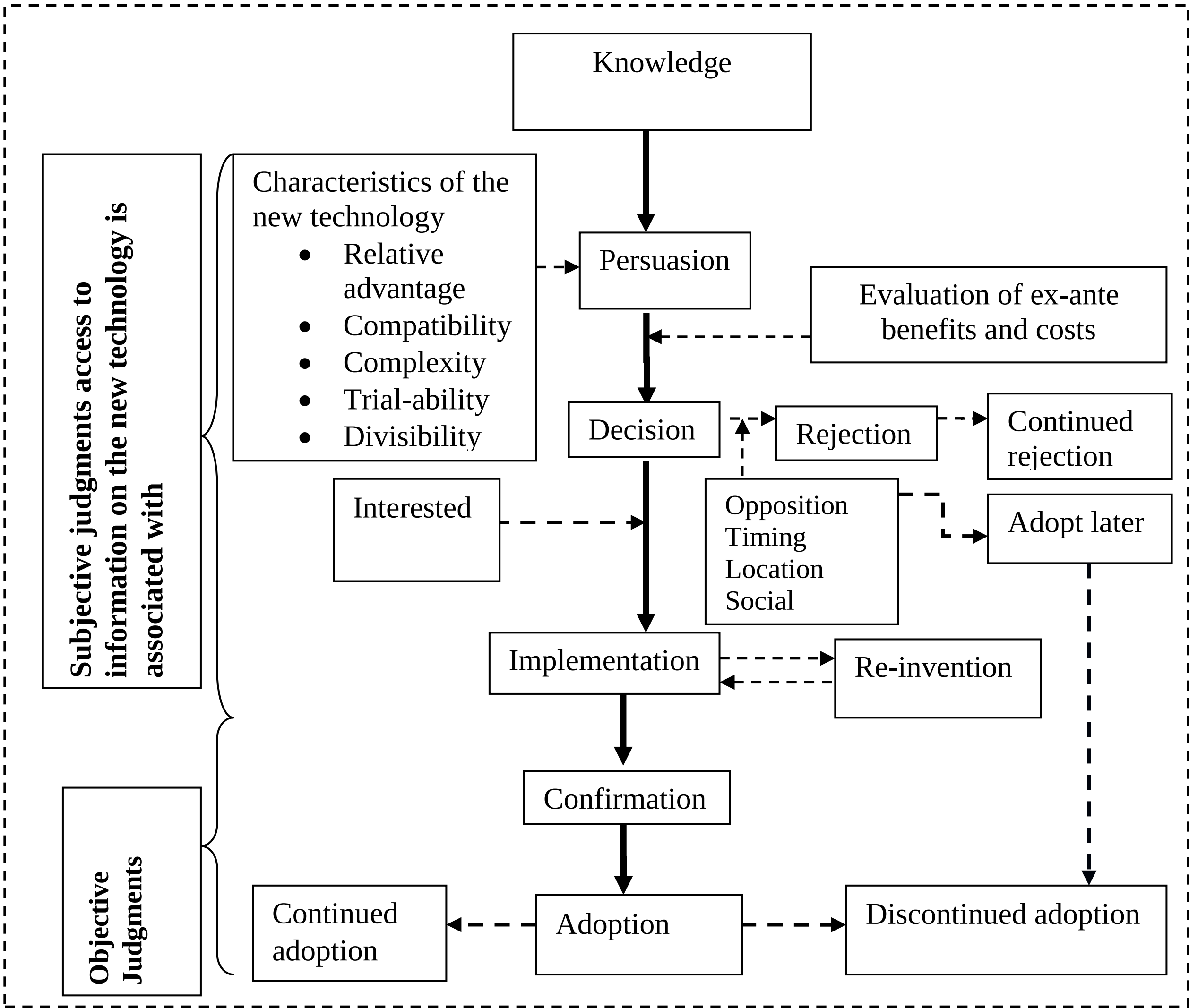

Figure 1: Model of technology adoption decision process (Taken from Albert *et al.*, 2018)

2.3. Opportunities and Challenges of Soybean Production in Ethiopia

The total area of land under the production and total volume of production of soy bean has been growing over years. It is found that the major source of increase in the total production of soy bean has been mainly resulted from increase in area of land allocated for its production. The total hectare of land under soy bean production between 2001/02 and 2011/12 has increased by 10 folds; while the total volume of soy bean production during the same period has increased by more than 21 folds. The increased hectare of land for the production of soy bean as well as increased total production during the last ten years has been resulted from increasing demand for soy bean at local and international market (CSA 2000-2011).

In Ethiopia relatively in the rural areas, a low level of understanding of a balanced diet is lack of capacity to purchase animal source proteins. Producing and consuming more soy would improve the situation as soy provides a nutritious combination of both calorie and protein intake: it is the most nutritionally rich crop, as its dry seed contains the highest protein and oil content among grain legumes (40 to 42% protein) with a good balance of the essential amino acids and has 18-20% oil on a dry seed weight basis. It is cheap and rich source of protein for poor farmers, who have less access to animal source protein, because of their low purchasing capacity (Hayilu, 2014). According to ministry of agriculture (2013), from 1982-2013 more than twenty soybean varieties were released.Oromia is one of the production area of soybean and total production obtained during 2015/6 cropping season 61,300 households and total area cultivated was 14,626.78 hectors and production obtained was 318,326.11 with productivity of 21.76 (CSA 2016).

The problems of producing soya bean is not only limited to market access but also low productivity and production, lack of processing facilities, lack of capital to increase production and no market information system for effective agricultural marketing (Bezabih 2010).Although soybean breeding and production have been going on in Ethiopia since the 1950's, it was not easy to achieve wider dissemination and production of the crop. The main limitations were lack of know-how of the local farmers on the utilization aspect of the crop, unavailability of attractive market for the produce, and lack of systematic approach in popularizing the crop, which emphasized training farmers on the production of soybean, its utilization, and market potential. Consequently, the land allotted for growing soybean in the country was limited for several years.

Previous studies (Bamire *et al*., 2002; Omolehin *et al*., 2007) indicated that in Africa, low level of contact between extension workers and farmers form one of the main reasons for low level of adoption of improved soybean technologies. Farmers in the study area depend on extension agents for information on improved agricultural technologies as well as knowledge of how to use the technologies. It will also negatively affect the likelihood of adoption of innovations and the intensity of use of the technologies. The agronomy of the crop is still complex to the respondents especially that the crop requires a great deal of precision in terms of depth of sowing, spacing, weeding requirement and the need to harvest on time so as to escape pod shattering (Ogunbameru, *et al* 2013).

The following area also major problems that are attributable to low level of soy bean production in the country. (I) The soybean scaling-up effort has not been consistent (ii) Weak market linkage between producers, processors, exporters and consumers (iii) Limited use of improved varieties,(iv) Limited knowledge in use of soy bean in cropping system (Hayilu & Kelemu, 2014). The agronomy of the crop is still complex that the crop requires a great deal of precision in terms of depth of sowing, spacing, weeding requirement and the need to harvest on time so as to escape pod shattering. A situation of low level of interaction between extension agents and farmers will retard the spread of innovations in the farming communities (Ogunbameru & Idrisa 2013).

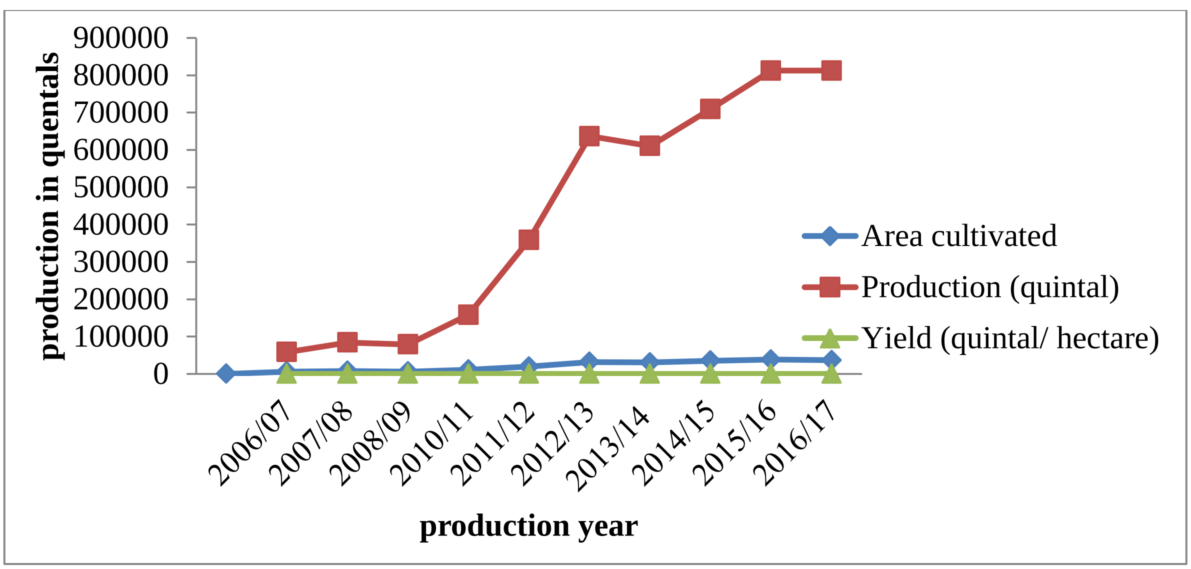

Figure 2: Area under cultivation, yield and production of soybean in Ethiopia.

(Source: CSA, (2017), CSA, (2013) and Bezabhe, (2010))

2.4. Empirical Review of Adoption of Soybean Production Technologies

Different adoption studies were undertaken by different scholars in the smallholder agricultural sector of Ethiopia. Literatures and findings of different countries show adoption of agricultural technology is influenced by a number of factors. Therefore, an empirical study reviewed from selected literatures is presented below. The most common demographic and personal characteristics that are frequently associated with adoption behavior are age, education, family size, farming experience, and household communication behaviors like information seeking behavior and others. A study by Negash (2007) on factors influencing the smallholder farmers' decision to adopt and use improved legume variety in the Southern Ethiopia using one-way ANOVA indicated that age was negatively affect technology adoption. Other studies reported that age is positive relationship between adoption behaviors of farmers (Kakuru 2019).

Previous studies (Bamire *et al*., 2002; Idrisa *et al*., 2012) indicated that in Africa, low level of contact between extension workers and farmers was one of the main reasons for low level of adoption of improved technologies. Farmers in the study area depend on extension agents for information on improved agricultural technologies as well as knowledge of how to use the technologies. Diro, *et al.*, (2017) studied factors affecting adoption and degree of adoption of soya bean in Ilu-Aba-Bora zone; southwestern Ethiopia. The study based on cross sectional data of 185 soybean producing farmers using the Logistic regression model to identify factors affecting probability of adoption, Sex, training, use of soy food at home, affected positively and significantly while age, farm size and distance to nearest market affected negatively and significantly in adoption of soya bean. The same result was found with the study of (Fufa & Hassan, 2006).

A study done by Abebe (2018) on adoption of improved soybean varieties the case of Buno Bedele and east Wollega zones of Oromia region, using probit model showed that more unit (year) increase in farmers age increases the intensity of adoption of improved soybean varieties and indicated that increase in farmer's age increases farmers' experience in farming and understanding more the benefits of the technology. The result was consistent with the findings of (Kaguongo *et al*., 2012; Tena *et al.*, 2017) and contrast to (Thomson *et al*., 2014). Dogbe *et al*., (2013**)** in Ghana, find that specifically females incurred a higher cost for hired labor related to all aspects of the soybean production practice (land preparation, planting, weeding, harvesting, threshing) than males. A study done by Gebresillase (2015), on factors influencing application of fertilizer by smallholder farmers of northern Ethiopia shows those male headed households increase the probability of being user of chemical fertilizer than their female households. This implies that being male headed household increases the probability of using fertilizer as compared to female headed households.

In most of the rural areas males have access to updated information than females, because male participates in different activities than females; this makes male headed households to have updated information about the use of fertilizer and they have an exposure to use it; in addition to this male can participate in different non-farm income as compared to females and have better income sources than females; hence male headed household has the exposure to buy and use chemical fertilizer than female headed households.

A study done by (Ogunbameru & Idrisa 2013) on empowering small-scale farmers through improved technology adoption on the case study of soybean farmers in Borno State, Nigeria using descriptive statistics indicated that, education of the household head would increase the probability of adoption of soybean technology. Other study done by Win & Chumjai (2009), on adoption of improved soybean production in northern Shan state of Myanmar also revealed that farmers possessing a high level of knowledge adopted the package technologies more than farmers with medium and low level of knowledge (Ogunbameru & Idrisa 2013). Another finding by Suleiman *et al.,* (2017), twenty-second annual conference on mainstreaming entrepreneurship in agricultural extension practice in Nigeria using multiple regression analysis show that the more educated person the more adopt the technology. This is supported with the findings of Nurudeen (2012) & Bukunmi & Yusuf (2015).

Afework & Lemma (2015) conducted a study on the determinants of improved rice varieties adoption in Fogera district of Ethiopia. The study was based on cross sectional data of 151rice producing farmers using univariate probit model on factors affecting the decision to adopt rise production. Household size, education of the household head, land, rice farming experience, access to new cultivars of rice, off-farm and income affected positively and significantly while distance to the nearest village market, access to main market, distance to access agricultural extension office affected negatively and significantly the probability of participation in improved rice cultivation. Farmers residing at a distance located closer to an FTC were found to be better adopters of rice technology packages compared to those residing at a farther distance from an FTC (Tena *et al*., 2017).

A study done by Fenta (2017), on chickpea technology adoption using tobit model showed that household size has a negative and significant effect on the probability of adoption of chemical fertilizer. This indicates that farmers who have less family size are more likely to use chemical fertilizer (DAP) on the production of chickpea crop than other farmers. A study conducted by Idrisa *et al*., (2012) reported the opposite result. This implies that the more the household members the lower the output, this may be as a result of less supply of labor or non-active participation by the younger members of the households because youths of modern days prefer white-collar jobs. The negative coefficient is consistence with findings of (Damisa *et al.,* 2007).

Labor availability is one of factors that affect technology adoption. A study done by Beshir (2014), on factors affecting the adoption and intensity of use of improved forages in north east highlands of Ethiopia using double hurdle model elaborated that labor availability positively influenced the intensity of using improved forages. This showed that improved practices are labor intensive and hence the household with relatively high labor force uses the technologies on their farm plots more than others similar signs found for other technologies .However, household size in adult equivalent negatively influenced the intensity of using improved forages. The negative and significant effect of household size on intensity of using improved forages might be related more to the land allocated for food crops and higher food requirement of the household member than to the adoption of improved forages. The studies by Bekele *et al*., (2016) confirmed the same result.

Contrary to Beshir (2014), a study done by Gebresilassie (2015), on factors influencing application of fertilizer by smallholder farmers of northern Ethiopia using tobit model showed that family size in adult-equivalent ratio affected use of chemical fertilizer positively and significantly. A unit increase in the family size in man equivalent increases the probability of use of fertilizer and it increases the level of use of fertilizer among users and the total sample size respectively. Larger farm size is associated with greater wealth and increased availability of capital, which makes investment more feasible. Hence, the impact of farm size on maize technology adoption decisions in Ethiopia is clearly positive. Mulgeta (2011) also indicated farmers with large farms have a higher probability of using mulching technology than those with smaller farms. This is because, when farmers have larger farms, they can plan different management practices for improving their land (Heyi & Mberengwa 2012). Large farm sizes also increase farmers' prospect of implementing crop rotation (Chomba, 2004).

