EFFECT OF SOCIAL NETWORKS ON SOYA BEAN TECHNOLOGY ADOPTION AND PRODUCTION IN JIMMA ZONE, OROMIYA REGIONAL STATE, ETHIOPIA

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ASHENAFI GIRMA

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EFFECT OF SOCIAL NETWORKS ON SOYA BEAN TECHNOLOGY ADOPTION AND PRODUCTION IN JIMMA ZONE, OROMIYA REGIONAL STATE, ETHIOPIA

JIMMA UNIVERSITY

A thesis submitted to the department of rural development and agricultural extension, school of graduate study in partial fulfillment of the requirements for degree of Master of Science in rural development and agricultural extension (rural development specialization)

By

Ashenafi Girma

Major Advisor: - Abayineh Amare (Ph. D)
Co-advisor:- Tamiru Chalchisa (MA)

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As Thesis Research advisors, we hereby certify that we have read and evaluated this thesis prepared, under our guidance, by Ashenafi Girma, entitled **EFFECT OF SOCIAL NETWORKS ON SOYA BEAN TECHNOLOGY ADOPTION AND PRODUCTION IN JIMMA ZONE, OROMIYA REGIONAL STATE, ETHIOPIA.** We recommend that the thesis be accepted as it fulfills the Thesis requirement.

Abayineh Amare (Ph. D)	___________________	________________
Major Advisor	Signature	Date
Tamiru Chalchisa (MA)	___________________	________________
Co-advisor	Signature	Date

As member of the Board of Examiners of the M. Sc. Thesis Open Defense Examination, We certify that we have read, evaluated the Thesis prepared by Ashenafi Girma Kebede and examined the candidate. We recommended that the Thesis can be accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Agriculture, Rural Development, and Agricultural Extension (rural Development Specialization).

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________________________	___________________	________________
External Examiner	Signature	Date

DEDICATION

‘To commemorate of my Mother w/o **Geshegesh Bala Bikamu’**, whom I physically lost, but she were always guide me to go to school by saying ‘‘One day you will be a man, but that is far from you. if you want to come that day, do not stay at the back and remain blind as I did, but let your eyes be opened and able to see where the humankind is’’.

STATEMENT OF AUTHOR

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Name: Ashenafi Girma Kebede Signature:__________________________

Place: Jimma University, Jimma

Date of Submission: February 2020

BIOGRAPHIICAL SKETCH

The author was born on Nov, 05, 1982 E.C at Gambella Region, Ethiopia. He attended his elementary at Ras Gobena elementary school and attended secondary school (grade 9-12) at Gambella Senior comprehensive High school, Gambella. Then after he joined Haramaya University in 2002 E.C and graduated with B.Sc degree in Rural Development and Agricultural Extension in July 2004. Soon after graduation, he joined UNDP-Assisted Project called 'Promoting Autonomous Adaptation at community level in Ethiopia as project coordinator from November 1/2004-2008 E.C at different capacities. Then after, he joined Gambella Woreda risk disaster, prevention, and food security office as 'Risk disaster and avert core processor for 2 year. He joined Jimma University Post graduate studies to pursue MS.c study in Rural Development and Agricultural Extension (Rural Development specialization). He is married and had one son.

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LIST OF ABBREVIATIONS AND ACRONYMS

BoARD:	Bureau of Agriculture and Rural Development
BoA:	Bureau of Agriculture
CEDEP:	Consultants for Economic Development and Environmental Protection
CSA:	Central Statistical Authority
DAs:	Development Agents
FAO:	Food and Agriculture Organization of the UN
FHH:	Female Headed Household
Ha:	Hectare
ILDP:	Integrated Livestock Development Program
IPMS:	Improving Market Productivity and Market Success of Ethiopian Farmers
KM:	Kilometer
M.A.S.L	Meter above Sea Level
MHH:	Male Headed Household
MOA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
NCFs:	New Coalition for Food Security
NGOs:	Non-Governmental Organizations
Pas	Peasant Associations
PLWs:	Pilot Learning Woredas
PLS	Pilot Learning Site
PRA	Participatory Rural Appraisal
SPSS	Statistical Packages for Social Sciences
WoARD	Woreda office of Agriculture and Rural Development

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Abstract

The importance of social networks and their effects on the development process have gained wide recognition among academicians and practitioner's; Social networks play a significant role in learning and in farmers' adoption of new agricultural technologies. Thus, the study was carried out to identify effects of social networks on soybean technology adoption and its production. To meet the objective of the study, multistage sampling procedure was used to select Woreda, Kebles and 386-sample respondents Moreover, both qualitative and quantitative data were collected have reliable information from primary and secondary sources. Data were analyzed using descriptive statistics, inferential statistics (T-test and chi-square test), and binary logistic regression model. Social Network Analysis (Ucinet software, version6) were used as a tool to analyze the existing social networks. The results identified three type of social networks for dissemination of soya bean technology, which include: bonding, bridging and linking, among them about 82.5% of adopters and 17.5% of non-adopters involved in all type of bonding, bridging and linking of social networks. Those involved in all bonding, bridging, linking social network had the highest level of output (4.75 quintal/household), and those involved in single social network had 1.5 up to 4.125 quintal/household of soya bean production. The binary logistic regression model output showed that, family size, off/non-farm income, training for soya bean, bridging, linking, bonding and bridging, bridging and linking, all bonding, bridging, linking were found to have positive and significant influence on the adoption of recommended soya bean technology. Likewise, education and marital status have negative and significant influences on adoption of soya bean technology. In general, study showed that involving of all in bonding, bridging, linking social networks, relatives, friends, and neighbors were the most important nodes of information, seed sources; influential networks in the adoption of recommended soya bean technology and soya bean production in the study area. Therefore, government and nongovernmental organization should emphasized on capacity-building program on social capital strengthen strategy and more research investments in understanding the differentiated outcomes of these forms of social networks on use and adoption of technologies to further guide agricultural interventions.

Keywords: - Social networks, unicet software version 6 , technology, adoption, Soybean, Jimma Zone.

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Soya bean is number one on the world import list of agricultural products based on value FAOSTAT, (2018) representing that it is one of the most agricultural product traded and consumed globally as an alternative protein source to the rural families and can be utilized at home in different forms.

Soya bean production also has possible agronomic benefit of rejuvenate soils. Soya beans are highly palatable, high in unsaturated fatty acids and contain no cholesterol (Singh *et. al*: 2012) Soya bean canopies protect the soil from recurrent erosion, fix atmospheric nitrogen into the soil and moldy root residues improve soil fertility thus supplements agriculture with minimal input requirement(Lubungu, 2013).

Malnutrition is a sober public-health problem that has been associated to a substantial increase in the risk of humanity; especially women and young children are the most trouble bearer of the problems related to starvation (ACC/SCN, 2017). Malnutrition and specific nutrient deficiencies are the leading underlying cause of immune deficiency, most important to infections and other diseases. As a result, diversification of food consumed with protein-rich legumes such as soybean is best solutions to protein-calorie malnutrition, particularly in emergent countries (Burstin, *et al.*, 2011).

Despite huge benefits and good environmental condition in Ethiopia for soya bean production for smallholders, soya bean technology adoption and productivity remains imperfect. These may interrelated with low input usage (such as improved seed varieties and fertilizer), major post-harvest loss, population pressure, poor farming practices, land degradation and hidden unmeasured social network variable (Negatu,2004; Rashid, *et al.*, 2010; Yao, 2002). Lack of credible information is one potential constraint for adoption, and social relationships can serve as important vectors through which farmers learn about, and influenced to adopt new agricultural technologies (Munshi, 2004, Bandiera and Rasul, 2006, Conley and Udry, 2010). Among the explained constraints, differential access to social networks is one possible explanation for the large variation in adoption of technology and productivity (Fan *et al*., 2000; Murgai *et al*., 2001).

Even though there are wide literature on the adoption of technology related with social networks and social interactions (Rogers, 2008; Feder *et al*, 2009, Feder and Umali,2009; and Foster and Rosenzweig,2010), studies on Ethiopian agriculture largely ignore the effects of social networks on technology adoption and agricultural productivity.

1.2 Statement of problem

A comprehensive study by Monge *et al*.,(2008) on how interactions in social networks affect adoption of new technologies among farmers in Bolivia highlighted that the denser the interactions between farmers and agents with whom they have weak ties, the higher the expected adoption intensity. However, once a technology was adopted in a given community its diffusion rate was influenced by strong ties. Flow of information among farmers and similarity in farmer characteristics also play a role in learning in social networks. Farmers involved with high yielding wheat and rice varieties in India found that information flow disjointed and learning within networks was threaten among rice farmers where there was much heterogeneity in growing conditions and population characteristics. In contrast, among wheat farmers who shared similar farming characteristics, both the flow of information and social learning were robust. To compensate for lack of social information, the rice farmers, who lacked the extended networks enjoyed by wheat farmers, tended to experiment on their own farms compared with wheat producer (Munshi, 2004).

Conley and Udry, (2005) in their study of fertilizer technology adoption by pineapple farmers in Ghana also found that information flow and learning in social networks was strong among farmers with similar characteristics. Additionally, they found that other factors were connected to technology adoption including credit access, growing conditions, clan membership, and religion. Accounting for these other factors, they concluded that farmers were prejudiced most by information from their experienced neighbors to make adoption choices. This study from Ghana demonstrates that learning is enhanced when information is available in a social system, but adoption decisions may also be affected by other location specific factors.

Social network factors and tie strength as well as individual characteristics can influence farmers' learning and adoption behaviors in different ways and at different times in the adoption process. For example, Foster and Rosenzweig, (2005) examined how learning by doing and learning from others influenced adoption of high yielding varieties of wheat and rice at the onset of the Green Revolution in India. They bring into being that the impact of learning from others with more experience was outstanding early in the changeover to new technologies. Over time, however, farmers' own experiences evolved to have more influence on their decisions. Similar to (Monge *et al*. 2008) Foster and Rosenzweig concluded that social relationships connecting farmers to their peers helped to promote information sharing and decision-making regarding adoption of new technologies. However, decisions to adopt were also influenced by farmers' inter linkage relationship rather than intera-relationship with outside the community.

In sum, farmers' learning in social networks have influenced by the different of factors. It is a continuous process involving farmers' processing information from a variety of sources (Diouf *et al*. 2000) including (a) their own experiences, (b) the experiences of other farmers, and (c) the nature of their ties (strong or weak) with other farmers and network members. Numerous researchers (e.g., Doss 2006; Hoang *et al*; 2006; Manski 1993; Matuschke 2008) have identified a gap in understanding the role these various social network factors have in acquiring information and adopting a new technology.

As Dessalege,(2008) indicated, Bridging social networks have the only effects on sorghum variety whose impacts were related to previous and recent settlers as well as male and female headed households in terms of membership in different economically oriented groups ,associations and participation in social networks while ignoring bonding and linking social networks. Hence, to the knowledge and in the context of Ethiopia and particularly in Jimma zone, effects of social networks (Bonding, Bridging, linking), in food crop production particularly on soya bean technology adoption were weak or missing has not been investigated more. The study was designed to address this gap. It highlights effects of social network factors in adoption of soya bean technology and production.

1.3 General objective of the study

The general objective of the study is to **analyze Effects of social networks on soya bean technology adoption and Production in Jimma Zone Oromia National Regional State, Ethiopia**

1.3.1 Specific objectives

- To identify type of social networks used for soya bean technology dissemination in the study area.
- To analyze effects of social networks on soya bean technology adoption in the study area
- To determine factors affecting soya bean technology adoption in the study area.
- To analyze effect of social networks on soya bean production in the study area.

1.4 Research question

1. What type of social networks existed for adoption of soya bean technology in the study area?
2. What are the effects of social networks on the adoption of soya bean technology in the study area?
3. What are the determinants of soya bean technology adoption?
4. What are effects of social networks on soya bean Production in the study area?

1.5 Significance of the Study

In the past, adoption and diffusion research has been conducted with minimal consideration for social capital variables (type of social network like bonding, bridging, linking). Because of these and other factors, the degree of adoption of technologies and production was very low. The paper contributes to the current debates in social networks by providing a qualitative, quantitative method for the measurement of the different forms of social networks and the relationships that these have with the adoption of technologies by soya bean producer. At the same time, better understanding of such networks can lead to the identification of policies that complement existing networks already serve the poor well, and to policies that can substitute for networks that simply are not reaching the poor.

1.6 Scope and Limitation of the Study

The study was a micro level study limited in to two Woreda of Jimma zone, Oromiya Region. The study was carried out by surveying a sample of randomly selected sample population farm households from Kebles , it is not possible to study the entire farming population in the Woreda. The study area was a diverse area in terms of culture, social capital, agro ecology, resource endowment. Therefore, this study cannot be typical or warrant generalizations for the entire Jimma zone in general, or the region in particular. However, recommendations and policy implications of this study was used in other locations having comparable or similar context (socio-economic characteristics).In addition; this study was also limited in terms of, time, resource availability, and being cross-sectional data. Nevertheless, the result of this study has been practical validity mainly to areas having similar features and can be used as a reference for other similar areas.

1.7 Organizations of The thesis

The thesis consists of five chapters including the introduction, literature review, methodology, results and discussion, and conclusion and recommendation. Chapter 1 gives a general overview of the context of the study, followed by the study objectives and the organization of the thesis. Chapter 2 contains a literature review of the current concept and definition of terms; and social networks, social capital, adoption, recommended technology, empirical evidence and conceptual frameworks. Chapter 3 presents the study area and hypotheses of the study, as well as the methods used. Chapter 4 presents and discusses the results of the study, while Chapter 5 concludes the study and provides recommendations for further research.

2- LITERATURE REVIEW

2.1 Definition and Concept

2.1.1 Social capital

“Social capital” is defined by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors whether persons or corporate actors within the structure. Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible” (Coleman, 1988: S98). “Social capital refers to the norms and networks that enable collective action” (The World Bank). "The rules, norms, obligations, reciprocity and trust embedded in social relations, social structures, and society’s institutional arrangements which enable members to achieve their individual and community objectives" (Narayan, 1997: 50).

“Social capital may be defined operationally as resources embedded in social networks and accessed and used by actors for actions. Thus, the concept has two important components: (1) it represents resources embedded in social relations rather than individuals and (2) access and use of such resources reside with actors” (Lin, 2001: 24-25). “The basic idea of social capital is that one’s family, friends and associates constitute an important asset, one that can be called upon in a crisis, enjoyed for its own sake, and/or leveraged for material gain” (Woolcock,2001: 12). Some definitions focus on what it is, its sources, while others focus on what it does its outcomes and consequences. It is also referees to variously as an attribute of individuals or of communities. It is useful therefore to consider social capital as a multidimensional, overarching term, rather than a singular concept in itself “a code word used to federate disparate but interrelated research interests and to facilitate the cross-fertilization of ideas across disciplinary boundaries” (Durlauf and Fufchamps, 2005: 1642).

Social networks could explain both at community level and at individual level. At community level, the structural component of social capital defined in terms of the density and diversity of associations (institutionalized social networks) within a community. At the individual level, structural definitions consider social capital as embedded in the network of friends, relatives and acquaintances (private social networks) an individual interacts with based on "norms of reciprocity". Although institutional social networks could also compose of friends or relatives as members, they differ from private social networks in their structure and functioning (Katungi, 2007).

It understood that social capital are not considers as a single entity, rather it is multidimensional. There are many definitions, controversies over the definitions and ways of explaining this concept. However, it understood that, social capital is a network of people or institutions and organizations that can improve the efficiency of society in general and individual Households in particular. Therefore, for this study, social capital means the formal and informal networks of people, institutions, and organizations that facilitate the exchange of social resources (information, knowledge, inputs etc) in the process of improving the livelihood of Households and the well-being of the society.