Another study by Dawit & Abduselam (2018) on adoption and intensity of use of improved high land maize varieties in west Shoa using tobit model showed that, farm size had statistically significant effect on probability of adoption of high land maize varieties, which means that an increase in farm size increases the probability and intensity of use of improved highland maize and implies household with larger land holdings allocated more land to improved highland maize varieties production than their small land counterparts. Insufficient land area may therefore play a role in farmers' adoption of such practices. The same result was confirmed by (Gebresillase, 2015). Fabiyi (2015) studied on adoption of improved soya bean technologies in Bauchi local government area of Nigeria using multiple regression analysis showed that, house hold size and labor force affected the probability of adoption positively while processing experience was affected a negatively on adoption of improved soybean technologies.

Participation in off-farm activities is believed to have a bearing on the income of households. According to Diiro (2013), Non- farm income is expected to provide farmers with liquid capital for purchasing productivity enhancing inputs such as improved seed, machinery and fertilizers. Abebe (2011) and Legese *et al.,* (2010), found a positive association between off farm income and adoption of improved maize varieties. Thus, participation in off-farm activities had a positive influence on the intensity of fertilizer use technology. A study done by Eba, and Bashargo (2014),using Tobit model indicated that participation in off-farm activities increases the intensity use of fertilizer. Additional income earned through participation in these activities improves farmers' financial capacity and increases the ability to adopt new technology. It is observed that farmers with off-farm income are more likely to adopt improved maize varieties than farmers without sources of off-farm income (Kassa *et al*., 2017).

Farming experience can generate confidence in adopting new technology, because farmer with more experience can become more or less risk averse in judging new technology (Owusu 2013). Contrary to this Odendo e*t al.,* (2011) found that farming experience retards the uptake of new technology. Farmers with long farming experience takes longer time to assess the potential of new technology before making the uptake decisions based on past experiences with new practices. Livestock is considered as an asset that could be used either in the production process or in exchange (Beshir, 2014). It was also found to have a positive relationship with manure application. A study done by Gedefa (2016) on showed that adoption and cost benefit analysis of sesame technology in drought prone areas of Ethiopia farmer who has more number livestock will be more likely to adopt improved sesame varieties. This may be due to relatively having more livestock offer a means for a better propensity to buy improved sesame seed and also farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with the adoption of improved sesame varieties. Owing to the fact that animal manure is bulky and less transportable it is more supply driven than demand driven. As such, households with more animals will also have more manure and will in turn be more likely to use animal manure in their farms (Snyder *et al*., 2014).

Institutional factors deal with the extent or degree to which institutions impact on technology adoption by smallholders. Institutions include all the services to agricultural development, such as finance, insurance and information dissemination and mechanisms that enhance farmers' access to productive inputs and product markets (Melesse, 2018). A study by Abebe (2018) on soybean production technology reveled contact with extension agent's exposes farmers to information on new ideas and technologies during the production year and on the importance and application of new innovations through counseling and demonstrations by extension agents on a regular basis. It can therefore stimulate adoption. According to Fitsum, (2016) on adoption of soybean technology in Pawe district using tobit model farmer who has access to extension, the probability of adoption and level of adoption of soybean production technology would increase compared to their counterparts. This shows that the households who had contact with the extension are more probable to adopt soybean production technology than those who have no contact.

Cooperative membership is one factor that enhancing farmers' decision to adopt new technologies (Abebe 2018). In their struggle to improve agricultural production, farmer's cooperatives/ farmers' organizations play a vital role in agriculture. A study done by Tena *et al.,* (2017), on eastern Ethiopia using tobit model showed that, being a member of a cooperative institution was found to positively influence in adoption of wheat technology packages. Earlier findings from Kebede*et al.,* (2017) and Ahmed (2016) are consistent with this result. Access to market is one of the factor that affecting adoption of technology. A study done by Gedefa (2016) on adoption and cost benefit analysis of sesame technology in drought prone areas of Ethiopia using chi-square illustrated that, distance to market center has also a negative and significant relationship with probability of adoption of improved sesame varieties. The implication is that the longer the distance between farmers' residence and the market center, the lower will be the probability of improved sesame varieties adoption. Gebresilassie and Bekele (2015) found that distance to market centers was negatively and significantly related to adoption of fertilizer.

Having access to credit service increases the probability of using chemical fertilizer and it increases level of use of fertilizer. Gebresillase (2015) on factors influencing application of fertilizer by smallholder farmers of northern Ethiopia, using tobit model showed that using access to credit facility was affected the use of chemical fertilizer positively and significantly. Another study by (Namwata *et al*., 2010) indicated that credit affect adoption of improved agricultural technology for Irish potatoes significantly and positively. Studies by (Tura *et al*., 2010; Odoemenem & Obinne, 2010) were consistent with this result. A study done by Gelgo *et al*.,(2016) analyzing the determinants of adoption of organic fertilizer on smallholder farmers in Shashemene district, using double hurdle model elaborated that access to information media increased likelihood of adopting organic fertilizer and it is positive influence on the adoption of organic fertilizer.

Farmers who have had access to information through television, radio or any other social media were considered to have access to information media. Better access to information could likely empower farmers to seek for agricultural technologies which may improve their farm productivity. This is mainly because access to information could enable one to have more knowledge and awareness about different technologies (Solomon *et al.,* 2011).

Generally from empirical evidence it was concluded that demographic, socio economic and institutional characteristics of the households affects were the initial points for the study .Hence this study was tried to investigate on adoption of agricultural technology in general also affects the adoption of soybean production technology and in the study area there was no published empirical evidences on adoption of any agricultural technology in general and adoption of soybean production technology in particular. So the empirical findings was assisted to assess the factors that affecting adoption decision, intensity of adoption and challenges and opportunities of soybean production and fill the gap the variation among the farm households of Kondala district.

2.5. Conceptual Frame Work of the Study

A conceptual framework represents the researcher's combination of literature on how to explain a phenomenon and conceptualize the current study. It maps out the actions required in the course of the study given his previous knowledge of other researchers' point of view and the research problem (SM & Riggan, 2016). The conceptual framework of this study was based on the assumption that factors affecting adoption of soybean production technology namely personal, institutional and socio-economic variables identified based on the empirical studies of technology adoption discussed in the previous sections. The framework emphasized on the relationship of the explanatory variables with the intensity or level of adoption that is dependent variable. According to Klerkx *et al*., (2012), practical experiences and observations of the reality has shown that, one factor may enhance adoption of one technology in one specific area for certain period of time while it may create barrier in other locations. Hence, the conceptual framework presented in figure below explains that affect the adoption of soybean production technologies in the study area.

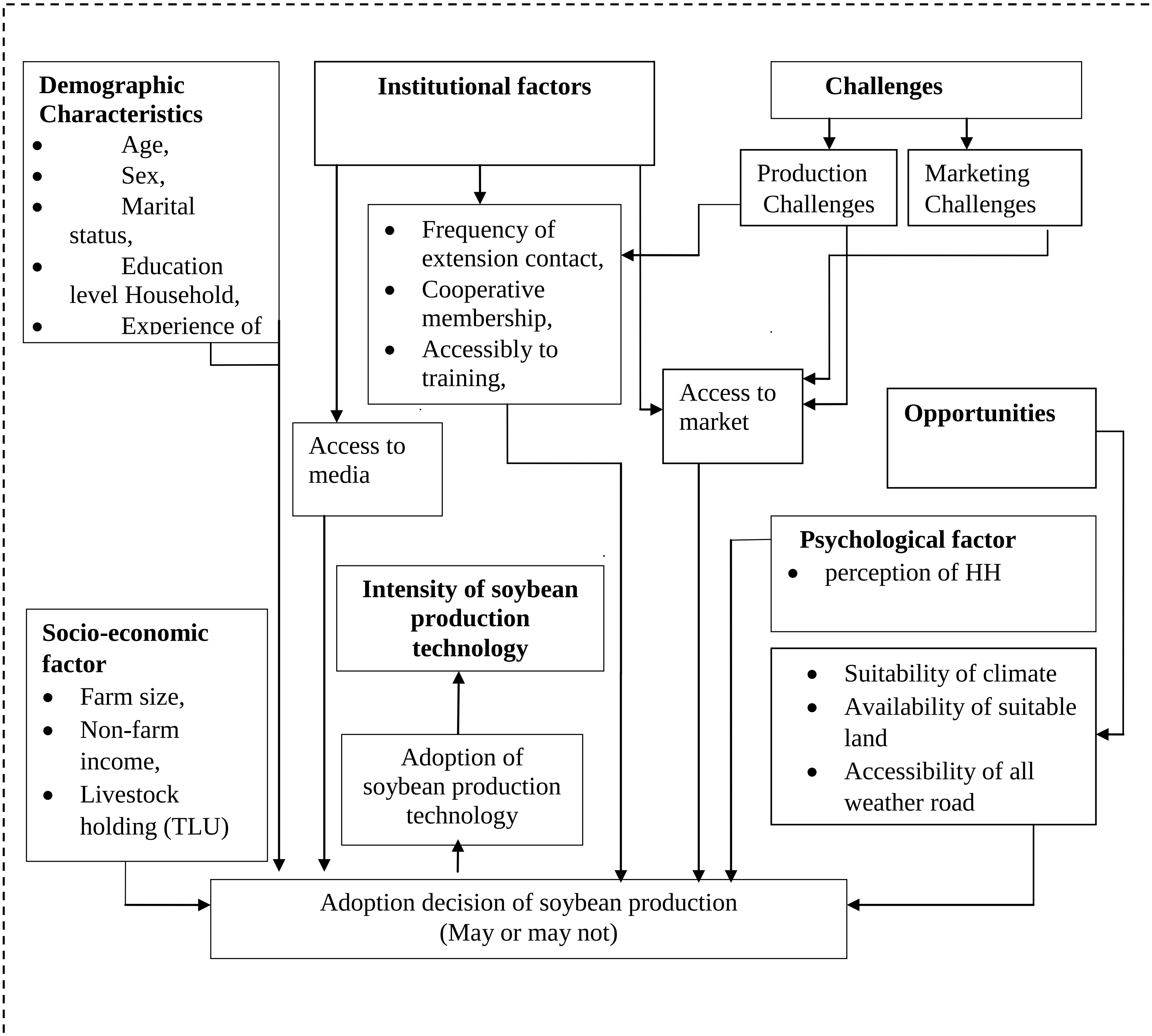

Figure 3: Conceptual frame works, Source: Own computation (2019)

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Under this topic, location and area, climatic condition, socio-economic condition and bio-physical of the study district are explained. This research was carried out in Kondala district which is one of the 22 districts of west Wollega zone of Oromia National Regional State, bordered by Begi district in west, Kelem Wollega zone in south and south east, Benshangul Gumuz region in north and Babo-Gambel and Mana-Sibu in eastern direction. It was established in December 2005 after being separated from Begi district. Currently, the district has 36 administrative kebeles of which 32 are rural kebeles and the remaining 4 are small towns. Gaba Dafino town is the administrative center of the district located in eastern part of west Wollega zone and 211 Km away from zonal town (Gimbi) and 652 km far to the west of Addis Ababa (KDANRO, 2018).

3.1.1. Demographic features

The total population of the district is 112,479 of which 48% were men and 52% were women; 6,617 or 5.89% of its population are small town dwellers (KDHO, 2018). The 32 kebeles have 16,366 farm households that started using fertilizer and improved maize seed in 2005 of which the majority of farm households make use of maize production by using the modern agricultural technology (KDANRO, 2018). The majority of the inhabitants (85.39%) follow Islamic faith, while 7.92% follows the Ethiopian Orthodox Christianity faith, and 6.61% are Protestants (DLSAO, 2019). In Kondala district, Oromo are dominant covering 99.1% and the remaining 0.9% is Ma'o. Afan Oromo is the main and administrative language. The agricultural and natural resource office of the district, which is responsible for providing extension service, has 25 different experts and 4 non-technical staff and 96 development agents in Animal Science, Plant Science and Natural Resources, and 11 supervisors of DA's at kebele level that give extension services to farm communities. There are also 11 Cooperative extension agents and Animal Health technicians (KDANRO, 2018 unpublished).

3.1.2. Climate conditions, vegetation and wild life

According to the district agricultural and natural resource office, the major rainy seasons in the district starts at the end of March and rains till the end of October. The agro ecological zone of the district is Wayina-dega and Kola, which consists of 24 and 8 rural kebeles respectively. The area receives annual rainfall between 1100-1750 mm/year and its altitude ranges from 970 to1900 m.a.s.l, and its mean temperature is $21C^0$-$24C^0$ (KDANRO, 2018). The data from the district agricultural and natural resource office also indicate that about 19,200 of the total area of the district is covered by natural and man-made vegetation including Azadirachta indica, Cordia a fricana, Acacia albida, Albizia malacophylla and other exotic specious such as Juiperous procera, Jacaranda mimosifolia, Gravila robusta and Eucalyptus.

There are also different varieties of wild animals in the district. Some of the major types of wild animals in the district include, lions, buffalo, pig, hyena, and tiger, are among the major ones. The farmers of the study area frequently suffer from wild animals' attack from apes, monkeys, pigs and birds which destroy their crops. The wild life conservation in the district covered 18,000 hectares which is part of the so called Dati Welal Park that is partially found in Kelem Wollega zone (KDFEPO, 2018). According to DIAO, (2018), there are four major rivers in the district that are used for irrigation. They are Tobbi, Boni, Hofa& Dabus Rivers. Dabus River is the biggest river in the district and is the major tributary of Abay River.

3.1.3. Economic activities and institutional setup of the district

The major economic activity of the study area, like other rural Ethiopia, is agriculture particularly mixed farming. The total land area of the district was classified as cultivated, forest and potentially cultivable land, pastureland; barren (unproductive) land, degraded and built up areas. The district has a total land area of 129,832 hectare of which 32,898 hectare is covered by annual crops (KDANRO, 2018). The most widely cultivated crops in the study area include coffee, maize, oil seeds (soybean, Niger seed, Sesame, Sunflower), and horticultural crops. Coffee, Khat and legumes are cash crops of the district. In addition to this soybean production become dominant income generation agricultural activity. Among 32 rural kebeles, 10 kebeles are favorable for production of soybean. Oxen are dominantly used for draft power. Even though farmers practice animal fattening since 2004 and use it as source of income but it was limited to only who owns fattening animals, particularly oxen. In addition, the productivity of the animals is very low owing to focusing only on the number of the animals than their health and productivity (KDANRO, 2018). There are 1 Kindergarten, 24 first cycle (1-4) primary school and 34 second cycle (5-8) primary schools and 4 senior secondary (9-10),1 preparatory school and one technical vocational school in the district (KDEO, 2018).

Regarding accessibly to road, since 2016 except three, all of the kebeles are accessible by road throughout the year and accessibility covers 94% (KDRAO, 2018). As the information received from the Kondala district Finances and Economic Cooperation Office indicated, there are only two financial institutions in the district. One is the Commercial bank of Ethiopia, Kondala branch which was opened in 2015 serving farmers, government and non-government employers and other traders for money transfer, providing credit and saving services. The other is Oromia Saving and Credit Share Company, Kondala branch which serves the community in saving as well as providing credit service for saving for farmers, women and youths of the district (KDFECO, 2018).

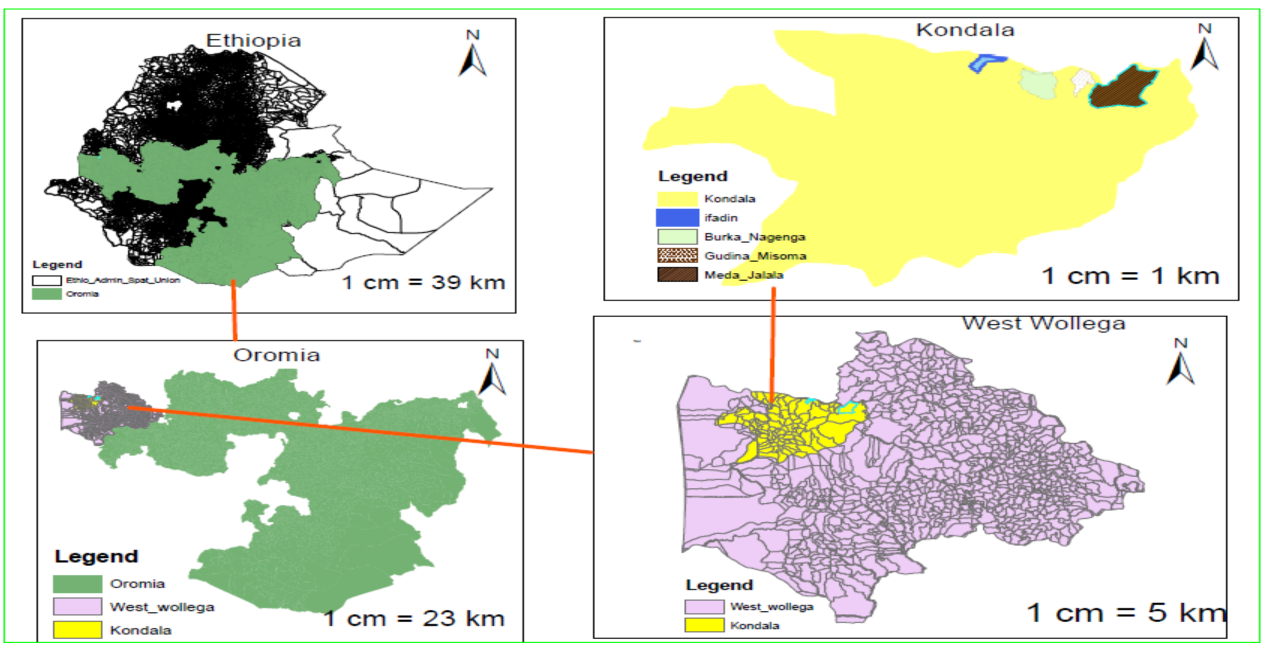

Figure 4: Map of the study area

3.2. Research Design

In this study cross-sectional research design in which the survey conducted was applied. Research design provides a logical structure for research data gathering and analysis (Bryman, 2008). The study adopted a cross-sectional survey research design as its framework to guide the process of data collection. Cross-sectional survey research design is the collection of data mainly using questionnaires or structured interviews to capture quantitative or qualitative data at a single point in time. Formal survey method was employed to generate data for this study.

3.3. Sampling Methods and Sampling Procedures

A clear identification and definition of the population of the study is an important prerequisite for research sample design. The study was under taken in the Kondala district, west Wollega Zone, of Oromia. A two stage sampling techniques were applied. This study defines the survey population at two levels, namely at the rural kebeles level and at the farm household level. First, four rural kebeles were selected from ten soybean producer kebeles using simple random sampling. The data of those households which containing both soybean producers and non-producer were taken from development agent. In the second stage, 185 farm household heads were selected using probability proportional to size of each of the four selected rural kebeles. Lastly each farm household was obtained using systematic sampling technique. The total sample size was determined following Yemane (1967) formula as fallows.

$$\boldsymbol{n} = \frac{\boldsymbol{N}}{\boldsymbol{1} + \boldsymbol{N}\boldsymbol{e}^{\boldsymbol{2}}} ------------------------------ (\boldsymbol{1})$$

Where, n = sample size, N= total number of households in the sample (1953) and e= margin of error which is 0.07 in this study, 93% confidence level. Thus, n=1953/ (1+1953 X (0.07)2, n=185, which is the determined sample size of the study area. The sample size thus obtained was assigned to each kebele based on probability proportional to size of the households (PPS).

Table 1: Population and sample size of the study kebele’s

Sampled Kebeles	Total population			Sample Size								
	Male	Fema	Tota	Males		female		Total		Overall		
				Ado	Non	Ado	Non	Adop	non	Mal	female	Total
Ifadin	316	38	354	16	14	2	2	18	16	30	4	34
Burka Nagaa	584	58	642	32	24	3	2	35	26	56	5	61
Burka Misoma	425	35	460	24	16	2	1	26	17	40	3	43
Madda Jalala	453	44	497	25	18	2	2	27	20	43	4	47
Total	1778	175	1953	97	72	9	7	106	79	169	16	185

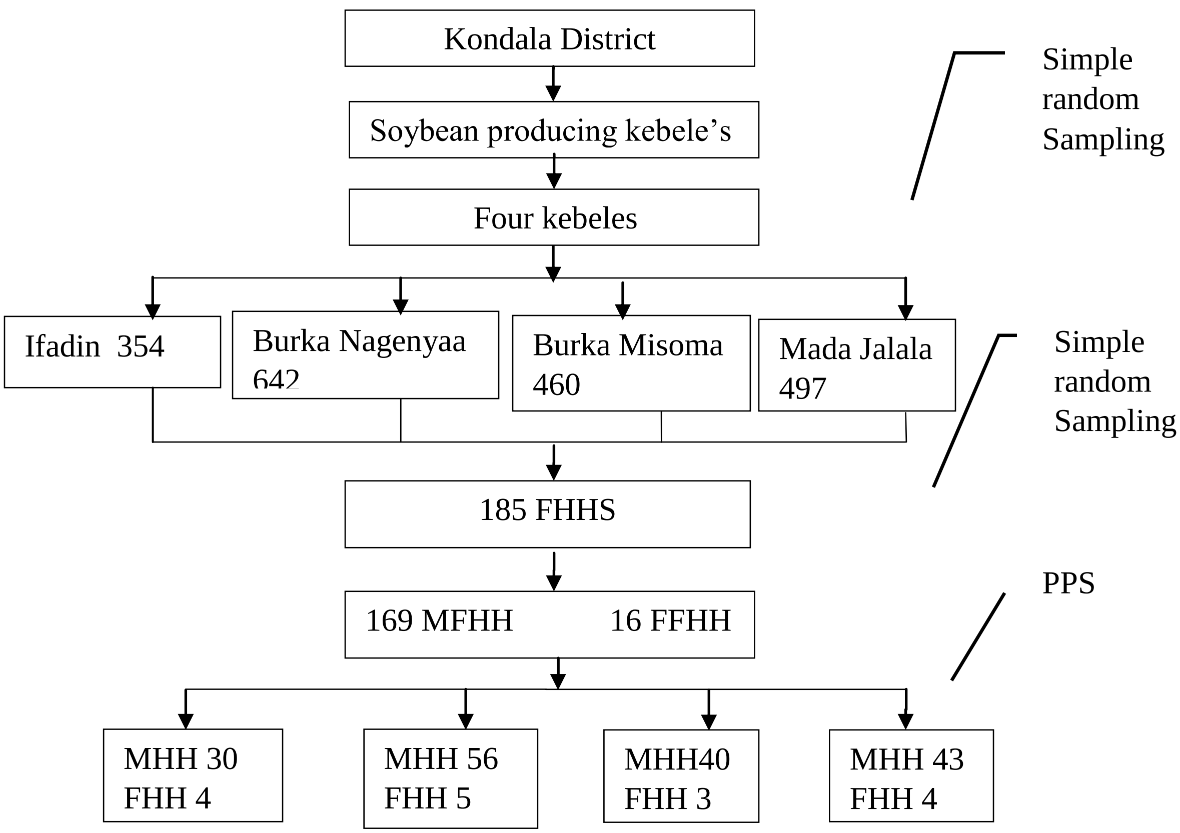

Figure 5: Sampling frame of study kebele’s

3.4. Types of Data and Data Sources

There were two types of data used for this study. These were primary and secondary data. Data sources used for this study includes, qualitative and quantitative data sources. Primary data sources include semi-structured interview schedule, focus group discussions, key informant interviews, informal discussions. Primary data were the main source of data for this study.Secondary data source includes review of relevant literatures at different levels district administrative office, documents and reports that enabled the researcher to extract information useful for supplementing primary data.

3.5. Methods of Data Collection

The study was conducted in western Ethiopia particularly Kondala district and data were collected from April first to March 15, 2018 in selected soybean producing kebeles. Before data collection undertaken four DAs' were trained as enumerator on how the questionnaires were interviewed under supervision of the researcher. The questionnaires were administered to the respondents after the permit were obtained from the district agricultural and natural resource office. Semi-structured questionnaire was prepared and pre-tested, and the necessary modifications were made before it was used for the actual survey. The questionnaires were translated to local language (Afaan Oromo) and face-to-face personal interviews were under taken. A survey was conducted in four kebeles namely Ifadin, Burka Nagenya, Gudina Misoma and Mada Jalala to collect primary information on soybean production technologies.

Both qualitative and quantitative data were collected from primary and secondary sources to identify important independent variables that affect household adoption.Data collected included information on land tenure system, farmer access to credit, training services, farm size, and off-farm income, sex of the household head, age of the household head, education level of the household head, extension services, (cooperative)group membership, and market distance from the farmer's homestead. Accordingly, information about factors affecting soybean production technologies and the opportunities and challenges that constrain the production potentials of soybean was collected (see Appendix 1).

Four focus group discussions with six to nine farmers each were held in all the four kebeles with individuals selected through the assistance of the DA's who were thought to have a better understanding on socio-economic and biophysical context of the study area. They include (community leader, religious representative, elders & DAs). After a brief introduction about the purpose and scope of the discussion, the FGDs were conducted with one DA, from a each kebele, as an assistant mediator. The discussion was made for one hour's. The qualitative data that could be obtained from the session was considered as a very important data for the study. The participants were allowed to speak without any hesitation with only some proper interception to keep the discussion on track. With all the encouragements made, it was also observed that some discussants were passive and usually dominated by other active participants. The reason why focus group discussions were applied is that it was quick and relatively easy to provide useful information into a topic that may be more difficult to gather information through other data collection methods.

Key informant interviews were also under taken with people who know what is going on in the community during the production of soybean in the past three years. It was done by selecting group of individuals who were likely to provide the needed information, ideas, and insights on the particular subject.Key informant interview was essential to triangulate the study and the maximum number was up to 15 numbers (Krishna 1989). From each kebeles, one key informant interview which consists of 7 to 8 persons was under taken with selected and knowledgeable peoples (DAs, Experts of the district, elder, and representatives of communities).From the key informant interview information such as variety preferred, time of sowing, methods of sowing, types of sowing, marketing price, opinion, perceptions, or ideas on technology adoption that is necessary interventions in study areas were obtained. The discussion made was the same themes as FGD. Both key informant interview and focus group discussion were purposively selected through non-probability sampling.

3.6. Methods of Data Analysis

Descriptive and econometrics analysis were employed to analyze the collected data. Both SPSS version 20 and STATA version 13 software were used for data analysis. The result of the analysis was interpreted and discussed using descriptive, inferential statistics and econometrics models.

3.6.1. Descriptive statistics

In this study the first specific objective was analyzed using descriptive and inferential statistics. Descriptive statistics includes mean, standard deviation (SD), frequency, ratio, and percentage which were used to examine the socio economic and farming characteristics of households and categorization of the famers' classification. Inferential statistics such as chi-square test (for categorical variables) and T-test (continuous variables) were also used to compare and contrast different categories of adoption decision of the sample units to draw some important conclusions. The third objective was described and analyzed by descriptive analysis methods using Kendall's W Test which used to rank the coefficients in their priority of ranking with chi square test.

3.6.2. Estimation of the adoption index

Before analyzing the factors affecting adoption of recommended soybean production technologies, it is important to calculate the level of adoption for the entire sampled household. There are two options of measuring level of adoption when there are multiple practices in the technology:

Adoption index: measures the extent of adoption with some specified period of time.

Adoption quotient: measures the degree or extent of use with reference to the optimum possible without taking time in to account.

In this study the first option (adoption index) was employed for obtaining values used for calculation of intensity (Nagash, 2007).This was done through seed allocated divided by seed recommended ,fertilizer allocated divided by fertilizer recommended and land allocated by land recommended and totally the value obtained was divided by all practices. Among the recommended soybean production technologies on three practices (land allocation, seed rate and fertilizer rate) was included to calculate the index value. Accordingly, adoption index which shows the extent the respondent farmer has adopted the whole set of package was calculated using the following formula.

$$ALi = \sum_{i=1}^{n} \frac{\left(\frac{ASi}{TASi} + \frac{SRi}{FSR} + \frac{FAi}{RFA}\right)}{NP} -----------------------------(2)$$

Where:

ALi = Adoption index of the i^{th} farmer,

NP = Number of practices,

$I = 1, 2, 3 \ldots \ldots \ldots . . n$, n is the total number of respondent farmers,

ASi = Area under improved variety of soybean of the ith farmer,

$TASi$ =Total area allocated for soybean production (improved variety+ local) of the i^{th} farmer,

SRi = Seeding rate applied per unit of area for the i^{th} farmer,

FSR = Recommended seeding rate per unit of area,

FAi = Fertilizer amount applied per unit of area,

RFA = Recommended fertilizer amount in per unit of area.

The adoption index is a continuous dependent variable calculated using the formula presented above with a value ranging from 0 to 0.97. The soybean production package comprises a number of practices in different application level *i.e.* for cultivation of the seed rate, for land allocated for soybean, agronomic practices and fertilizer rate from which the three practices were taken for this study. For all, there is a recommendation of practices to be followed as a package of practice according to agricultural office of the district and SG 2000 manual(not published) as well as cited by other authors (Beyene, and Dinku, 2017; Miruts, 2016). It means that the ratio of seed applied and seed recommended, fertilizer applied and fertilizer recommended and land cultivated and land allocated. As indicated above the result of each practices were added and then divided by all those three practices. After summing up for all the elements of the package of recommendations, a maximum obtainable adoption score is fixed at ranging from 0 to 0.97 .The general value obtained was used as an adoption index. Thus based on the value a farmer practices all technologies it takes the value of up to 1(adopter) and if not it takes 0 (non-adopter) Roger, (2003).

3.6.3. Econometric analysis

Tobit model: The most econometrics models commonly used in adoption are qualitative choice models including the linear probability function, logistic distribution function (logit), and normal distribution function (probit) (Ebrham, 2019). Adoption of improved technology alone is not sufficient enough since improvement in production and productivity of farm households depend not only on adoption but also on the intensity of use of the technology. Hence, dichotomous variable often is not sufficient for examining intensity of adoption (Feder *et al.*, 1985). In this study, Tobit model was applied to identify factors affecting the adoption and intensities of use of soybean production. The model also has both discrete and continuous part.As stated by Abubakar *et al*., (2016), it was also used to see the relative influence of different personal, demographic, socio-economic, institutional and psychological variables on adoption and intensity of adoption of improved soybean production package.

The model was used to determine the relative influence of explanatory variables on the dependent variable. It has advantage over other adoption models because it was dealing with a dependent variable with censored distribution and generating information for both probabilities of adoption and intensity of use of the technology and handles both the probability and intensity of adoption at the same time (Endris, 2003). According to Gujarati (1995) this model helps to examine the factors affecting adoption and intensity of use after the practice is adopted simultaneously. In soybean production technology the value obtained from index of seed recommended to seed applied, fertilizer recommended to fertilizer applied and land allocated to land cultivated was used for calculating intensity. The variables hypothesized to influence the adoption intensity of soybean production are presented in the form of a model as below. Following Maddalla (1992), the Tobit model can be specified as follow:

Where:

$$\mathrm{ALi}^{*} = \mathrm{B0} + \mathrm{BiXi} + \mathrm{Ui} \text{ ------------------------------- } (3)$$

$$\mathrm{Yi} = \mathrm{Yi}*, \text{if } > 0, (\mathrm{Yi}* = \mathrm{BiXi} + \mathrm{Ui}) \text{ ------------------------- } (4)$$

$$= 0 \text{ if } \mathrm{B0} + \mathrm{BiXi} + \mathrm{Ui} \leq 0$$

ALi^{*} = is the latent variable and the solution to utility maximization problem of intensity of adoption subjected to a set of constraints per household and conditional on being above certain limit.