2.1.2 Social networks

A social network is defined as a set of individuals or groups who are connected to one another through socially meaningful relationships (Wellman & Berkowitz, 1988). This definition can be refined further: a social network is a finite set of actors who are connected to one another through relations. A social network can consist of groups and sub-groups of actors. Examples of such socially meaningful relationships include family, friends, or relations based on trust, giving advice, or sharing information. Before specific characteristics of social networks can be explored, or their quality investigated, the network type being studied in any given social capital research must be identified (Stone, 2001).

Other define a social network as a set of actors or nodes (individuals, agents, or groups) that have relationships with one another (Hanneman and Riddle 2005; Marin and Wellman 2010). Social networks evolve due to ties between actors, which may arise because of kinship, affection or familiarity between them (Easley and Kleinberg 2010). The simplest social network is a dyad (pair of linked actors), in which one actor (whose network is being studied), is referred to as the ego, and the other as the alter (Smith and Christakis, 2008). This raises the question for the study, whether the number of connections an actor has determines their exposure to Soya bean technology adoption. To address this question, the study applies the concept of node-level properties of social networks, particularly centrality measures in net-draw visualization form (Borgatti, 2005). These measures determine positions and power of network actors, which predispose them to opportunities and constraints that determine outcomes (House, *et al.*, 2007; Borgatti, *et al.*, 2009). Key among centrality measures is degree, which refers to the number of other actors to which an actor is directly connected (Newman, 2010). The study was hypothesize that respondents with a higher network degree occupy positions that predispose them to more learning opportunities about improved soya bean technology; hence, they are more likely to have a higher intensity of exposure than those with a lower degree.

2.2. Typology of social networks

Woolcok and Narayan, (2000) see bonding social networks as operating as a defense mechanism against poverty, whereas bridging social networks is what is required for real economic growth to take place. They see bonding social networks as what communities use to get by and bridging social networks as what they use to get ahead. (Leonard and Onyx, 2003), however, argue that bridging social networks should not replace bonding social networks and linking social networks as communities have multiple sources of social capital that they draw on for different functions. The three types of social networks, therefore, complement each other, in that the strong bonds existing in bonding social networks are diversified by the existence of bridging social networks, whose bonds are weaker but more cross cutting, hence enabling increased diversity in an otherwise closed community.

2.2.1. Bonding social networks

“Bonding” occurs in relatively “alike” groups. It typically arises in connections and ties among families or specific ethnic or kinship-based groups. It might also arise within a particular social group bound together by shared identities, interests, and place of residence. Frequently the term bonding social capital is confused with the notion of “strong ties”. In practice, “strong ties” do involve bonding social capital in the sense that they arise from relationship among “alike” members of a network. Bonding social capital complemented by strong ties can provide important emotional, personal, and health-related benefits to its members through close support for getting by in life (Woolcok and Narayan, 2000).

2.2.2 Bridging social networks

“Bridging” social capital connects different types of people and groups (e.g. ethnic, social, gender, political or regional) and can be particularly effective for people seeking social and economic gain beyond their immediate society for getting on in life. This type of social networks arises when associations and connections are made across social, geographical, or strong ethnic “identity” lines. Weak ties and “structural holes” (Burt, 2000) may facilitate reaching out to new ideas, persons and resources.

2.2.3. Linking social networks

“Linking” social networks connects groups and individuals to others in a different social position (e.g. more powerful or socially advantaged). It includes also relations and interactions between a community and its leaders and extends to wider relationships between the village, the government, and the market place. Many scholars also agreed that three element need to be in balance. If bonding is too dominant, for example, it can lead to neighborhoods becoming inward looking and intolerant of outsiders and change. Its residents cannot "get ahead". This can lead to racism and ethnic based social relation (Leonard and Onyx, 2003).

Robert Putnam, 1998 cited in Stone, (2001) distinguishes between informal and formal networks, what he terms formality of civic engagement. Informal ties, according to Putnam, include those held between family, kin, friends and neighbors, whereas formal ties include ties to voluntary associations and the like. Among informal networks, distinction is first made between families within and beyond the household, as it is anticipated that family units within one household cooperate and function in different ways to extended networks of kin beyond the household. Informal ‘communities of interest’ beyond family and kin include friendships and other intimate relationships as well as bonds among neighbors. Formal networks of social relations concern those aspects of life most often described as civic (Baum *et al.*, 2000) or institutional. These include associations with formally constituted groups, as well as non-group based activities.

2.3 Common networking terminology

In addition to defining social networks, some common social networking terms need to be explained in order to understand the social network approach more fully. The following definitions are summarized from (Wasserman and Faust, 2002).

Actors: - these are the nodes in the network. An actor can be an individual, a group, an organization, or even a nation-state.

Ties: - These are the links between actors. These ties can be reciprocated, or unreciprocated, and they can be directed (e.g. a person giving another person money) or undirected (e.g. two people working at the same organization).

Relations; -A relation is a specific type of tie between actors in a network. There are many different kinds of relations: communication or social interaction, friendship, reciprocity, trust, diplomacy, advice, and so forth.

Group:-This is a bounded collection of actors on which ties are to be measured. One must be able to argue theoretically, empirically, or conceptually that the actors in this set are tied to one another and are more or less bounded. The actors belong together in a bounded set, one in which the number of actors is finite and the boundaries around this set of actors are clearly defined.

Norms of reciprocity:-Reciprocity is the process of exchange within a social relationship whereby ‘goods and services’ (meaning exchange of any kind) given by one party are repaid to that party by the party who received the original ‘goods and services’. Reciprocal relations are governed by norms, such that parties to the exchange understand the social contract they have entered into (Stone, 2001).

2.4 Adoption

Adoption of an innovation within a social system takes place through its adoption by individuals or groups. According to (Feder, *et al*; 2003), adoption may be defined as the integration of an innovation into farmers’ normal farming activities over an extended period of time. (Dasgupta, 2002) noted that adoption, however, is not a permanent behavior. This implies 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. (Feder *et al.*, 2003) classified adoption as an individual (farm level) adoption and aggregate adoption. Adoption at 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 potentials. In the context of aggregate adoption behavior, they defined diffusion process 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 (Dasgupta, 2002).

2.4.1 Technology Adoption

Adoption and diffusion of technology are two interrelated concepts. Adoption commonly refers to the decision to use a new technology or practice by economic units on a regular basis. Diffusion often refers to spatial and temporal spread of the new technology among different economic units. Many scholars defined the two concepts in relation to their own fields. Among others, the definition given by (Rogers, 2004) is widely used in several adoption and diffusion studies. He defined diffusion as the process by which a technology is communicated through certain channels overtime among the members of a social system. Rogers, (2003) then defined adoption as use or non-use of a new technology by farmer at a given period of time.

Adoption is integration of an innovation into farmer's normal farming activities over an extended period. Furthermore, adoption classified as an individual 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, they defined adoption process as the spread of new technology within a region. This definition implies that aggregate adoption are measured by aggregate level of use of a given technology within a given geographical area (Feder; *et al*., 2003)

The adoption decision also involves the choice of how much resource (i.e. land) to be allocated to the new and old technologies if the technology is not divisible (e.g. improved seed, fertilizer, and herbicide). However, if the technology is divisible, the decision process involves area allocation as well as level of use or rate of application. Thus, the process of adoption decision includes the simultaneous choice of whether to adopt a technology or not and the intensity of its use. Peter, (2012) while quoting Pannell earlier work of 2006 on his study factors affecting farmers' adoption of agricultural innovation says the adoption of agricultural technology depends on a range of personal, social, cultural, and economic factors, as well as on the characteristics of the innovation itself.