AI =is adoption index for i^{th}farmer,

Xi= Vector of factors affecting adoption and intensity of adoption,

Bi= Vector of unknown parameters, and

Ui =is the error term which is normally distributed with mean 0 and variance $\sigma 2$.

As cited in McDonald and Moffit (1980) the following technique was used to decompose the effects of explanatory variables into adoption and level of adoption.The marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$\frac{\partial E(ALi)}{\partial Xi} = F(z)\beta i ---------------------------------(5)$$

Where, $\frac{\beta i X i}{\partial i} = Z$

The Change in the probability of adopting a technology as independent variable Xi changes is:

$$\frac{\partial F(Z)}{\partial Xi} = \frac{f(z)\beta i}{\partial} ---------------------------------(6)$$

The change in the level of adoption with respect to a change in an explanatory variable among adopters is:

$$\frac{\partial \epsilon \left(\frac{ALi}{ALi} *> 0\right)}{\partial Xi} = \beta i \left[1 - Z \;\frac{f(z)}{F(Z)} - \left(\frac{f(z)}{F(Z)}\right)^2\right] ---------------------(7)$$

Where, F (z) is the cumulative normal distribution of Z, f(z)is the value of the derivative of the normal curve at a given point (i.e., unit normal density) and Z is the z − score for the area under normal curve, ß is a vector of Tobit maximum likelihood estimates and σ is the standard error of the error term. Before running the Tobit model all the hypothesized explanatory variables was checked for the existence of multi-co linearity. The two measures to test the existence of multi-co linearity are

1. VIF (variance inflation factor) was used for testing the association between the hypothesized continuous variables and the value of VIF can be computed using the formula,

$$VIF(XI) = \frac{1}{1 - R2}$$

Where, Ri^2 was the squared multiple correlation coefficient between Xi and the other explanatory variables (Maddala, 1992). SPSS 23.0 version was employed to compute the VIF values. To avoid the problem of multi collinearity, it is essential to exclude the variables with the high VIF value (10), which will happen when R^2exceeds 0.95 (Gujarati, 1995).

2) Contingency Coefficients:

This was used to calculate dummy variables. In order to test multicolinearity problem between discrete as well as dummy variables, contingency coefficient, which is $\chi 2$ (chi-square) based measure of association was computed. The values of contingency coefficient, ranges between -1 ,0 and 1, with 0 indicating no association between the variables and values close to 1 indicating high degree of association. The association is high when the value is greater than 0.75.

$\mathrm{C.C} = \sqrt{\frac{\chi^2}{n+\chi^2}}$Where: C. C = Contingency Coefficient, n= sample size, $\chi 2$=Chi-square value.

3.7. Definition of Variables and Working Hypothesis

3.7.1. Dependent variables

The dependent variable in this study was operationalized as adoption and intensity of soybean production technologies which is treated as continues variable. Technologies include, improved variety, seed rate and fertilizer rate) that takes an index value$0 < \chi \leq 1$, with 0.97 if a household cultivates soybean production technologies and 0, if the household did not use soybean production technologies.

3.7.2. Definition of independent variables and hypothesis

Age of the household head: Age was a continuous variable measured in number of years and is one of the factors that affect adoption intensity in several ways. The direction of influence is not, very clear however, there are always mixed results from empirical analysis. Age of a household's head somewhat captures his or her farming experience and the variable is assumed to have positive relationship with adoption of soybean production technologies. Older farmers may have more experience, resource, or authority that would allow them more possibilities for trying new technologies. Omonona *et al.,* (2005), Uaiene *et al*., (2009) and Nchinda *et al*., (2010) found a positive relationship between age of household and technology adoption. Contrary to this age of the household head may negative effect on the adoption and intensity of adoption of improved agricultural technologies (Mauceri *et al.,* 2005).Thus, expected sign for age is both negative and positive.

Sex of the household head: This is a dummy independent variable indicating sex of the household head. It was represented by 1 for males and 0, otherwise. Female headed households are not efficient and able to adopt new technology as compared to their male counterpart (Yemane, 2014; Diro *et al.,* 2017). In the study area female focused more on off farm activity than agricultural activities. Therefore, it is hypothesized that male farmers are more likely to adopt soybean production and the intensity of adoption.

Perception of farmers: The perceived advantages of recommended soybean production packages are assumed to have influence on adoption behavior of recommended soybean production technologies (Oladele *et al.,* 2007). It is categorical variable and measured with Likert scale containing response of categories ranging strongly agree, agree, neutral, disagree and strongly disagree for 5,4,3,2 and 1 respectively. Hence, it is hypothesized that good perception is expected to positively influence the probably of adoption.

Education level of farmers: It is a continuous variable measured in number of years of schooling attended by the household head; otherwise 0 for never attended school. Farmers with more education are likely to have an increased ability to manage new agricultural technologies and capable of applying information provided through extension services and through farmer networks. Households with more years of formal education will be more likely to sustain adoption and experience higher performance in soybean production (Tamimie, 2017). Hence, household head's educational level is expected to influence the probability of adopting technologies positively (Afework and Lemma, 2015).Therefore, number of schooling was expected to be positively related to adoption behavior of farmers.

Marital status: in this study marital status includes farm households that married and known by DAs as married recorded as households. It is categorical variable that contains the value of 1 for single 2 if, married, 3 divorced and 4 widowed. Marital status has also been shown to have an effect on asset accumulation (Arslan *et al*., 2014) especially married farmers highly adopt and use of improved soybean production technologies. It is assumed that married couples share experience in adoption of recommended agricultural technologies (Furahisha, 2013). In this study married households were more adopt soybean production technologies than others.

Farm size: It refers to the farm land owned by the household in hectares and is the single most important resource. It is continuous independent variable. Farm size is expected to influence households' decision to adopt and intensity of high yielding soybean production technologies. This specifies that households who have relatively large land size more initiated to adopt improved technologies (Hagos, 2016). In this study, farm size is hypothesized to have positive relation with adoption of soybean production technologies.

Livestock holding is measured as the number of livestock in Tropical Livestock Unit (TLU). Livestock are important source of income, food and draft power, and represent an asset which indicates the wealth statuses of the household. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with the adoption of improved soybean varieties (Otieno, 2010). TLU was computed by listing all livestock's owned by the respondents and changing to smallest number by using conversion factors used to calculate Tropical Livestock Units (strock *et al.,* 1990). Therefore, livestock ownership is assumed to be hypothesized positively affecting the adoption of soybean production technology.

Off-farm income: Off-farm activities here refer to agricultural activities which take place outside the person‘s own farm. It includes handicraft activities (weaving, spinning, carpentry, house mudding, pot making, remittance etc.), petty trade (grain trade, fruits and vegetables trade, khat trade), selling of local drinks, trading of small ruminants and cattle, and remittance transfers within and across nations. It is continuous independent variable where a farm household has non-farm income and acts as an important strategy for overcoming credit constraints faced by the rural households in many developing countries (Nagash *et al.,* 2007). A positive correlation expected between off-farm activities and the decision of adopting high yielding soybean technologies.

Distance from market center: It refers to distance from the residence of the farm household in kilometers. It is continuous variable which is measured in kilometer. Market distance increases adoption and intensity of adoption (Dereje, 2006; Nagash, 2007; Idrisa *et al*., 2012). Access to market was hypothesized to be positively related to the probability of adoption of innovation and the reverse is true. Therefore, it was hypothesized that households who are nearest to market center were more likely to adopt and to participate in soybean production adoption in of farm households.

Experience in soybean farming: is continues variable which measured in number of years since a respondent started farming soybean production technology on his/her own. Tufa and

Tefera (2016) indicated that farm experience affects adoption and intensity of adoption of soybean production technologies positively. Therefore, the more year of farming experience the more adoption of soybean production technologies .Experience of the farmers is likely to has a range of positive influences on adoption of soybean farming and affect adoption of soybean production technology (Bekele *et al*., 2016).

Frequency of extension contact: This refers to the number of days of contact between the household head and extension agent in 2017/2018 production year. It is categorical and measured in frequency and having a number 4,3,2,1 and 0 for every day, every week, every fortnight, every month and no contact respectively. It helps farmers to be aware of the benefit and the existence of high yielding soybean production packages. A positive correlation expected between frequency of extension contacts and the decision of adopting soybean production technologies (Win, & Chumjai 2009; Mulugeta 2011).

Participating in training: One of the means by which farmer acquires knowledge and skills on any agricultural technologies was participating in training. It is a dummy variable which take the value of 1 if a farmer is participate to training and 0 otherwise. Hence, participation in training is expected to positively influence farmers' adoption behavior (Dereje, 2006). So training was hypostasized positively on adoption of the technology.

Membership to cooperative: This is dummy variable; 1 represents if a household was a member of a certain farmers' association or cooperatives and 0 otherwise. Membership to an association let farmers to access inputs easily with an affordable price that is pertinent to increase agricultural production and thereby farm income (Hailu *et al*., 2014). Hence, farmers can easily adopt chemical fertilizer and improved variety of soybean on time through an affordable price as well as through credit that will be returned back soon after harvesting. Due to this, while determining accessibility of inputs likes improved seed and fertilizer through cooperatives membership was expected positively to adopt the soybean production technologies.

Access to input supply: This is dummy variable, which measured as 1 if accessed or 0 otherwise. Getting improved agricultural technologies close to the farm or near by the farmers' village, particularly improved seed, and chemical fertilizer is the key constraint that affect farmers' desire to adopt (Teklewold *et al.,* 2013). Accessibility in this context is the presence of the intended technology in the locality of the farmers and the farmers able to get inputs at the required time if not farmers were used not full package as a result the productivity was less. Therefore, in this study access to technology input supply (such as improved seed of soybean and fertilizer) were hypothesized to positively influence adoption of soybean production technologies.

Access to media: Media is an important tool for providing information of technologies and used to link innovations from the source to end users. Radio and television are media materials used to disseminate information about new technologies. As far as awareness is prerequisite for behavioral change its role cannot be underestimated. In the study area radio is the main source to get agricultural and other information. It is expected to have positive influence on soybean technology adoption (Negera & Getachew, 2014). It is expected to have positive influence on technology adoption (Solomon *et al.*, 2011).

Table 2: Independent variables and their characteristics

No	Variables	Variables& their characteristics	Variable description and measurement	Exp sign
1	Age	Continuous	numbers of years of household heads	+/-
2	Sex	Dummy	1 if the household head is male, 0 otherwise.	+
3	Farm size	Continuous	Total land holding in ha	+
4	Livestock owned	Continuous	Total livestock owned by a household in (TLU)	+
5	Farm experience	Continuous	Experience in farming of the households in year	+
6	Off-farm income	Continuous	Income of farmer from non-farm activities in a year	+
7	Perception of farmer on soybean technology	Categorical	5 ,4,3,2,1 for very highly perceived, highly perceived, neutral Lowly perceived, very lowly perceived respectively	+
8	Marital status	Categorical	Married=2, 3=divorced widowed=4	+
9	Distance to the nearest market	Continuous	Distance to the main market in kilometer	-
10	Education level	Continuous	Educational status, 0 for no read and write, otherwise1,2,3 class attended	+
11	Frequency of Extension contact	Categorical	Frequencies of extension contact: a value 4, 3, 2, 1 and 0 for ,every month ,every fortnight, every week, every day and no contact respectively	+
12	Cooperative member	Dummy	1 if the household is a member, 0 otherwise	+
13	Access to media	Dummy	1 if the household listen to radio, 0 for no.	+
14	Participation in training	Dummy	1 if the household get training 0 otherwise.	+
15	Access to inputs supply	Dummy	1 if the household gets inputs 0 otherwise	+

4. RESULT AND DISSCUSIONS

This chapter presents the overall result of the study under adoption and intensity of soybean production technologies. It is divided into three sections. The first section presents descriptive statistics on adoption decision of on soybean production technology packages used by smallholder farmers. The second section presents the Tobit results on socio-economic and institutional factors hypothesized to influence adoption and intensity of use of soybean production technology. Finally, the last section presents the challenges and opportunities that hinder the production of the particular crop.

4.1. General Characteristics of the Respondents

Sample respondent of the study area consists of both male and female individuals. The male respondents were found to be 91.35 % of the total sample household whereas the remaining 8.65 % were females. Male household headed were more than females household headed. Regarding their house, from the total respondents 84(45.41%) constructed their houses with corrugated iron sheet and 101 (54.6 %) were grass roofed houses. Concerning their religious, all respondents were Muslim faith followers**.**

4.1.1. Land use pattern in the study area

Land is one of the wealth indicators of rural Ethiopian farmer as well as in the study area. The farmers in the study area came from Hararghe in 2003/4 G.C due to drought and resettled in Kondala district. After the settlement, land and different support facilities were provided to them. Thereafter, they become independent and tried to adopt different agricultural technologies. Currently they become stable farmers and accumulating initial wealth's to sustain their life as permanent resident farmers. Like any other Ethiopian smallholders in the study area, crop production is their basic economic activity. The major crops grown were maize, sorghum, soybean, groundnut, khat and to some extent homestead coffee. All the crops produced by farmers were used for the purpose of both consumption and sales. In the study area the average land used for the major crops production such as maize and soybean were, 0.59 & 0.23 hectares for the adopters and 0.47& 0.015 hectares for the non-adopters respectively (Table 3).

Table 3: Descriptive statistics of the major crops of sample farmers (ha)

Variables	Adopters(N=106)		Non adopters(N=79)		T-test
	Mean	Std. Dev	Mean	Std. Dev	
Total farm size	1.894	0.652	1.451	0.663	29.58***
Soybean	0.215	0.147	0.015	0.001	7.63***
Maize	0.596	0.243	0.476	0.252	25.53**
Sorghum	0.573	0.201	0.554	0.221	28.54**
Groundnut	0.231	0.156	0.163	0.139	15.93***
Khat	0.150	0.097	0.101	0.073	16.51***
Coffee	0.020	0.040	0.000	0.010	5.00***
Sweet potato	0.090	0.040	0.080	0.050	21.32***
Other,(Spices)	0.110	0.050	0.090	0.060	22.57***
Annual+perennial	1.910	0.640	1.440	0.650	30.96***

Source: Own computation (2019) ***, **, significant at 1 & 5% level of significant

4. 1.2. Livestock's of the respondent farmers

This part covered livestock holding that is main indicator and wealth status of the household in the study area. Like other Ethiopian farmers, in the study area, livestock are very important for traction power, manure usage for soil fertility improvement and fuel, human nutrition from their product and income generating from live sale and their byproduct. The survey result showed that average cow and ox owned were 1.80 and 4.71, for the non adopters and 4.83 and 2.43 for the adopters respectively. This means most farmers have a minimum of one ox and the maximum of four oxen. This is relatively larger in the crop livestock mixed system. In general, in the study area the sampled household has better position in their livestock. This is an indicator for soybean production technology adoption.

Table 4: Descriptive Statistics of livestock population the sampled households

Variables	Non adopters(79)			Adopters (106)			Over all mean	T-test
	Min	Max.	Mean	Min.	Max.	Mean		
Tropical Livestock Unit	3.10	17.2	8.80	3.50	21.40	9.150	9.68	-0.739
Oxen	1.00	2.00	1.80	1.00	4.00	2.430	2.09	0.738*
Cow	1.00	10.0	4.70	1.00	12.0	4.830	4.72	-0.648
Heifer	0.00	6.00	1.10	0.00	6.00	1.050	1.05	0.015
Calf	0.00	2.00	0.29	0.00	2.00	0.304	0.30	-0.271
Sheep(adult+ young)	0.00	1.00	0.02	0.00	1.00	0.057	0.06	0.156
Goat (adult+ young)	0.00	1.00	0.09	0.00	4.00	0.359	0.33	-0.524
Donkey(adult+ young)	0.00	1.00	0.09	0.00	4.00	0.359	0.10	0.191
Chicken	0.00	1.00	0.13	0.00	1.00	0.188	0.354	0.930

Source: Own computation (2019), (*) Significant at 10%

4.2. Adoption Categories of Respondents on Soybean Production Technologies

Variations in productivity of soybean technology among the farmer's are mainly due to large differences in the level of adoption of selected production technologies and the underlying determinants of adoption of these technologies. According to SG (2000) manual, there are five soybean production package practices that are recommended by research system. These practices include seeding rate, fertilizer rate, spacing, tillage practices &frequency of weeding and land allocated for soybean production technologies. Among them only three practices (seeding rate, land allocated and fertilizer rate) were used for calculating the adoption index. Due to absence of variation among farmers and difficulty in getting reliable figure on adoption of practices among the households, the remaining package components were excluded from adoption index calculation.

Adoption index score was calculated by adding the adoption quotient of each practice and dividing it by number of practices adopted by a farmer to know the level of adoption of each sample farm households. The adoption quotient of each practice was also calculated by taking the ratio of actual rate applied to the recommended rate, which indicates the extent to which an individual farmer has adopted the package practices. The final adoption index scores of sampled adopter groups were categorized into four as none, low, medium and high. The non-adopters group were given a score of 0 and kept as separate category to investigate factors influencing adoption and intensity of soybean production technology package. The adoption index of sample households indicated that from sample respondents (42. 7) had adoption index score of 0 which shows they are non-adopters. The remaining (53.3%) were scored an adoption index between 0.11-0.99 in which their level of adoption was lies between low adopters to high adopters (Ashenafi and Oliyad,2020) .The results of descriptive statistics showed that, 2.16% had adoption index ranging from 0.11 to 0.33 which indicates low adopters, while 58 respondents (31.35%) had adoption index score stretching from 0.34 to 0.66 indicating medium adopters, and (37) respondents (20%) had adoption index score ranging from 0.67 to 0.97. which show high level of adopters (Roger, 2003;Miruts,2016).

Table 5: Adoption index and percentages of farmer's level of adoption

	Non adopters	Adopters		
		Low	Medium	High
Adoption index score range	0.00	0.01-0.33	0.34-0.66	0.67-0.99
Adoption index average	0.00	0.17	0.49	0.83
Percentage of farmers	42.7	5.9	31.35	20

Source: Own computation, 2019

4.3. Soybean Production Technologies and Practices

4.3.1. Land allocation and cultivation

This refers to sequence of management practices and activities recommended for producing soybean as material provided by SG-2000. This project started to disseminate the new varieties of soybean and production technologies in 2008. Even though soybean was introduced recently into the study area, it has rapidly gained popularity in terms of household usage. Among the uses to which soybean served are, preparation of soy wet (weaning food) cheese/milk and also used as cash crops. Land allocation for any agricultural production technology was very essential particularly for soybean production technology. According to Idrisa *et al*. (2010), adopters were any farmer that devoted at least 10% of his/her land for soybean production; and non-adopters were any farmer that devotes less than 10% of his/her land for soybean production. In this study the results of descriptive statistics showed that area covered by soybean for sample households were varied among respondents. The mean and standard deviation of total land cultivated for soybean were 0.2150 hector and 0.1470 hector for adopters and 0.015 hector and 0.001 hector for non-adopters respectively (Table 6). This showed that there is statistical mean difference between adapters and non adopters in terms of land allocation and cultivation for soybean production technologies.

Land preparation for sowing the particular crop is vital and respondents also explained that three times cultivation was very curial to get good production. The respondents indicated that the sowing time was from mid-May to first week of June (SG-2000 unpublished). According to the respondents of the study area, timely sowing was very important. If the planting time was before the given time the crop would be deteriorated by rain and becomes vegetative with less fruit. Contrary to this, if planted after the given time, rain stops before flowering and hence low production. The focus group discussions were also supported this idea.

4.3.2. Seed rate,sowing, weeding and spacing

Agronomic studies show that significant increases in yield can be achieved when cultivating soybean in combination with the application of targeted packages of improved agricultural technologies (Ronner *et al*., 2018). From the soybean recently released, the verity mostly grown in the study area was Wallo (TGX-1895-33F) which was suitable at medium altitude of (520-1800) m.a.s.l and maturing with (121-150) days. Seeding rate is one of soybean production technology which decide the production and productivity of any agricultural technology. The mean and standard deviation of seeding rate applied was 8.21 kilogram and 3.15 kilogram for the non-adopters and 50.73 kilogram and 11.03 kilogram for the adopters (Table 6). As far as fertilizer use was concerned, it is also one of the technologies for soybean production.Fertilizer application rate of sample respondents vary between adoption categories. For this study the average rate of fertilizer applied for soybean production by sample grower households during the 2017/18 production year was 78.9 kilogram and standard deviation of 14.52 kilogram for the adopters and 0 kilogram for the non-adopters (Table 6).

Sowing methods is fundamental for getting high product in soybean production technology. Most of farmers in the study area who used fertilizer were used row methods for several crops production including soybean. According to the survey result, 57.4% of the respondents have sown their seed by row and the remaining 42.6% used broadcasting. During interview, households who plant their seed through row said that it was more beneficial for them in terms of saving seed easily hoeing weeding and give more production. The farmers used spacing of 22-25 cm between rows and 4 to 5.0 cm between plants (SG-2000 manual). Respondents who broadcasted their seed were also asked why they used the method and they responded that it is labor demanding and time consuming. Weed infestation was one of the factors that hinder crop production. Soybean competes poorly with weeds for light, water, and nutrients. As respondent said, it was recommended that two to three times hand weeding was important for their crops. If weed was not adequately controlled, infestations can reduce yields by certain amount. During early stages of vegetative growth, weeds can quickly overgrow. Although weeding results in significant productivity gains, the survey results indicate that the farmer of the study area weed soybean one to three times.

Table 6: Farmer's adoption status & level of soybean production

Variables	Adopters (N=106)		Non Adopters (N =79)		T-test
	Mean	SD	Mean	SD	
Land cultivated (ha)	0.215	0.147	.015	0.001	-7.63***
Seed applied (Kg /ha)	50.73	11.03	8.210	3.150	-4.48***
Fertilizer applied (Kg/ha)	78.99	14.52	0.000	0.000	-1.42**
Production (per ha.)	13.01	4.590	7.440	1.140	-7.16***

Source: Own computation (2019); (***, **, significant at 1% &5% respectively).

Under this topic a focus group discussion was under taken from each kebele for one hour's. According to focus group discussion they grow soybean called Gishima and Wallo for the past 10 years .The production was started with project around FTC through trial and gradually expanded to their fields. They used soybean for consumption wet &*nifro* (*shumo*) and as cash crop. They were still much benefited from the crop.The results of FGDs indicated that since they produce soybean, they compare both Gishima and Wallo varieties. During discussion the participants revealed that farmers have their own knowledge on selection the best variety to their produces. Wallo soybean variety was suitable for theirenvironment as well as for food.One of the participant said that even our wives prefer Wallo than Gishima due to easily cocking while preparing wet. FGDs also discussed on time and methods of sowing, way of fertilizer applications. Land preparation was crucial since properly land cultivation from two-three was needed for obtaining good harvest.

4.4. Socioeconomic Characteristics of Small holder Soybean Producers

4.4.1. Descriptive & inferential statistics of continuous variables

Age of the households: Age is one of the demographic factors that is useful to describe households and provide evidence about the age structure of the sample and the population. It plays an important role in household decision to adopt soybean production technologies. The ages of respondents range from 23 to 60 years with mean 38.3 years for the adopters while the minimum and the maximum age was 24 to 70 years and standard deviation of 41.4 years for the non-adopters respectively. As indicated in the figure below, when the age increased from 23-39 the adopter number less compared to non adopters, while in between 40-55 aged, the number of the adopters greater than the non adopters. This showed that age was directly related with probability of adoption soybean production. Hence the result of t- test showed that there was mean difference between adopters and non-adopters in terms of their age on adoption of soybean production technology. The study was consistence with findings of (Yemane, 2014; Samuel *et al.*, 2017).

Education level of the respondents: According to Rogers (2010), the complexity of a technology is one of barrier for people to adopt the technology and it is believed that this hurdle can be overcome by more education. Educated farmers are better able to process information and search for appropriate technologies to alleviate their production constraints. Therefore, the more education to a society means the more intervention in different economical and social activities by that society. In this study level of education was one of the continuous variables that assumed to increase farmers' ability to obtain, process, and use information relevant to the adoption of improved soybean production technology.

Hence, it was hypothesized that level of education has a positive relationship between the household head and soybean production technology adoption. With regard to their education status, the average years of formal schooling for the sampled farmers was 5.05 years for the adopters and 1.17years for the non-adopters (Figure 7). The result shows that there was a mean difference between the adopters and the non- adopters in term of their education. The reason is that education could likely allow farmers to make efficient decision, easy to see and grasp knowledge on new information. This result was consistent with the findings of (Orinda, 2013).

Livestock ownership: In rural context, livestock holding is an important indicator of household's wealth position. Livestock's are prosperity indicator of Ethiopian farmers and an important source of income and draft power, food and means of transport. They played an important role in supporting the production and productivity of farmers. In this study livestock holding was assumed positively and significantly related for decision to adopt soybean production implying that farmers with more livestock holding are more likely to devote the portion of their land for soybean production than those households with less livestock holding. The result of t-test showed that there was no mean difference between adopters and non-adopters in terms of their livestock holding (Table 7) .The study was consistence with the findings of (Mulugeta, 2009) and opposite to study of (Solomon *et al*., 2013).

Experience in farming soybean technology: Another important measure of adoption and intensity and use of soybean production technology is experience in soybean farming. Farmers with higher experience in adoption of new technology appear to have often full information and better knowledge to evaluate the advantage of the technology. It could also imply that knowledge gained over time from working decisive production environment may thereby influence their adoption decision. This result illustrated that the mean experiences of soybean farming was 5.69 years for the adopters and 1.41 years for the non-adopters. The minimum and maximum experiences of adopter were between 3 and 9 years while the minimum and the maximum experience of the non-adopters were between 0 to 3 years. The coefficient of soybean farming experience was found to be positive and significant at 1% significant level (Table7). This showed that there was mean deference between adopter and non-adopter in terms of their experience on adoption of soybean production technology. This was because the more experienced farmers may have better skill to access new information about the technology. The result of this study was similar with findings of (Sudu *et al*., 2016).

Farm size: Farm size is one of the determinant resource that affect technology to adopt or rejecting. Many studies have reported a positive relation between farm size and adoption of agricultural technology Ahmed, (2016); Uaiene *et al*., (2009); Mignouna *et al*. (2011). The result of this study showed that farm size and soybean production technology adoption were positively correlated. The descriptive result of the sampled respondents indicated that average land holds of the sampled households were 1.95 hectare for the adopters 0.43 hectors for the non-adopters. The results of t-test showed that farm size was significant at 5% significant level. The result of t-test showed that there was mean difference between adopters and non-adopters in terms of their farm size (Table 7). This was due to the fact that farmers with large farm size are likely to adopt a new technology as they can afford to devote part of their land to try new technology unlike those with less farm size. The study was opposite to the findings of Beshir *et al*., (2012) and Rapsomanikis, (2015).

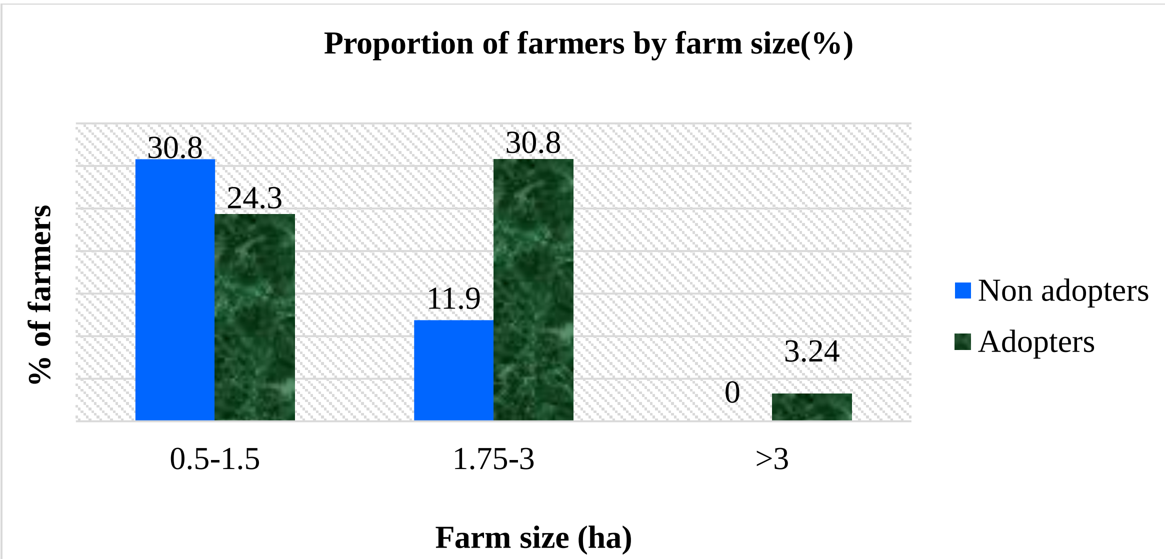

Figure 6**:** Farm size of the households

Off-farm Income (ETB): Participation on off-farm can affect the decision to adopt new technologies. This is particularly true if the adoption of the new technology would require a minimum investment in purchased inputs. The study also identified another income generating activity which called non-farm employment which determines the wealth status of respondents. These additional incomes will support individual farmer to adopt technologies. The off-farm activity in the study area includes petty trade, chat trade, trade of oxen, hand craft and donkey cart. The descriptive statistics result showed that mean annual off-farm income of adopters 10,229.7ETB and 3104.4 ETB for the non-adopters and was found to be significant at 1% significant level. The t-test result showed that there was a mean difference between adopters and non-adopters in terms of off-farm income participation (Table 7) .The study was in line with the findings of (Eric *et al*., 2016).

Distance to the nearest market: Accessibility of market is an important variable in adoption decision of soybean production technology. This is because a relatively closer distance of farmer's home to the market enables and facilitates marketing of inputs and outputs. It is also important for the producers to get attractive market price through reduction of transportation cost. The increase in market distance make farmers to get out-dates market information and becoming out of adopting new agricultural technologies. The mean and standard deviation from market center of households were 3.45km and of 1.97 km for the adopters and 10.49 km and 3.88 km for the non-adopters respectively (Table 7). This shows that the adopters were closer to the nearest market place compared to the non-adopters counterpart. A farmer who is closer to the market place is likely being more informed about technologies compared to the one who is furthest from the market place. This study was similar with Adebayo *et al.,* (2013); Langyintuo, *et al*., (2008).

Table 7: Over all descriptive summery statistics of continuous variables

Variables	Adopters(106)		Non-adopters (79)		Overall	T-test
	Mean	SD	Mean	SD	Mean	
Age(year)	38.26	7.39	41.35	12.01	41.13	-3.93***
Education (schooling year)	5.05	1.59	1.04	1.17	3.47	-5.27***
Farm size(ha)	1.95	0.61	1.17	0.413	1.73	-3.15**
Livestock ownership (TLU)	9.32	4.87	9.150	3.46	9.68	11.87
Distance to the nearest market (km)	3.45	1.97	10.49	3.88	3.76	-7.097***
Farm experience (year)	5.69	1.41	1.21	1.1	1.06	-3.41***
Off farm income (ETB)	10229	7568	3104.4	5633	5426	15.8***

Source: Model output (2019): ***, **,* significant at 1, 5& 10%.

4.4.2. Descriptive statistics results of dummy/categorical/ variables

Sex: It was one of determinant factor in affecting adoption of any technology. Sample respondent of the study area consists of both male and female individuals. The male respondents were found to be 91.35 % of the total sample household whereas the remaining 8.65 % was female. Male household headed were more than female household headed. The result of descriptive statistics showed that from 16 female households 9(56.3%) were adopters and 7(43.7) were non adopters and from 169 male households 97(57.4%) were the adopters and the remaining 72 (42.6%) were the non adopters. The result descriptive statistics illustrated that there was no observable percentage difference between adopters and non- adopters in terms of their sex.