2.5. Soya bean production in Ethiopia

Soybean is one of the oldest crops raised by man (Glycine, 2008.). It was first grown in East Asia about 5000 years ago (BIDCO, 2005). It has a high commercial value and contains all the amino acids required by the human body except methionine, usually found in cereals such as maize (Osho, 2000). Of all grain legumes, soybean has the highest concentration of protein. While most other grain legumes contain about 20% protein by volume, soybean contains about 40% protein. It is important to note that beef and fish contain about 18% protein. Soybean products are cholesterol free and high in calcium, phosphorus, and fiber (Greenberg and Hartung,1998). Soybean provides more protein and low levels of saturated fat (Bidco, 2005) than most other vegetable grains. About 19 African countries are recorded in the world soybean production statistics compiled by FAO. These countries and the proportion (%) of African soybean production that each accounts for are: Nigeria (48.9%), Uganda (16.8%), South Africa (14.9%), Zimbabwe (8.4%), Ethiopia (2.7%), Rwanda (2.0%), Egypt (1.7%), and DRC (1.4%) (FAOSTAT, 20016).

Soybean first cultivated in Ethiopia in 1950s. The years 1956 to 1971 were a trial period of selecting promising varieties and suitable growing areas. During this year about twenty varieties were introduced from various parts of the world and were tested by Ethiopian institute of agricultural research. In 1974 soybean was introduced to the farm population. The aim was to replace the soybean flour imported for Faffa production with flour made from locally grown soybean and to introduce this new bean into Ethiopian diets. However, the farming community (Whigham, 1974) discontinued all the efforts made to multiply the soybean and bring it to the local community because of low acceptability.

Today in Ethiopia, soybeans are used in both the public and private sectors. In the public sector, soybean is used commercially in the manufacture of Faffa food, Cerifam and Famix by Faffa food factory. In the private sector, it is used as milk, Injera, and bread in addition to this it is used as feed for dairy, export beef, and poultry sector. Access to local markets appears to be the main constraints in Ethiopia where local soybean production could improve farmers' income and the sustainability of the production system. Often soybean is imported into country by the local vegetable oil and feed industries and as a consequence the demand for the crop is decreasing in the farming community (Bezabhe, 2010). There are favorable climatic and soil conditions for soybean production, especially in south and western Ethiopia, which are essential for both commercial purposes as well as for subsistence farming (PARC, 2010). In spite of the importance of the crop and efforts made to enhance its production, the productivity of soybean on farmer's field has been low *i.e.,* 3.20 – 20.00 qt/ha.

Soybean production in Ethiopia currently is at 610,249.16 quintal at an average yield of 20qt/ha. According to CSA from 31,854.75 hectares of land 636,531.01 quintals of soybean was produced during 2012/2013 production period. It is further indicated that the increase in area planted over 10 years until 2012/2013. This was the greatest production registered from 2003/2004 to 2013/14 and its status is increased though time to time up to 2017/18. Therefore, the average production was 19.98 quintal per hectare. The yield increased to 20 quintals per hectare in 2013/2014 from 4.46 quintals per hectare in 2003/2004 up to 2017/18 production season.

Table 1:- Area under cultivation, productivity and production of soya bean in Ethiopia

Years	Area (hectare)	Productivity (quintal/hectare)	Production (quintal)
2003/04	1027.0	4.46	4574.0
2004/05	2606.0	3.20	8335.0
2005/06	3327.0	11.5	38119.0
2006/07	6327.0	9.20	58489.5
2007/08	7807.4	10.8	84006.4
2008/09	6236.4	12.7	78988.9
2010/11	11264.1	14.1	158244.2
2011/12	19397.2	18.5	358802.9
2012/13	31854.7	19.9	636531.0
2013/14	30517.4	20.0	610249.2
2014/15	32616.5	21.00	632347.1
2015/16	31944.5	20.4	609889.8
2016/17	34845.9	20.9	
2017/18	33678.9	21.6	647687.2

Source: - CSA, 2010-2018 report

The growth trend of production of soybean in Ethiopia shows up and down movement for the last fifteen years. This may be because of market problem of the crop, processing problem and unavailability of drought resistant and high yield crop varieties.

2.6. Leverage of Social Networks in Adoption of Technology

The literature that exists concerning the influence of social networks on different social, economic and institutional aspects is too diversified to be exhaustively reviewed here. Therefore, only those studies that was directly or indirectly related to the variables of this study were reviewed. Relatively speaking, only few studies have been conducted on the influence of social networks variable on technology adoption and production. This could be attributed to the recentness of the concept, which addresses the important role of social networks variables. Application of the social networks concept in agriculture has shown that communities with higher levels of participation and local organizations are more efficient in information sharing and more receptive to extension projects, and therefore more likely to use modern agricultural inputs than those without.

Mozambique Farmers would be exemplary than more likely to adopt if other people in their network also adopted, In these research, three quarters of farmers reported being more likely to adopt if a family member adopted. Around half said they would be more likely to adopt if a friend, neighbor, or a friend from their church adopted. The influences of networks does not pass the boundary of the village, only five percent said they would be more likely to adopt if a friend from another village adopted (Bandiera and Rasul, 2003). Several studies have documented that households who are actively involved in social networks are better insured against unforeseen risks of failures or financial losses than households who are less involved in social networks and have few relatives (Barlett, 2002). (Masuki *et al.*, 2004) highlighted that group networking, number of years spent in formal education, age of head of household and pathways of agricultural information all affect the intensity of adoption positively and significantly. (Agbamu, 2005) also indicated that, information sources that positively influence the adoption of technologies could include other farmers; media; meetings and extension officers.

Indeed, studies of innovation adoption and diffusion have long recognized information as a key variable, and its availability are typically founds to correlate with adoption (De Harrera and Sain, 2000). (Doss and Morris, 2001) in their study on adoption of improved maize technology in Ghana basically suggests that gender-linked differences in the adoption of modern maize varieties and chemical fertilizer are not attributable to inherent characteristics of the technologies themselves but instead result from gender-linked differences in access to key inputs. (Swan and Newell,1995) argued that the network of professional organizations was the single most influential variable in determining the adoption of new technology by firms (accounting for 18% of the variance). Similarly, Chaves, (2000) indicated that the existence of religious networks almost doubled the probability of adoption of the practice of ordination of women.

Wellman (2004) showed that the larger the network, the greater the chance of finding at least one member able to provide resource (information, labor, inputs like seed etc to their members). In addition, the larger the network size the greater the chance that several individuals possess the same resource, thereby avoiding the need to refer constantly to the same individual for resource (information, labor, inputs like seed etc). Wellman has also demonstrated that the more the members of a network are interconnected (network density), the greater the chance of similarity of the resources they exchange among themselves. In a dense network, exchanges occur more easily and are better co-ordinate, although the accessible resource may be less varied. The inverse is true for networks with weak interconnections among members.

According to Narayan, (2000), strong networks and membership-based organizations extended beyond the family and immediate community are essential to help poor people gain access to other assets and resources. It had been found, however, that political participation in the related to the degree of involvement one has in the social system. Participation in institutional areas other than the political systems provides one with a network of contacts, which mediates between the individual and the political process and functions as a catalyst for political participation (Van and Robert, 2003).

Finally, from the above empirical evidence, the study was gathered, it is increasingly recognized that information on agricultural innovations diffuses through social networks rather than being freely available in the village. Social networks play a crucial mediating role in the process of technology uptake in rural farm communities. The study were stick on to this view in studying the effect that social networks may play in facilitating information exchange in soya bean technologies among rural households in Kersa and Ommo Nada Woredas of Jimma zone.

2.7 Effects of social networks on adoption of technology

Individual nodes and links among them through which information, money, goods or services flow define a social network. The importance of a link is not the same as the frequency of exchange over the link – e.g., Granovetter, (1973) finds that ‘weak’-low frequency links are more important in the job search process than ‘strong’-high frequency links and, more generally, different links may have different value and behavioral influence. A given link may be unidirectional i.e., flows are one way only, as from trade publications to farmers or from master farmers to novices or bidirectional and a network may mix links of both types.