Marital status of the respondents: The data of the respondent showed that about 93.5 % of the respondents were married and living with their spouses and 3.78% and 2.7% of household heads were found to be divorced and widowed respectively and no single/not /married respondents. This indicates that the society in the study areas is stable. A stable society in general and stable households in particular can concentrate more on production than unstable society or family. From the total respondents the adopter were encompasses (55.67%) married, (1.62%) divorced and 0% widowed. The non-adopters includes married (37.8%),divorced (2.2%) and widowed(2.7%).The result of descriptive statistics showed that there was no observable percentage difference among the adopter and the non-adopter household heads in terms of their marital status.

Member to cooperatives: Membership in farmers based associations serve as a platform for accessing and dissemination of information and technology (Martey *et al.*, 2013). It also is enhancing communications for development (Berhe, 2014).It can help farmers pulling resources together for their individual benefits which give them the opportunity to adopt more technologies than others who are not members and get more information about new technologies. In this study, access to cooperative member was helped farmers get better information and the variable was hypothesized to have a positive relationship with adoption of soybean production technology. The result of this study showed that out of the total sampled households interviewed, 58.9% of farm households were members of cooperative organizations while 41.1% were not members of cooperative organization. The result of the χ 2 test indicated it was significant at 1% level of significant. There was statistical percentage difference between adopters and non-adopters in terms membership in farmers' cooperatives (Table 8). The result is in line with the study of (Emana *et al*., 2017). Focus group discussion showed that increase in possibility of meeting with other farmers as one becomes a member of different farmer groups and be informed about the new technology.

Frequency of extension contact: The use of agricultural innovations by farmers can be understood from the perspective of diffusion of innovations whereby innovations generated by agricultural research are passed to farmers through extension agents (Mwaseba, 2005). Frequency of extension contact is the way to spread new agricultural technologies within the field of communication between extension agents and the farmers at the grassroots level. The result of χ 2 test showed that, it was significant at 1% level of significance (Table 8). Based on this, the result of descriptive statistics showed that there is the percentage difference between the adopters and the non-adopters in terms of frequency of contact with extension agents. This indicated that the more frequent to extension contact was the more adoption soybean production technology packages. The finding was similar with study of Hana (2019) and Tefera *et al*., (2018).

Accessibly to inputs: For Roger, a technology composed of two parts: hardware and software. Hardware is "the tool that embodies the technology in the form of a material or physical objects (Rogers, 2010). In this study the hardware was different inputs like, improved seed, fertilizer. Respondent farmers' access to inputs was measured using percentage, out of 185 farmers, 64.8 % (120) were accessed to inputs and 35. 2% (65) were not accessed to inputs. Accessibly to input was assumed to be positively affected the adoption decision of soybean production technology. The χ 2 test showed that access to inputs significant correlation with adoption of soybean production package. The result showed that there was percentage difference between adopters and non-adopters in terms of accessibly to inputs. Bago *et al*., (2018) find the same result.

Access to training: Training was one of the independent variable that affects the adoption of any agricultural technology. It supplies farmers with new knowledge and skill, which help them to perform new practice properly. If a farmer has no skill and know-how about certain technology, he/she may have less probability of adoption. The skill acquired through training helps to carry out a new technology effectively and efficiently. According to the respondents of the study area, in the year training was provided two times by DA's and district agricultural experts for farmers. That was during meher time (in March) for rain feed crops including soybean production and the second was given at September for the irrigation purpose. The data of the interviewer showed that out of total 185 farmers interviewed only 50.8% of them were found to attend and the rest 49.2% did not attend in the program (Figure 7). So the result of χ2 showed that there was no significant percentage different between the adopters and the non-adopters in terms of training on soybean production technologies and the study was opposite with findings of (Tefera, 2018).The reason behind is that the training was not given at the intended time. It was given after the farmers were already sowing their own local seed.The training given by the expert was not for the purpose of target group but for achieving the direction given from Zonal agricultural offices. The focus group discussions result support this idea.

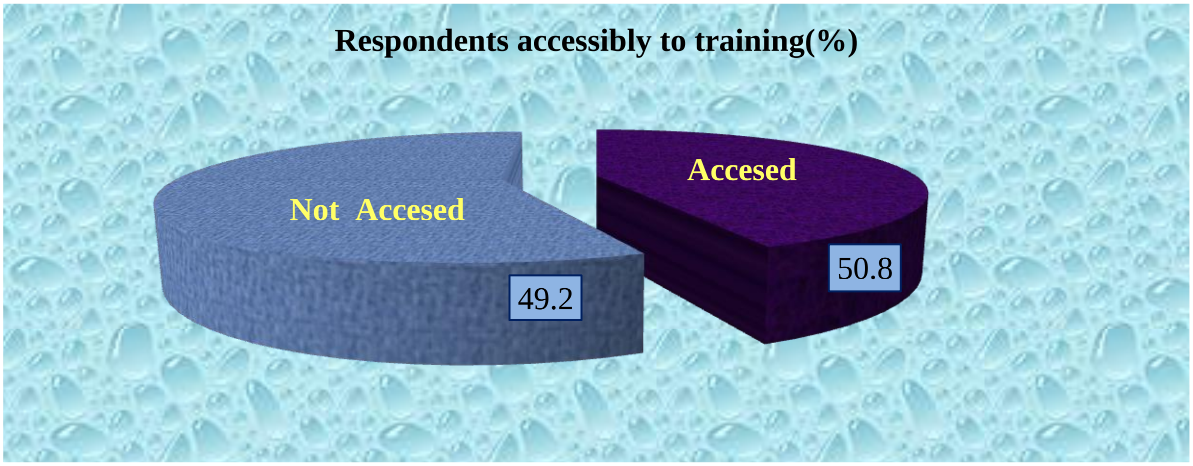

Figure 7: Accessibly to training

Farmers' perception: Ohemeng *et al*., (2018) stated perception as the process that organizes and interprets by our sensory in order to give meaning about the environment. It is the set of processes by which an individual become aware of and interprets information about the environment. Perception was measured and responses of sample respondents on the perception related questions were analyzed using Likert type scale. In this study five positive and five negative soybean production related question was developed for interview. Accordingly, the ratings such as very high (5), high (4), medium (3), low (2), and very low (1) indicates how farmer perceives the characteristics being presented for evaluation of the given question in a decreasing manner. According to the result of the interview, most of the respondents perceived that using improved seed, fertilizer and appropriate spacing for soybean production to increasing the productivity of the crop. The overall $\chi 2$ test indicated that there was positive relationship between perception of respondents about soybean production packages and the results were statistically significant at 5% as explained in (Table 8) .The result was consistent with the findings of (Fallon, *et al.*, 2019).

Access to media: As declared by Rogers (2010), mass media and interpersonal communication are the two communication channels. While a mass media channel includes TV, radio, or newspaper, interpersonal channels consist of a two-way communication between two or more individuals. In this study mass media (radio) was hypothesized positively in affecting the adoption and intensity of soybean production technology. The result of the sample respondent showed that out of 185 households 53.5% (99) respondents had access to radio 46.5% (86) had no access to media(radio).The $\chi 2$ square result of the study showed that there was no relation between mass media (radio) and adoption of soybean production technology package. The study is consistence with the findings (Abdulai, 2018). The reason is that they use their radio only for following of news and recreational purpose (listening music). The focus group discussion also replied that, they use the radio while they returned from the agricultural activity for recreational purpose and following news. They did not know when the program of agricultural activity was transmitted.

Table 8: Over all descriptive statistics of dummy/categorical/ variable

Variables	Characteristics	Non adopters		adopters		Tota1	χ2	p-value
		Fre	%	Freq	%			
Sex	male	72	38.9	97	52.43	169	0.08	0.99
	female	7	3.78	9	4.86	16		
Marital status	Married	70	37.8	103	55.67	173	.694	0.71
	Divorce	4	2.2	3	1.62	7		
	Widowed	5	2.7	0	0	5		
Access to train	No	45	24.32	46	24.86	91	.039	0.18
	Yes	34	18.38	60	32.43	94		
Access to cooperatives	Yes	58	31.35	51	27.57	109	17.6***	0.00
	No	21	11.35	55	29.73	76		
Frequency of extension contact	Daily	4	2.16	28	15.12	32	89.7***	0.00
	Weekly	9	4.86	59	31.9	68		
	Twice a week	23	12.4	16	8.65	39		
	Monthly	15	8.1	3	1.62	18		
	No contact	28	15.12	0	0	28		
Access to media	No	42	22.7	44	23.78	86	2.47	0.14
	Yes	37	20	62	33.5	99		
Farmers perception	Very low	27	14.59	23	12.43	50	9.57**	0.05
	Low	16	8.65	18	9.73	34		
	Medium	9	4.86	27	14.59	36		
	High	8	4.32	18	9.73	26		
	Very high	19	10.27	20	10.8	39		
Access to inputs	No	41	22.2	24	12.97	65	17.0***	0.00
	Yes	38	20.54	82	44.3	120		

***, **, significant at 1& 5%; Source: software output, 2019.

4.5. Econometric Model Results

The previous section dealt mainly with explanation of the sample population and test of the existence of relationship between the dependent and independent variables to identify factors affecting adoption of improved soybean production package. Identification of factors affecting adoption of improved the particular crop and agronomic practices alone are however not enough to stimulate guiding principle unless the relative influence of each factor is known for priority based intervention. The intensity of adoption has also been represented by the amount of resources (e.g. time, land or capital) allocated to technologies (Tambo and Abdoulaye, 2011). Tobit model was employed to identify factors affecting the adoption and intensities of use of soybean production technologies.

Marginal effects are more useful to interpret the results of Tobit model effectively and this effects show the probabilities of occurring the dependent variable with respect to the changes in explanatory variables. Before running the model, the hypothesized explanatory variables were tested for existence of multicolinearity problem that is the situation where the explanatory variable is highly interrelated. The variance inflation factor (VIF) shows absence of multicolinearity problem among the independent variable**.** It was concluded that in this study there was no serious multicolinearity problems among the explanatory variables, as their respective values were less than 10 (appendix 3).

4.5.1. Determinants and intensity of household adoption of soybean technologies

This section presents maximum likelihood estimates of the Tobit model to identify determinants of adoption and intensity of use of soybean production technology. The assumption of Tobit model illustrated that all variables that were influence the adoption decision of households also influencing the intensity of use of soybean production technologies of farm household hence, using a decomposition procedure suggested by McDonald and Moffitt (1980).The dependent variable for the Tobit model was adoption and intensity of adoption of soybean production technology packages. The Wald Chi-square statistic was used to test the overall significance of variables. This result implied that the model was significant at 1% level of significance, and the explanatory power of the factors included within the model is satisfactory.From fifteen variables that used to determine the technology eight were dummies and seven were continuous variables**.**The total of eight variables was found to be significantly determined adoption and intensity of use of soybean production technologies. The significant variables were, age of household, level of education, off farm income, market distance, contact of extension with farmers, access to inputs, membership in cooperative and farm experience. Based on this fact, the effect of changes

in the explanatory variables on the probability of adoption and intensity of use of soybean production package was computed and the results are summarized in (Table 9).

Table 9: Tobit model estimation for determinants& intensity of soybean production technology

INTENSTY	Coef.	Std. Err.	P>t	Change in Probability(y>0)	Change in intensity	Intensity for entire sample E(y/y>) (marginal effect)
Age	.0084	.0029	0.004***	.0087	.0042	.0059
Sex	.1739	.1979	0.381	.1989	.0772	.1095
Marital status	.1073	.1253	0.393	.1125	.0538	.0762
Education	.0293	.0123	0.020**	.0307	.0146	.0208
Farm size	.0582	.0458	0.205	.0610	.0292	.0414
Tropical Livestock Unit	-.0075	.0057	0.187	.0078	.0038	-.0053
Cooperative member	.1129	.0613	0.067*	.1159	.0576	.0813
Distance to the nearest market	-.0449	.0138	0.001***	-.0470	-.0225	-.0319
Off farm in income	8.89e-1	3.23e-1	0.007***	9.32e-1	4.46e-1	6.32e-1
Access to inputs	.1801	.0668	0.004***	.1951	.0865	.1225
Farmers perception	-.0058	.0219	0.790	-0061	-.0029	-.0041
Farm experience	.0366	.0188	0.052*	.0383	.01833	.0259
Access to train	-.0961	.0629	0.128	.1003	-.0482	-.0683
Frequency of extension contact	.2699	.0313	0.000***	.2831	.1353	.1918
Access to media	.0029	.0582	0.960	.0031	.0015	.0021

Number of obs = 185 Prob > chi2 = 0.0000
LR chi2 (15) = 167.29*** Log likelihood = -69.508087
Pseudo R2 = 0.5462106 = uncensored observations
Left-censored observations at INTNSITY<=79

Age: As it was hypothesized, the econometric results from Tobit model indicated that, age of household head was positively related with the probability of soybean production technology adoption at 1% significance level. The marginal effect depicted that as age of household head increases by one year, the likelihood of being technology adopter in soybean production would be increased by factor of 0.0087 units keeping other thing constant. It also increases the intensity of soybean production technology adoption by factor of 0.042 and 0.006 units, on average for those adopters and for the entire sample respectively. Perhaps it is because age indirectly represents experience in farming. The implication is that the increase in farmer's age increases farmers' experience in farming and understanding more the benefits of the technology. The result is consistent with the findings of Mignouna *et al.,* (2011); Martey, *et al.*, (2014).

Education: Similar to prior expectation, education level of households was positively affected the probability of adoption and intensity of soybean production at 5% significant level. This showed that, as participation in formal educational level of household head increases by one year of schooling, the likelihood of being technology adopter in soybean production would be increased by factor of 0.031units on average, keeping other constant. It also increases intensity of soybean production by a factor of 0.015 and 0.02 units, on average for those adopters and for the entire sample respectively. This is because the more knowledgeable the farmer the more understand than no read and write. The result of this study was similar with (Sudu *et al.*, 2016).

Membership in cooperatives: Similar to prior expectation, the econometric results from Tobit model indicated that, member ship in cooperatives of household head was positive and significant at 10 % probability level. Membership to one additional local farmers based association increased the adoption decision of soybean production technology by 11.6 % on average, keeping other constant. It also increases intensity of soybean production by 5.7% and 8.3%, on average for those adopters and for the entire sample respectively. Farmers who participated more in community-based organizations such as cooperatives were likely to engage in social learning about the technology, hence raising their likelihood to adopt the technologies in soybean production. Similar results were reported by Mmbando &Chagwiza (2014), Baiyegunhi (2016) and Kebede *et al.*, (2017).

Distance to the nearest market: It was negatively related with the probability of adoption of soybean production packages and statistically significant at 1%level of significance. The results of this study in (Table 9) indicated that, on average each additional one kilometers of distance from market center the likelihood of being technology adopter would be decreased by factor of 0.47 units on average ceteris paribus. It also decreased the intensity of soybean technologies by factor of -0.023 and -0.032 units for those adopters and entire samples. The implication of this negative relationship is that if the distance between farmers' living home and the market area is longer, the farmers will be discouraged from adopting improved soybean technology. This indicates that farmers living at a distance from the main market centers are less likely to adopt the soybean technology than those who are located closer. The relatively proximity to market also reduces marketing costs The longer the distance between farmers' residence and the market center, the lower will be the probability of adoption the technology. This finding was consistent with (Gedefa 2016).