Identifying and measuring the effects of social networks also called ‘social interaction effects’ on technology adoption is not a trivial matter (see, e.g., Manski 1993, Brock and Durlauf, 2000). The first challenge involves identifying appropriate reference groups who is in an agent’s network? Is network defined by prospective/hypothetical or retrospective/activated links? Does one include just direct (‘first order’) links or also indirect (‘higher order’) links? Once one identifies the network, obtaining an accurate picture of a farmer’s social network from the information contained in a limited sample is not straightforward either. Existing methods of doing so all have shortcomings, as we discuss further below. Second, even if social networks are well-measured, inferring causal social interaction effects from correlations in individuals' behavior is difficult. Within an identified reference group, there almost surely exist correlated attributes among individuals. Agents’ behaviors and characteristics affect not only the formation and structure of social networks, they may likewise influence the behaviors of other network members, giving rise not just to changed economic outcomes but also to feedback that causes network structure to evolve endogenously (Barrett 2005, Jackson 2008, Stephens 2009, Chantarat and Barrett forthcoming).

Therefore, whether these matching and selection effects, a common external (agro ecological or economic) environment or other confounding factors, spurious correlation in behaviors and outcomes often leads analysts to overstate the importance of social interaction effects. A third challenge arises when agents interact and change behavior simultaneously, generating a ‘reflection problem’, essentially, making it difficult to separate endogenous from exogenous effects (Manski, 2017).

2.8 Soya bean technology Adoption

Several studies in Africa including in Ethiopia shows that adoptions of improved agricultural technologies, though variably and incompletely, had positive impacts on income, food security and poverty reduction (Wanyama *et al*, 2010; Solomon *et al*, 2010, Adekambi, *et al*, 2016, Setotaw *et al*, 2003). Despite its huge impact on food security and livelihood different factors affect adoption of agricultural technologies. Those factors were discussed classified in to socioeconomic, technology specific and institutional factors.

The result of different researchers done on different countries on different agricultural technologies explored different socioeconomic variables hypothesized to affect adoption. Shiyani *et al*., 2000 on his study on the adoption of soya bean shows that farm size is significantly but negatively affects the adoption, which was also consistent with the finding of (Allaudin and Tisdell, 2016). The coefficient of farming experience were found to be significant at 5% in influencing decision to adopt improved soybean seeds because more experienced farmers might have better skills and access to new information about improved technologies (Idrisa *et al*, 2012). There is positive and significant relationship between farmers", expenditure on hired labor and adoption of improved soybean seeds in the study area. Meaning, soybean farmers who could afford to hire labor will tend to maximize returns on investment in soybean farming (Idrisa *et al,* 2012).

On another research, Mustapha, (2012) showed that the educational level, farming experience and sources of information had significantly and positively influenced the adoption of improved soybean production technologies by respondents while age and farm size had significant but negative influence among the respondents. The negative influence of age could be expected because of the fact that as a farmers grow old, there is tendency to reduce level of adoption as their ability to cope with various farm operation diminishes. The result indicated that sex and household size had no significant influence. Level of education of the respondents was a very important factor ($\rho \leq 0.01$) that influenced the extent of adoption of improved soybean seeds as production technology in the study area (Feder *et al*., 1985; Mustapha *et al*, 2012; Weir and Knight, 2000). They also confirmed that there is a positive and significant relationship between household size and the extent of adoption of improved soybean seed as production technology. Family size had been recognized to play a vital role in the adoption of any particular technology or farm practice since it provides the human labor and management inputs.

The second core factor to affect adoption of agricultural variables is technology-specific factors. According to (Idrisa *et al*, 2012), among the technology specific characteristics considered for the study, the results showed that: respondents" utilization of soybean at household level, maturity period of soybean and yield of soybean were found to be significant in influencing the decision to adopt improved soybean as production technology. This agrees with earlier findings by (Sanginga *et al*, 2000) that household utilization formed a major reason for the adoption of soybean. Maturity period was also founded to be an important determinant influencing the adoption of improved soybean seed as production technology. The variable was significant at 5% probability level with negative sign. This is expected as early maturity gives the crop an advantage, especially in the study area, which is prone to drought. Yield of soybean was also found to be a very important factor that influenced the adoption of improved soybean seed among farmers. The yield variable was found to be positive and significant at 1% level of probability. This finding agrees with (Adesina and Zinnah, 2002) on the research done on improved mangrove swamp varieties of rice in Sierra Leon.

Access to credit was found to be important in influencing the likelihood of adoption of improved soybean seed among farmers (Ouma *et al*. 2006). This is partly explained by the fact that most agricultural technologies require complementary inputs such as fertilizers and pesticides. Access to extension services and frequency of contact between farmers and extension personnel positively and significantly influenced the extent of adoption of improved soybean seed by the respondents. Extension contact determines the information that farmers obtain on production activities and the application of innovations through counseling and demonstrations by extension agents. Accordingly, frequent contact with extension has improved cassava adoption in southwestern Nigeria (Polson and Spencer, 2000) and improved maize in northern Tanzania (Nkonya *et al*., 2000).

In assessing the performance of any agricultural research, it is important to know the extent to which technologies generated by the project have spread throughout the target population and to understand the factors that have influenced the adoption process. According to Morris *et. al*, (2001) four indicators of impact assessment of technologies: agricultural productivity, farmer incomes, nutritional status, and gender equality. However, as above explained there is no any research that made all independent variable as social network factors, because seeing this factor will help to decide in what level adoption of soybean technology is affected. So the study was first identified soya bean technology adopter and non adopter then identified effect of social networks that adopter and non adapter of soya bean technology using appropriate model.

2.9. Effects of social network on soya bean production

There was a gap of research related to social network analysis at a Woreda level to measure the relationship between the network actors (regions and types of grains) to assist the producer in the planning of agricultural production. The analysis included data extracted from the following variables: areas planted per hectare, yield, and production (Conab, 2014). In this context, for effectiveness in soya bean production, new forms of agricultural planning can be performed based on the centrality of the network, i.e., other technological applications in terms of resources and enhancement techniques can be employed in Woreda with the highest centrality. The degree of centrality measures the number of links between actors in the network, allowing inclusion of the strategic position of each actor (Scott, 2000). From this, emerged the following research question, which area has the greatest impact on soya bean productivity in relation to the planted area, yield per hectare, and production per hectare? To answer this question, these researches chose to analyze Social Networks. These structures can be defined by the reciprocal relationship between independent, but economically interdependent, cooperatives, aimed at cooperation to achieve common goals (Powwe, 1990, Williams, 2002, Borgatti, 2003).

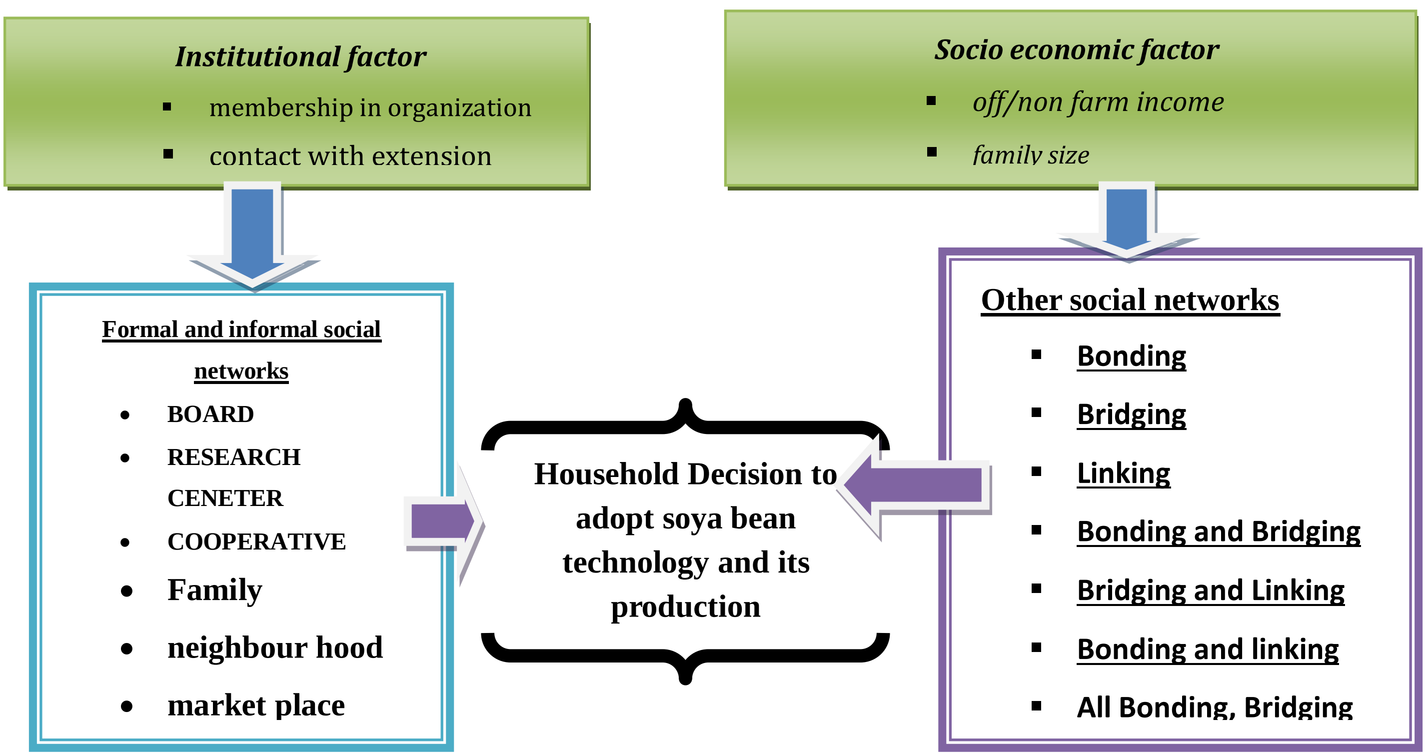
The structure of the network and the position of the actors can affect the functions of the organization, families, friends and their skills in generating value (Lazzarini, 2008). Connectivity, which is the ability to link each individual network, can be represented by the intensity and frequency of communication between the actors (Borgatti, 2009). The most common representations of networks are those in which the nodes represent actors and ties, allowing transfer of information (Krackhardt, 2000). We can classify the links / bonds by their intensity, denoting absent, weak, and strong ties (Granovetter, 1995).

Thinking of the research question, this study aims to assess which area of the study in 2010/2011 harvest had strong and weak social network in relation to the acreage productivity per hectare. This can help other producers with agricultural planning and will present the factors that influence the culture of soya bean production. This analysis was done using Ucinet software. By applying network analysis with relational matrices, and the visual analysis of graphs of these same networks, it allowed the finding of new indicators, other than those offered by traditional statistical analysis with specific focus on the degree of centrality.

2.10 Conceptual Framework of the Study

The conceptual framework indicates that Adoption of soya bean technology and soya bean production could stem from various actors at macro or micro level and channeled into a given social system through formal or informal social networks. Decision making at household or individual level to adopt and diffuse these technology depends on the preference, trust, solidarity, and cooperation of the household or individuals towards the members of the networks. It is hypothesizes that, rural individuals or households rely more on informal social networks than formal ones for information and material exchange, which is the crucial element of the adoption and production process. The bold arrow in the study were carried out indicates, households or individuals are more influenced by their informal and formal social networks (Peer pressure) to adopt and production a given soya bean technology.

Figure 1:- conceptual frame works



Source: - own formulation

3 RESEARCH METHODOLOGY

This chapter consists of description of the study area, research design (sampling design and sampling methods), data collection methods, and data types and methods of data analysis.

3.1 Description of the Study Area

Jimma Zone are one of the 18 zones of Oromia Regional State located to the Southwest of Ethiopia , The zone has 17 woredas & one town administration with a total population of 2,780,549 (CSA, 2015). Jimma is far from Addis Ababa in Southwest 345 km and lies between 36° 10´ E longitude and 7° 40´ N latitude. The zone has an elevation ranging from 880 to 3360 meters above sea level (masl). The area experiences annual average rainfall of 1000 mm for 8 to 10 months. The main rainy season extends from May to September and the small rainy season takes place in February, March, and April. The temperature of Jimma zone varies from 8-28°C. The average annual temperature is 20°C. The agro-ecologies of the area have an altitude range of 1000-1500 (lowlands), 1500-2500 (intermediate), and 2500-3360 masl (highlands). The study had conducted in a two purposely-selected rural administrative Woredas of Jimma zone of Omonada and Kersa Woreda. They are cultivator of soya bean production.

Kersa is one of the 17 districts found in Jimma Zone, Oromia region, southwest Ethiopia. It situated 18 km away to the north east of Jimma town and 345 km southwest of Addis Ababa. The district has a total population of 176,667 and 978 km2 and bounded by Limmu Kossa, Tiro Afttata, Ommo Nadda and Manna, Dedo to the north, east, west and south, respectively. The district has 31 Kebles and Serbo is the main town situated 25 km from the center of Jimma. It found on 1600 to 2400 m above sea level. About 85% of the population economically depends on the agriculture in general and 65% on coffee production in particular (CSA, 2001). The area is covered by forest, and the soil is very fertile, black in color, and has a good retention capacity (CSA, 2001). Kersa district lies between altitude 2000 and 2500m.a.s.l (47%). sub-tropical and temperate agro climates do respectively constitute 47% and 53% of the district areas (CSA, 2001).

Omo Nada district lies with elevation between 1500 and 2000m.a.s.l (65%) are characterized by flat land. sub-tropical, temperate, and tropical agro-climates do respectively constitute 75%; 15%and 10% of the district areas. The vast area of the district annual rainfall varies between 1300 and 1700 mm. Omo Nada district has a total population 234,950 during 1995 E.C of at which 117,094(49.8%)

were males and 117,856(50.2%) were females population.