Off farm income: Off-farm income has a positive and significant effect on the probability of adoption and intensity of use of soybean production technology. The marginal effect of the Tobit model showed that off farm income positively affected the probability of adoption and intensity of soybean production at1% significant level. Each additional birr off farm income of a farmer increased the probability of adoption by factor of 9.3 units. On average, it also increased the intensity of soybean production technology by factor of 4.4 and 6.3 units for those adopters and for the entire sample respectively. A reasonable explanation for this is that off-farm income acts as an important strategy for overcoming credit constraints faced by the rural households in study area. The result was similar with findings of (Abebe, 2014) and contrary with study of (Geta *et al*., 2013).

Access to inputs: Shortage agricultural inputs especially seed and fertilizer (NPS&UREA) were one of the major factors that affect the adoption decision and intensity of adoption as far as soybean production technology package was concerned. This may be due to the fact that the lack of input required for the implementation of the technology package may lead to the rejection of such technology adoption.As the Tobit model result indicates, the variable access to inputs had positive and significant influence on the likelihood of adoption of soybean production technology at less than 1% significance level (Table 9). The result of the marginal effect stated that those farmers who have access to input, from agricultural office or cooperative farmers increases the probable to adopt soybean technology package by 19.5% than those who have no access to inputs. *Citrus paribus*, it also increases in the intensity of adoption of soybean production technology package by 8.6 % and 12.2 % for adopters and entire sample respectively. A reasonable explanation for this is that, a farmer access to input is cultivated his land with time and gets more production and motivated to adopt the technology than others. Unavailability of input is enforced farmers to discourage to discontinuance of adoption. The result was similar with findings of (Asfaw *et al.*, 2011).

Farm experience: Farming experience was positively and significantly related at 10 % with probability of adoption and intensity of soybean production technology. Experience of the household head in soybean farming is one of the factors that affect technology adoption process in soybean production technologies. The result of the model illustrated that as experiences of household head increases by one more year, the probability of being technology adopter in soybean production would be increased by factor of 0.0.04 units on average, keeping other things constant. It also increases the intensity of soybean production by factor of 0.018 and 0.026 units on average for those adopters and for the entire sample respectively. This is expected because more experienced farmers may have better skills and understanding to way of implementing about the technology. The study was similar with findings of (Ainembabazi and Mugisha, 2014).

Frequency of extension contact: Frequency of extension contact is powerful and crucial to achieve better adoption of improved agricultural innovations like soybean production technologies which is expected from the very purpose of extension services. This is due to the fact that, frequency of contacts with extension agents increases the probability of acquiring up to date information on the new agricultural technologies. In this study frequency of contact with extension agent was hypothesized positively related with the probability of adoption and intensity of soybean production technologies and significant at 1%. The marginal effect explained that, as frequency of contact with extension agents increases in one more day the probability of adopting soybean production technologies would be increased by 28 %. On average it also increases the intensity of soybean production technology by 13.5% and 19.2%, for those adopters and for the entire sample respectively. The result was agreed with findings of Ebrahim, (2019) Ouma, (2011) and Meinzen *et al.*, (2011).

4.6. Opportunities and Challenges of Soybean Production Technologies

4.6.1. Challenges of soybean production technologies

The third objective of the study was addressing challenges and opportunity of soybean production. In the study area both opportunities and challenges were identified and discussed. According to the sample respondent’s price of their produce was the first bottleneck to soybean production in the district particularly in the study area. Insofar the market’s role is to move commodities from the farm gate to central market or the processing sector, farmers in the study area were commonly complained about no markets for soybean. They are usually referring to the lack of competent collectors. In relation to price the respondent 64 (34.6%) said that they had not enough buyers for their soybean products. Consequently, farmers were forced to sell at the lower price to local collectors. As a result, the prices offered by farmers were much lower compared to the costs incurred by the farmers.

The focus group discussion result also revealed that no well-known legally registered collectors even the trade office of the district could not follow up the collectors and they dominated legal and well known assembler even if they came from neighbor district they were torch and indirectly prosecution (punish) action was taken on them. They are usually complaining about the lower price of their produce due to the lack of competent buyer, well known and certified collectors. They do not have decision on the price of their produce. The price was fixed by those local assemblers.' Generally, there is a much of distrust between farmers and traders.

In the study area the second production challenges of the soybean production technology was insect pest specifically called termite. According to the sampled respondents, problem and occurrence of termite was the second hindering factor for soybean production. A termite infestation was common across all study kebele's and reported as the harsh problems by the respondents. Out of 185 respondents, over 40 (21.5 %) of the households in the study area reported that termite was a serious and major concern that hinder not only the soybean but also other crop production. So termite infestation was the major problem among the producers in reducing their production and ranked as the second challenge.

High price of inputs (fertilizer & improved seed) was also frequently mentioned as a constraint to soybean growers, especially in the study area. It was ranked as the third and accounts 38(20.5%) of respondent producers of soybean production technology. Profit for farmers is the value of the output minus the cost of production. A high percentage of respondents considered that fertilizer was needed for effective soybean cultivation and the supposed necessity to add fertilizer to soybeans was to obtain a good harvest. Price was a constraint because due to incremental cost of fertilizer from time to time and additional costs of transportation to get the materials to their fields. The result of the survey was consistent with study of (Pocket. 2016). The farmers in the study area also complain the cost of fertilizer which was different from neighboring district of Benshangul Gumuz region.

Unavailability of inputs on time and even not totally brought to farm household was the other challenge that hamper the adoption of particular crop. It was ranked as the fourth problem and taken 20(10.8%) by respondents in affecting the soybean production technology in the study area. Timely availability of inputs is very important not only for soybean production but also for any other agricultural technologies. Farmers in the study area face and complain about timely unavailability of inputs. For the fact that it is difficult for farmers to obtain high-quality seed and most soybean producing farmers are forced to save their own seed or buy from local markets. The problem was consistence with study of (Beyene, 2010).

Poor storage facilities were ranked as the fifth most important constraint to soybean production in the Kondala district. The survey result showed that 14(7.57%) explained there are no formal, and good soybean storage facilities in the district. Soybean farmers therefore have to store their produce either in bags in their rooms or barns, which are rudimentary and susceptible to insect attack. Traditional storage facilities have certain deficiencies, including a low elevated base giving easy access to rodents, wooden floors that termites could attack, weak supporting structures that are not moisture-proof, and inadequate loading and unloading facilities. Poor storage facilities, which consequence in high post-harvest losses, are a discouragement to soybean production in the district. Due to the problems associated with storage facilities most farmers store only a portion of their crops for consumption and sell part of their crop early and this resulted in selling with the least cost. During the FGDs, it was reported that the quality of soybeans produced in the district was very poor and it was recommended that the district agricultural office should give training to farmers on methods of threshing and storing soybean.

Farm households also reported having problems associated with the agronomic practices on adoption of soybean technology in the study area and ranked as the sixth among the problems. The agronomic practices associated with soybean production are still varying among adoption categories especially the crop requires a great deal of attention in terms of depth of sowing, spacing, weeding requirement and the need to harvest on time. Accordingly, the agronomy of soybean production technology is still complex to the respondents especially that the crop requires a great deal of precision in terms of depth of sowing, spacing, weeding requirement and the need to harvest on time so as to escape pod shattering. Owing that some famers in the study kebeles did not apply all the recommended packages and management practice such as row planting, seeding rate, hoeing and earthling up.As a result, still their production less by far from the research trials .The result was consistence with (Ogunbameru & Idrisa, 2013).

The focus group discussion also replied that there are problems associated with the production of soybean. They faced with different production and marketing problems. From production problems, unavailability of the improved seed and low cost for their output are the major once. The termite problem is another factor considered by focus group discussion as production problem. According to the group discussion marketing problem and newly released seed problem should solved by government particularly district agricultural office.Low price of output solved by providing competent collector and as brokers were problem. Termite problem needs government and communities share.Accordingly the results of overall challenges were computed by Kendall's W Test as shown below.

Table 10: Challenges of soybean production technology

Constraints	Mean	Std, Dev.	Mean R.	Ken.(W)	χ^2
Timely un availability of inputs	3.39	1.73	3.53	0.038	42.4**
High price of improved seed& fertilizer	3.34	1.61	3.54		
Insect pests destroy	2.52	1.84	3.74		
Problem of storage facilities	2.94	1.59	3.39		
Low price of output	3.02	1.67	3.90		
Poor agronomic practices	3.02	1.61	2.90		

N=185, Chi-Square 42.4, Kendall's W .038, p- value 0.001, Source: Model output (2019)

4.6.2. Opportunities of soybean production technologies

Like other questioners provided for respondents and discussion made with Focus Group Discussion and key informant interview, discussion was also made on opportunities of soy bean technologies in the study area. According to the information collected from focus group discussions and key informant interviews, the overall opportunity for soybean production technology in the study area was explained as follows. They were suitability of climatic condition (rain full & temperatures) availability of land and accessibility of all-secondary weather roads. They were ranked it in order of their weight during the individual interview and focus group discussion. The reason behind was farmers in the study area said that from the legume crop/soybean/ the major crop grown and very suitable to the locality was soybean. In addition, people in the study area come from drought prone area of west and east Harerghe and they were very happy in the district climatic condition in which sufficient rain full and favorability of soils. The background of the people in the study area was very good culture by using group action called *Guza (Debo)* in digging their land which locally called “*Dongoruu*’’ with the help of their hoe for crop production.

The other reason is that the availability of all weathers roads is one prospect is that the district. The road was done by government using the project URRAP. All of the kebele’s in the study area are served by a gravel/rock and all-weather secondary road that connects the kebele’s to main road which connects Beghi-Kondala-Nadjo districts with Addis. Even though the selling price of their produce was with least cost, the availability of all-weather secondary roads was ranked as third opportunity by respondents. From the result of Kendall's W Test, it was concluded that availability of land had a mean of 3.12 and standard deviation of 1.96 and mean rank of 2.13. The respondent idea was similar with the findings of (Wijnands, *et. al.,*2007). Accordingly the score of the respondents presented in below (Table 10).

Table 11: Opportunities of soybean production technology

Constraints	Mean	Std. Dev.	Mean Rank	Ken.(W)	$\chi 2$
Availability of suitable land	3.12	1.96	2.13	.028	9.76**
Suitability of climatic and soil condition	2.84	1.51	2.01		
Accessibility of all weather roads	1.60	1.49	1.85		

N=185, Chi-Square 9.764, Kendall's W .028, p- value 0.0023 Source: Model output (2019)

5. SUMMRARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

In Ethiopia, legumes are important food and cash crops that play a crucial role in the country's economy. They improve farmer's food security, and are an affordable source of protein and diet. There are a wide range of suitable climatic and soil conditions for soybeans production in Ethiopia. Even though such suitable environment and soil condition for soybean production, the country is unable to meet the demand in local and international market. This is aggravated by low production and productivity of smallholder soybean producers. This study was done on the adoption and intensity of soybean production technology by rural farmers in Kondala district. In this area, soybean is an essential crop, which served as both food and cash crop. The main theme of this study was to assess the current status and intensity of adoption and identify challenges and opportunities in adoption of soybean technologies with its associated agronomic practices.

A two stage sampling procedure was employed in order to draw a sample from soybean producers. In order to get the sample of kebeles and farmers simple random sampling was employed. Descriptive and econometric models were used to identify factors and to what extent those factors influenced farmer's likelihood to participate in soybean production technologies. The data was analyzed with the help of employing SPSS version 20; and STATA version 13. Mainly Chi-square test and T-test were used to test the variation of the sample group towards adoption of soybean production. The result of descriptive statistics indicated that from total of 185 respondents (57.3%) were adopters and 79 (42.7%) of respondents were not adopted the recommended soybean production technologies. This showed that performance of farmers using recommended soybean production technologies such as improved varieties, land allocation and fertilizer application have not been at the expected level. Still there was big variation among adopter and non-adaptors. The result also showed that there was statistical significant between adopters and non-adopters in terms of land cultivated seed applied and fertilizer applied. The focus group discussions and key informant interview also revealed that time of planting, methods of sowing and usage of fertilizer were important to get higher production.

The Tobit econometrics model was employed to estimate the effects of hypothesized independent variables on dependent variable. Result from the marginal effect of the Tobit model indicated that out of the 15 explanatory variables eight of them are statistically significant in influencing the adoption of recommended soybean production technologies namely, frequency of extension contact, age of the household head, education of the households, members in cooperative, farm experiences, access to agricultural inputs, off farm income were positively and statistically significant where as distance from market center was negatively and significantly affect adoption and intensity of soybean production technologies. Hence, adoption and intensity of adoption of recommended soybean production technology can be perceived as outcomes of different set of factors.

The results of the findings also identified challenges and opportunities found in the study area. Accordingly the findings showed that low price of output, insect pest (termite problem), high price of inputs, and timely unavailability of inputs were the highest challenges ranked from 1-4 respectively. Other constraints poor storage facilities and problem of agronomic practices were also ranked from 5-6 respectively identified by the study area. An availability of land, suitability of climatic condition and accessibility of all-weather roads were opportunities identified and ranked 1-3 in the study area respectively. From focus group discussions and key informant interview soybean production technology was need great attention. The land was properly identified; repeatedly cultivation of land was important for getting higher output. The result of the study also discussed on production and marketing challenges that to be problem associated with soybean production technologies identified and ranked.

5.2. Conclusions

New technologies of soybean production comprised improved varieties and fertilizer have been introduced by SASAKAWA GLOBAL 2000 and governmental organization to the study area. From results of descriptive statistics and the econometrics models, the following points were concluded. In addition to agronomic practices, improved seed and inorganic fertilizer were very crucial for obtaining sufficient production in soybean technologies. In the study area there was variation in land allocation, seed usage, tillage practices and methods of sowing among adoption categories. The results of descriptive statistics also revealed that, the challenges and opportunities that were hinder and prospect for soybean technologies were considered. From the challenges, marketing problem for their production and termite infestation was the two major concern and critical problem which hinder the production of soybean.

Other problems like high price of input, timely unavailability of inputs and problems associated with agronomic practices were also considered. From the study, farmers were constrained by the mentioned condition to adopt soybean with the agronomic practices and discourage them to intensify further. Tobit analysis result showed that, factors that are affect adoption, includes; age of households, education level of households, cooperative member, and distance from market center, accessibly to inputs, farm experience and frequency of extension contacts affected both adoption decision and intensity of soybean production technologies at1%, 5%and 10% significant level. The intensity of adoption of all the technology components used in the production of soybean was low among the farmers in the sample. Overall, from this study it was concluded that, identified socio-economic and bio physical variables that constraints and impede adoption decision and the intensity of soybean production technologies identified and in general it was concluded that, promotion of the agricultural sector needs a packages of course of action and need further intervention by governments and nongovernmental organization.

5.3. Recommendations

Based on results of descriptive statistics and the econometrics models, recommendations are suggested for future research, development intervention activities to promote adoption and intensity and use of soybean production so as to improve farmers' income from the technology. Therefore, the following recommendations were generalized based on results of this study.

- Education has a significant and positive effect on adoption decision and intensity of improved soybean production packages. In this regard, the district Education office and Agricultural office should responsible to facilitate all necessary materials to strengthen the existing provision of formal and informal education.
- Farm experience increases probability of adoption and intensity of adoption of soybean production technology. The study further established that, many farmers learnt about the package from other farmers. The study therefore recommends the need to strengthen farmer-to-farmer extension whereby few progressive farmers who adopt the technologies of soybean by district extension experts. They would in turn disseminate the technology to the rest of the farmers in their neighbor kebele. The Agricultural office of district should strengthening experience sharing on best practices and scaling up to be importance among farmers.

- Distance to nearest market was statistically significant and negatively affected adoption of soy bean production technologies. Hence, stockholders (district transport office & rich's of the locality), need to establish market linkage for the farmers through facilitation of transport which increase the probability of adoption of improved soybean production packages.
- Cost of farm inputs was identified as a major challenge towards adoption of the soybean technology. The agricultural office of the district and zonal would required to make linkage between research institutions to the farmers to overcome the seed problem.
- At the same time, unavailability of inorganic fertilizer to be a constraint for adoption. District cooperative agency and primary cooperatives call for improvements in improved input (fertilizer) delivery to effectively cope with the demands of small holder farmers.
- Smallholder soybean farmers should be also encouraged to form or join farmers based organizations as it offers them the opportunities to getting better attention from Institutions in the Agricultural sector for delivery of inputs.
- For soybean production technologies, timing of the planting, spacing of the rows, weeding, pest management and timing of the harvesting are all critical practices. So based on the existing gap of knowledge effective production package training should be provided to overcome the agronomic problem of the particular crop.
- Smallholder farmers typically do not have access to marketing information and, rely on local brokers. The market must be made more efficient to ensure that all farmers have access to price information and reduce the margin extracted by traders and brokers. The district trade office should responsible for registering the crop under the Ethiopian Commodity Exchange (ECX) in which market information can be delivered directly from ECX to farmers as for coffee and sesame.
- District Cooperative office should support producers to cooperate and sell their produce directly to processor or central market.

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APPENDIXES

Appendixes -1 Questionnaires

TITLE: Smallholder Farmers' Adoption of Soybean Production Technologies in Kondala District, West Wollega Zone, Oromia Regional State of Ethiopia

PART I

1. **GENERAL INFORMATION**

1.1. HOUSEHOLD PERSONAL CHARACTERISTICS

Date of interview………………………
Name of the respondent (Code F1) ---------------------kebele------------age--------sex---
Education status -------- Village: ---------family size------------------------
NB: Education, write the class he/she attended, -------------
Marital status. 1. Single 2. Married. 3. Divorce 4. Widowed Religion ------------------------

2. HOUSEHOLD RERESOURCE OWNERSHIP CROP PRODUCTION 2010/11

2.1. Land ownership in 2010/11 E. c

Land allocation	Land size (in timad.)
Cropped land	
Grazing land	
Coffee land	
Chat/khat	
Forest land	
Fallow and degraded land	
Homestead and others	
Total	

2.2 crops grown by households in 2010 cropping season

Crops grown	Area coverage (timed)
Maize	
Sorghum	
Ground nut	
Soybean	
Sesame	
Sugar beat	
Pepper	
Others(specify)	

2.3 Livestock ownership

Category	Total	Remark
Local Cows		
Crossbred cows		
Oxen		
Local Heifers		
Crossbred heifers		
Calves		
Bulls		

Goats		
Sheep		
Poultry		
Donkey		
Others		
Grand total		

2.4. House type and number of houses

House type	Number	Purpose
Grass roofed		
Corrugated iron sheet		

3. Social participation/membership /

In which of the following organization are you member and leader?

Organization	Member (1)	Leader (2)	Committee (3)	Non participant(0)
Idir /Iqub				
Cooperatives / union				
PA council				
Saving &credit group				
School council				
Other (specify)				

4. Distance from market center

4.1. Did you sell soybean last year?1) Yes 2) No

4.2.1. To whom you sell your product

Codes A 1) Wholesaler2) Retailer 3) consumers 4) Middlemen 5) Rural assembler

4. 2.2. Did you sell your soya bean crop during the 2010/11 E.C year of cropping Season? 1. Yes 2.No

4.2.3. If yes, where do you sell your crop? 1. at farm gate 2. Village market 3. District market 4.Secondary market 5.Tertiary market 6.Others (specify)__________________

4.2.4. At what season do you usually sell soya bean product? 1. Right at harvest 2. Latter after harvest 3. Any time I face problem 4. Other (specify):______________________

4.3. How did you transport your output? 1) Carrying 2) donkey 3) cart 4) trucks

4.4. What is the trend in market price? 1) Decreasing 2) normal 3) increasing

4.5. Which months of the year had the higher price for soya bean? ____________

4.6. How long do you store soybean? _______months

4.6.1. Market centers accessible to you? How many K.M from you? Distance to the nearest market center (in km.) ___________

4.6.2**.** Distance to the all-weather road (in K.M.) ____________

5. Contact with extension

5.1. Extension services, frequency of contact with extension agent(s), training on soybean production technologies

5.2. Do you get advisory services from extension agents? ____________ 1=Yes 2=No…….

5.3. When does extension agent visit you? ________ 1) during credit collection2) During land preparation 3) During Sowing 4) During weeding 5) When disease/ pest occur 6) during harvesting 7) During input provision 8) others (Specify)____________

5.4. For how much time regularly do extension agents contact you?

No	Frequencies of extension contact				
	Never (0)	Daily(4)	Once in weekly(3)	Twice amonth (2)	Monthly(1)

5.5. Did you visit extension agents by yourself?1) Yes 2)No
5.6. When you did first heard of improved variety of soybean? _______year
5.7. From who/, which source? 1) Fellow farmers 2)DA 3)Research 4) NGO 5) relatives 6) Others

6. Farmers' perception on ISBPT

6.1. What parameters do you consider important to select among different improved varieties soybean? Put them in order of importance.

Variety	VSD(1)	SD(2)	M (3)	SA (4)	VSA (5)	Total score
More pod per plant than local						
Easily available during sowing						
Marketable than other						
Resistant to pests and diseases						
High yield						
Not more pod per plant than local						
Not Easily available during sowing						
Not Marketable than other						
Not Resistant to pests and diseases						
Not High yield						

7. Access to training

7.1**.** Have you ever received training in soybean row planting in the last three years? ______
1) Yes 2) No
7.2**.** If yes, how many times _______________, and who arranged for you? _____________
1. OoARD 2. Research org. 3. NGO 4. Others ________________
7.3. Have you hosted demonstration in the last five years? 1) Yes 2) No
7.4.If yes, how many times-----------and with whom you conducted demonstration?
1) WAO 2) Research 3) NGO 4) Others, Specify
7.5. Distance to the nearest research center? ___________

8. Off-farm or Non-farm activities

8.1 Do you involve in off/non- farm activities? 1. Yes 2. No
8.2 If Yes, type of off and non-farm activities and their contribution for monthly income

No	Activities	Average Monthly income	Total in a year
1	Petty trade		
2	Salary employment		
3	Handcraft		
4	Grain and livestock trade		
5	Transport services/motor bike		
6	Casual labor		
7	Khat trade		
8	Others		

9. Mass media usage on soybean production technologies

Indicate your access to and frequency of use of the following media materials on

Agricultural extension programs related with soybean production.

Mass media	Do you have?		For what purpose do you use		
	Yes	No	For agricultural information	For listing news	For recreational purpose
Radio					

NB: If yes; indicate 1, 0 for never, if yes do you follow program of agricultural technology?
How many times the program transfer in a week?

10. Intensity of adoption of improved soybean varieties & its agronomic practices in2010/2011 E.C

10.1.Soybean production activities include:1) Land preparation 2) sowing 3) Weeding 4) Cultivation 5) Harvest 6) Transportation 7) Storage 8) Marketing 9) others (specify)

S.n	Soybean variety Grown in K.G ✓			Area allocated in hector			Fertilizer rate(kg)		Yield per ha
	Walloo	Local	Total	improved	Local	Total	DAP	UREA	

10.2 Which method of sowing you used in soybean cultivation?1) Spacing 2) Broadcasting 3) Both

11.3 If your answer is spacing, to which variety you used this method?1) Local 2) improved 3) Both

11.4 did you apply fertilizer in soybean cultivation? 1) Yes 0) No

11.5. If your answer is yes, to which variety you applied fertilizer?1) Local 2) improved 3)both

11.6 Area Coverage by improved variety of soybean in 2010 E.C

Subjects	Area coverage(timad)	
	High yielding variety	Traditional variety
Total area allocated for soybean		
Fertilizer(kg/ha)		
Urea(kg/ha)		
NPS(kg/ha)		
Seed rate for HYV		
Inter row spacing		

11.7 .To which variety you applied fertilizer?1) Local _ 2) improved _ 3) both

Types of soybean	Amount of seed (kg)		Amount of fertilizer applied(kg)		Area covered In 2011 E.C		Production obtained(qu)	
	Local	Improved	NPS	UREA	Local	Improved	Local	Improved

11.8. If you apply NPS fertilizer in soybean production, what amount of /kg/ fertilizer used amount per hectare? 1) 100kg _ 2) 50-80kg _ 3, less than 50 kg _

11.9. If you did not apply fertilizer in soybean production, what is your reason for not applying? 1/high price 2/not timely available 3/Farm land fertile 4/other (specify)

PART II

OPPORTUNITIES FOR SOYBEAN PRODUCTION TECHNOLOGY

1. What opportunities are found in you localities ___________

1. Availability of land 2. Rainfall 3.Sutablity of the area 4.suport from government

4. Accessibility of market 5.market demand 6.if any

2. Have you ever used packages of soybean production? 1) Yes 2) no

3. If yes, when did you start using? _____________

4. Where did you get the seed? 1) Own 2) research 3) BoA 4) traders 5) farmers

13. Key Production Challenges for soybean production

1. What are the major problems related to soybean production in your area?

Production constraints	Rank them(1,23,4….)
Socioeconomic	
Timely un availability of inputs (improved seed, fertilizer)	
Poor trashing machine	
High price of improved seed& fertilizer	
Insect pests destroy	
Problem of storage facilities	
Low price of output	
Biological	
1. Drought	
2. Floods	
3. Pests	
4. Crop diseases (rusts…)& Weed infestation	

PART III Focus Group Discussions

Date………………………… Time: From………………. To …………………….

Adoption and intensity use of soybean production technologies

1. What type of improved soybean seed variety do you grow in this area?
2. Do you get training on soybean production? **5** above, how do you access them?
3. Give examples of improved soybeanseed you grow in this area.
4. From where do you get seed? Do you use fertilizer for soybeanproduction?
6. Who provide to you? do you know methods of sowing?
7. What are the differences between IMV and local varieties in terms of production?
8. What factors have contributed to the adoption of these maize varieties?
9. What are the challenges to produce/grow soybean technologies?
10. Are there any changes that have happened in your life since you have been growing ISBPT If Yes, what are these changes?
11. In your view why do you think you the Agricultural extension officers recommend the continued use of ISBPT?
12. Who are the people in your area who seem to be benefiting from use of ISBPT? How?
13. What are the perceptions of men and women farmers on improved maize seed varieties usage?

PART IVKEY INFORMANT INTERVIEW

Time: from…………….to:………Interviewee---

Position of interviewee in society/organization: ---------------------------------------

Name of the organization/Kebele---

Interviewer---

1. What improved soybean varieties do farmers produce in the district/kebele/ now and why do they produce them? How do you compare the advantage of improved soybean production technology with local one?
2. What methods of sowing they use?
3 Are they use full packages for production of soybean?
4. How much times they plough the land for soybean sowing?
5. How much K.G seed &fertilizer they use for one hector? And how much quintal they harvest from it?
6. Where did you sell your soybean production?
7. The level of benefits from soybean production. e.g. Price per kg?
8. How do you evaluate your kebeles regarding transport facilities in relation to access the main market?
9. Which month is recorded the highest price?
10. What do think are the possible causes for the average/low adoption rate among small holder farmers?
10.1 What do you think are the major factors affecting the rate of adoption of technology among small holder farmers?
10.2 What do you think can be done to improve adoption of technology among small holder farmers in kondlala district, around your village?
11. How can the challenges be addressed? By whom?

Appendixes 2**:** Results of Tobit model and maximum likelihoods probability of being adopter or non-adopter

<table>
<tr><th>INTNSITY</th><th>Coef.</th><th>Std. Err.</th><th>t</th><th>P>|t|</th><th colspan="2">[95% Conf. Interval]</th></tr>
<tr><td>Constant</td><td>-1.3601</td><td>.49111</td><td>-2.77</td><td>0.006***</td><td>-2.3295</td><td>.3906</td></tr>
<tr><td>Age</td><td>.0084</td><td>.0029</td><td>2.91</td><td>0.004***</td><td>.0027</td><td>.0140</td></tr>
<tr><td>Sex</td><td>.1739</td><td>.1979</td><td>0.88</td><td>0.381</td><td>-.2169</td><td>.5647</td></tr>
<tr><td>Marital status</td><td>.1073</td><td>.1253</td><td>0.86</td><td>0.393</td><td>-.1400</td><td>.3546</td></tr>
<tr><td>Education</td><td>.0293</td><td>.0123</td><td>2.38</td><td>0.02**</td><td>.0050</td><td>.0536</td></tr>
<tr><td>Farm size</td><td>.0582</td><td>.0458</td><td>1.27</td><td>0.205</td><td>-.0321</td><td>.1486</td></tr>
<tr><td>Tropical Livestock Unit</td><td>-.0075</td><td>.0057</td><td>-1.32</td><td>0.187</td><td>-.0188</td><td>.0037</td></tr>
<tr><td>Cooperative member</td><td>.1129</td><td>.0613</td><td>1.84</td><td>0.067*</td><td>-.0079</td><td>.2338</td></tr>
<tr><td>Distance from market center</td><td>-.0449</td><td>.0138</td><td>-3.24</td><td>0.001***</td><td>-.0722</td><td>-.0175</td></tr>
<tr><td>Off farm in income</td><td>8.89e-1</td><td>3.23e-1</td><td>2.75</td><td>0.007***</td><td>2.51e-1</td><td>.0001</td></tr>
<tr><td>Access to inputs</td><td>.1801</td><td>.0668</td><td>2.70</td><td>0.008***</td><td>.04829</td><td>.3119</td></tr>
<tr><td>Farmers perception</td><td>-.0058</td><td>.0219</td><td>-0.27</td><td>0.790</td><td>-.0488</td><td>.0372</td></tr>
<tr><td>Farm experience</td><td>.0366</td><td>.0188</td><td>1.95</td><td>0.053*</td><td>-.0004</td><td>.0736</td></tr>
<tr><td>Access to train</td><td>-.0961</td><td>.0629</td><td>-1.53</td><td>0.128</td><td>-.2202</td><td>.0281</td></tr>
<tr><td>Frequency of extension contact</td><td>.2699</td><td>.0313</td><td>8.62</td><td>0.000***</td><td>.2081</td><td>.3318</td></tr>
<tr><td>Access to media</td><td>.0029</td><td>.0582</td><td>0.05</td><td>0.960</td><td>-.11189</td><td>.1177</td></tr>
<tr><td>/sigma</td><td>.3261</td><td>.0241</td><td></td><td></td><td>.3737</td><td>.27854</td></tr>
</table>

Number of obs = 185 Prob > chi2 = 0.0000
LR chi2 (15) = 167.29 Log likelihood = -69.508087
Pseudo R2 = 0.5462 Left-censored observations at INTNSITY<=79
106 uncensored observations

Appendixes 3: Multi-co linearity test by variance inflation factor (VIF)

	Co linearity Statistics	
Variables	Tolerance	VIF
Age	0.92	1.10
Education	0.89	1.11
Farm size	0.77	1.29
Tropical Livestock Unit	0.91	1.09
Distance from market center	0.67	1.51
Off farm income of the households	0.71	1.41

Correlations

	1	2	3	4	5	6	7	8
Sex	1							
Marital status	-0.723	1						
Cooperative member	.022	-.090	1					
Access to inputs	.015	-.066	.269	1				
Farmers perception	-.008	-.040	.165	.064	1			
Access to train	-.033	-.017	.228	.295	-.085	1		
Access to media	-.017	-.012	.117	.040	.051	.080	1	
Extension contact	.015	-.132	.078	.188	.026	.038	.159	1

Appendices 4. Conversion factor for TLU

Conversion factors used to calculate Tropical Livestock Units (TLU)		
No	**Animals equivalent**	**TLU**
1	Calf	0.20
2	Heifer & Bull	0.75
3	Cows & Oxen	1.0
6	Donkey	0.70
7	Ship & Goat	0.13
8	Chicken/poultry	0.013

Source: Strock *et al*. (1991)