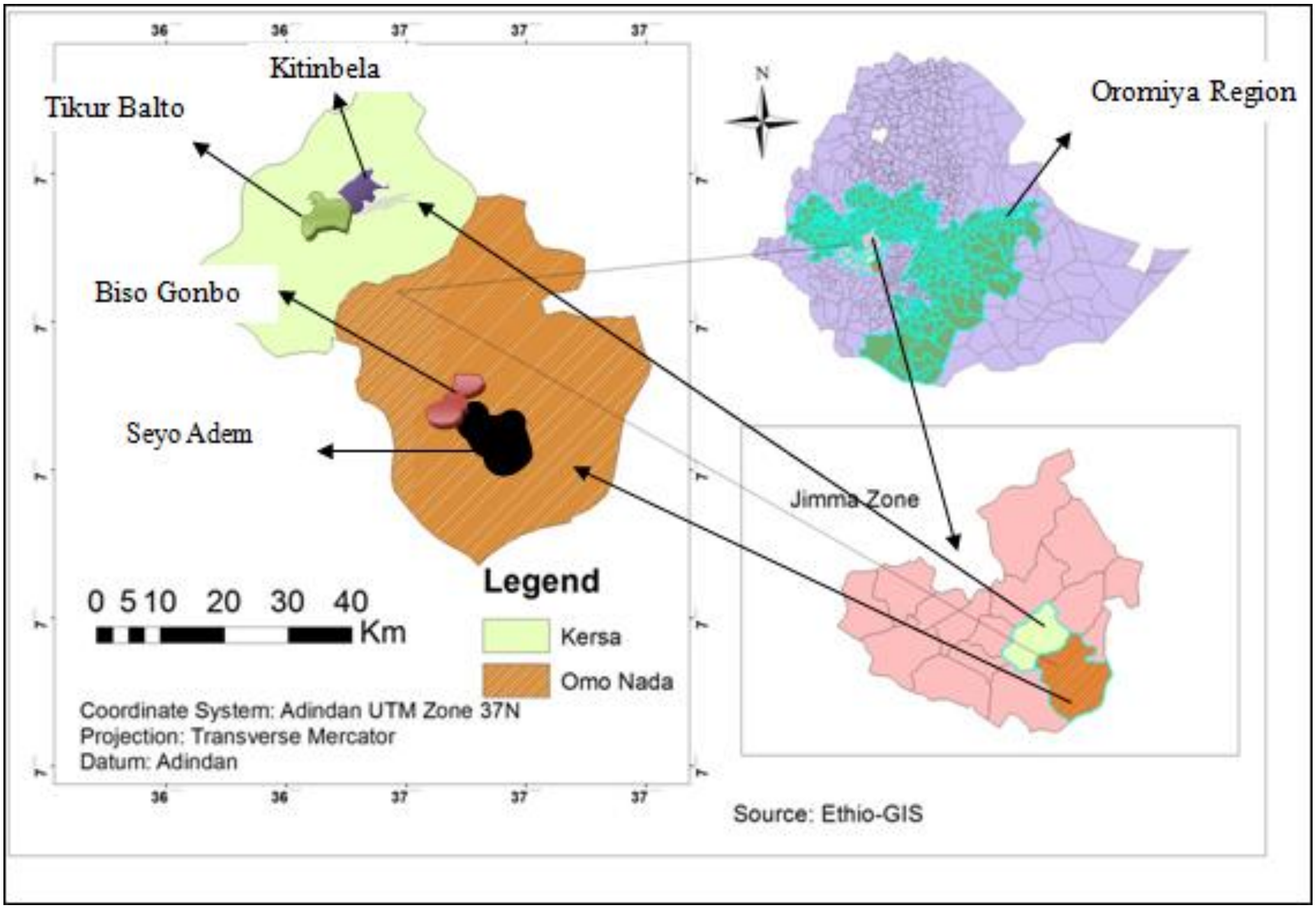


Figure 2:- Omonada and Kersa map

Source: - Ethio - GIS

3.2 Research Design

In this study, mixed method designs were used to investigate different aspects of the same phenomenon, which had both quantitative and qualitative methods were employed. For more accurate measurement of social capital, it is not enough to use quantitative data from questions such as “participation in a given organization” only; qualitative data from questions such as “consciousness of the members of the organization” and the characteristics of the organization itself are necessary. However, it should be kept in mind that subjective bias of interviewees has more influence on qualitative data than on quantitative data (Kajisa, 2002). In addition, the study was used mixed methods just to answer a broader range of research questions because the researcher can use more than one approach. The strengths of one method can be used to overcome the weaknesses of another method. The results from the methods may validate each other each and provide stronger evidence for a conclusion.

3.3 Sampling design and sampling method

3.3.1 Sampling Techniques and sample size

In order to conduct the study in a representative way and to increase its reliability and validity, both purposive and simple random sampling procedures were employed. Accordingly, multistage sampling procedures were used. In the first stage, Kersa and Omonada Woredas were selected purposely based on a potential on soya bean production. In the second stage totally four Kebeles were selected randomly. from the two Woredas, in Kersa Woreda there are 31 Kebles, among them Kitimbile and Tikur Balto, in Omonada Woreda there are 45 Kebeles, among them Seyo Adem and Biso Gonbo were selected in random sampling method. Lastly, about 386 sample respondents were selected using systematic random sampling techniques. PPS were used to redistribute sample respondents across Kebles. Cochran formula was used to determine sample size.

$$n_o = \frac{Z^2 * pq}{d^2} \longrightarrow n_1 = \frac{n_0}{1 + \frac{n0}{N}}$$

$$= \frac{0.5*0.5*1.96^2}{0.05^2} \approx 386$$

Where

n_o = Desired sample size Cochrans (1977) when population is less than 10000

n_1 = Finite population correction factors Cochrans (1977) when population is greater than 10000

Z = Standard normal deviation (1.96 for 95% confidence level)

P= population proportion to be included in sample

q = 1-p i.e. 0.5

N = Total number of populations which is unknown and greater than 10,000

d=degree of accuracy desired (0.05)

Table 2:-Sample size of soya bean producers by Keble

District	Keble	Population	Sample		Total Sample
			Adopter	Non-adopter	
Kersa	Kitimbile	489	148	43	191
	Tikur Balto	294	46	14	.60
Omonada	Seyo Adem	176	54	16	70
	Biso Gonbo	189	51	14	65
Total		**1148**	**299**	**87**	**386**

3.3.2 Data collection methods and data type

Both primary and secondary data were collected in this study. The primary data were collected from 386 sample respondents through household survey, and Group interview at community level.

For social network analysis, social interaction data were used that the data concerning the direction and strength of ties were collected using a structured questionnaire consisting of a single closed-ended question for determining the presence and strength of relationships. Through this question, each soya bean producers were asked to indicate how often he or she shared information with each other on adoption technologies. The questionnaire was constructed using a five-point Likert-type scale format (Very Often or Always, Often, Neither Often nor Seldom, Seldom, and Very Seldom). All 386-soya bean producers (adopter and non-adopter) were responded to the questionnaire. Response data was coded and then analyzed using SNA software UCINET Version 6.68 (Brummel, *et al*, 2012 and Crossley, 2010). Specifically, the ties were differentiated by strength and graphed separately as follows: weak (tie strength = 1 or 2 out of 5); moderate (tie strength = 3 out of 5); and strong (tie strength = 4 or 5 out of 5). These approaches were documented as useful way of identifying patterns within a network, such as finding cohesive sub-groups (Prel, 2012).

3.3.3 Data collection method

Household survey

A face-to-face interview with structured questioner was used to collect primary data. The interview schedule were pre-tested with 30 randomly selected farmers and based on the results of the pre-test necessary modifications were made. Enumerators who are knowledgeable about the area were recruited from the study area and they were trained on the objectives, methods of data collection and interviewing techniques. The data were collected by visiting each one of the sample households.

Necessary information from sample households were collected on the household demographics, socio economic conditions, types of social networks, characteristics of groups, organizations in which a household is member, data on network and mutual support organizations, seed exchange in soya bean technology, sources of improved verities, sources of shared information, no. of closed friend and social network variable were deeply elaborated. Data on the constraints of social networks which may affect the sustainability of the institutions in the process of technology diffusion in the community such as exclusion from group, conflict resolution (problem handling mechanisms), and cooperation among members.

Group interview and key informant

A group interview is a screening process where you interview multiple candidates at the same time. The point of a group interview is to see how candidates choose to stand out from each other, how well candidates function in a group of people they do not know and if candidates show the teamwork attributes that you need. Group interview was used because of nature of social network is hard to identifies unless selecting farmers systematically. Social networks is relational; it exists between people. Asking a group of people to respond together to certain questions and hypothetical situations may yield information that is more nuanced than data derived from surveys. As a result, Key informant was used to know the type of network existed among soybean producers. The community social networks profile was define through a series of group interviews conducted in the community during the initial days of fieldwork. This was allowed the researcher to become familiar with community characteristics and issues relating to social networks for reference for the data collection, especially the household survey.

Additionally the study was employed household level survey data to estimate the effect of social networks on soybean productivity among soya producers in the study area. This were preceded by analysis of secondary data, focus group interviews, and field visits to understand the local environment and it were necessary for the development of the survey instruments used to collect the quantitative data that were used in this study.

3.4 Methods of data analysis

After completion of the data collection, the data were coded and entered in to Statistical Package for Social Science (SPSS version 20) and Social Network Analysis (UCINET, version 6.68) for analysis both qualitative and quantitative data. Primary data were collected from individual and group respondents through interview schedule were analyzed using descriptive statistics, such as mean, standard Deviation, frequency, percentages and cross tabulation with statistical package for social science (SPSS version 20) qualitative data were analyzed by narration form. Net-draw diagrams were used for community social institutions. The importance of groups and associations to their household, importance of social networks in information exchange, seed source and exchange, as a influences of nodes in social networks to adopt a given soya bean technology and as a channel of innovation. Independent sample t-test, chi-squire test were also used to compare and test the significance of different variable among different people, institutions, age, family size, and adoption status of the household. Secondary information collected from BoARD of the Woreda, and other relevant governmental and NGO data were analyzed using descriptive statistics. In this study we used binary logit model to analyze effects of social networks on soya bean production and technology adoption.

3.4.1 Econometric Analysis: Model specification

3.4.1.1 Binary Logistics Regression

The study applied a binary logistic regression model to analyze the Determinants on adoption of recommended adoption of soya bean technology. The model was adapted from similar studies; for example (Sheikh, A.D,2003; Kassam, A.H.; Mkomwa2017; Pautsch, G,2001) The binary model is motivated by the fact that, when faced with a decision regarding an innovation, a farmer either adopts or rejects the technology (Nyanga, P.H,2012 and Agresti, A.2001) The logistic regression model was chosen because there is widespread literature showing that farmer adoption decisions can be analyzed using logistic regression. The dependent variable for this study was the farmer being an adopter or a non-adopter of adoption of soya bean technology with a value of 1 (if the farmer was an adopter of soya bean technology) and/or 0 (for a non-adopter of soya bean technology). The logistic model predicts the logit of the response variable (adoption of soya bean technology) from the independent variable(s). The likelihood of the farmer being an adopter of soya bean technology is predicted by odds (Y = 1); that is, the ratio of the probability that Y = 1 to the probability that Y = 1:

$$Odd\ Y = \frac{p(Y=1)}{(1-P(Y=1))} \quad ----------------1$$

The binary logistic regression model is specified as follows (Equation (2))The logit (Y) is given by the natural log of Odds;

$$In\left(\frac{p(Yi=1)}{(1-p(yi=1))}\right)\log Odds = Logit(y) ----------------------2$$

This can be expanded as:-

$$Logit(Y) = \propto\ + \sum \beta_{1X_1} + \sum \beta_{2X_2} + \sum \beta_n\ X_{n+\ \varepsilon_i} --------3$$

where Y = dependent variable (adoption of soya bean technology) with 1 = adopters and 0 = otherwise; *a* = intercept; *b*1, ..., *b*n = coefficients of the independent variables; X1, ..., Xn = the independent variables; P (p) = probability of adopting soya bean technology; 1- P = probability that a farmer does not adopt soya bean technology; and ln = natural log. With the independent variables of this model (X_1 = bonding, X_2 = Bridging, and so on), logistic regression for 'ADOPTION' in the study is expressed in the following form:

$$logit\ (Adoption\ of\ soya\ bean\ technology = In\left(\frac{P}{1-P}\right) = \propto\ + \beta_{1Bonding}\ + \beta_{2Briding}\ + \beta_{3Linking}\ + \beta_{4famsie} \text{ ---4}$$

Hence, the above econometric model was used in this part of the study to identify effects of variables that influence to adopt the recommended soya bean technology.

3.4.2. Social Network Analysis

Human communities comprise a series of overlapping social networks, within which members is connected by relational ties. Knowledge flows, shared information, through these ties (Brummel, , *et al*, 2012 and Crossley, 2010). The movement of knowledge within and between networks is related to the “strength of ties” between different actors in a network (Prell, *et al,* 2009) and Crossley, 2010). Strong ties indicate bonds between network members that support the sharing of information and advice, help build and maintain trust between members, allow members to influence other members’ beliefs and values, and encourage two-way communication between members (Prell,*et al*. 2009 and Crona, *et al*, 2006). Weak ties are formed by network members who bridge with disconnected or dissimilar groups either within or outside their network. These members act as brokers by helping to build trust and mutual understanding by sharing knowledge (Burt, and Closure, 2012)

In these study before proceeding to effect of social network on soya bean productivity first Strong and weak ties form a structure that were mapped and analyzed to determine patterns, both of the relationships between the actors and the knowledge they share, using methods that are collectively known as social network analysis (SNA) (Scott, 2000). SNA were used to study the effectiveness of processes such as knowledge sharing by evaluating network structures for different dependent variables (Lauber, *et al*, 2008 and Diani, 2003). For instance, SNA can be used to analyze the number of strong and weak ties in a network in order to better understand how knowledge is created and shared within and between soya bean producer’s members. These concepts are useful for explaining what is actually transpiring within a social network structure (Scott, J, 2000). This kind of analysis can identify network members who are influential in creating and sharing knowledge on production (Prel, 2012).

3.4.3. Relationship data

The analysis was done on a one-mode network, which was derived in part from a two-mode affiliation network and DL-Format. The relation between farmers is operationalized as a tie and represented as undirected, binary data. If a farmer has one or more types of relationships (kinship, affiliation friendship, cooperative member, neighbor relationships) with another farmer, then the tie has a value of 1, otherwise it has a value of 0. One reason for including the three types of relationships together is that there can be an overlap of relations in real-world circumstances. For example, there would be an overlap in the types of relationships when a father and son participate in the same association and the son rents from the father; however, they were represented as a single tie in this study.

This study categorizes the components derived from the one Mode format as adopter and non-adopter. The adopter and non-adopter components were decide before the survey conducting based on the data from pre test time. Other affiliation components were identified based on published and unpublished information from committees, associations, and clubs. The main types of networks data in this analysis are Farmers regarding adoption status. 1 if they adopt the recommended technology and 0 if not.

3.4.4 Social Network Analysis for soya bean production

For the creation of the soya bean production mapping, the study were used matrix and graphical analysis of the data provided to look at the relationship between the individuals in the network. For this, we used social network analysis software. This methodology allows the mapping of networks of study area with the respective values of production per hectare.

The values obtained from literature surveys were included in generated files in the Windows operating system notepad, thus building the files of type ".vna" (visual network analysis) required for implementation and enforcement in Ucinet® software. The processes result in the values of the degree of centrality of interaction of the actors within the network (Borgatti, 2002). The general degree of centrality is composed of the input degree of centrality and by the output degree of centrality, and these depend on the relative direction of flow. The sum of relations that an actor has with other actors is the output degree centrality, and the sum of relations that the other actors have with a particular actor is the input degree of centrality (Velazquez, and Aguilar, 2005). An actor is locally central, if it has a large number of connections to other points. It is globally central, if it has a significant strategic position in the network as a whole (Scott, 2000) the centrality of degree is measured by the number of ties that an actor has with other actors in a network (Wasserman and Faust, 2003).

Generally, for software available for network analysis, as used in this research with the Ucinet® and Net-draw module, the data is provided by relational matrices (socio-matrices in the language of sociologists), which can be viewed through graphs. The graphic display alone can offer new information and insights for researchers (Wasserman, Faust, and Iacobucci, 1994).This function was used via the Netdraw® module accompanying Ucinet® to enable the visualization of networks based on the ".vna" files generated.

The corresponding graphs of Planted area networks, Production were generated with Net draw, and relationships of higher intensities and their respective directions mark the images obtained. Likewise the actors are indicated (highlighted with discs in color) with its expanded size (larger diameter) based on their relative centrality, in order to visually indicate the actors with greater power or influence, and participation in the network by means of larger diameter. The design of centralities in accordance with the indications (Emirbayer. and Goodwin, 2000), obeyed the software, application of the following equation 1:

$\mathrm{CG(vk)} = \Sigma \mathrm{wkjnj} = 1$……………………………………….……………………….. Eq. 1

Where:

CG = Degree of centrality;

vk = Node of the net to be considered;

j = Number of nodes;

wkj = Number of adjacent nodes; and, wkj=1 if there is a link between the nodes *vk* e *vj*.

After visualizing the data for analysis and the corresponding graphical behavior in the networks under study, it were possible to obtain the patterns of the actor’s behavior and to transcribe this data to relational matrices (also known as sociometric matrices), which are necessary for the data analysis by the chosen analysis program, Ucinet®.

3.5 Definition of variables and working hypothesis

The dependent variable: dependent variable in this study is defined and treated as adoption of the recommended soybean technologies (improved variety, seed rate, and fertilizer rate). Here the adopter status were categorized before conducting the survey, Which were treated as dummy variable that takes value of one, if soya bean producer use recommended soybean technology (improved soya bean variety, seed rate, and fertilizer rate) if not ‘zero’. For the purpose of this study, soya bean producer who were using improved soya bean variety (Clark s1), seed rate and/or fertilizer at least for two years and continued using them were considered adopters of soya bean technologies. However, adoption of other related technology implement was not considered since there was no adopter of the technology observed/found in the study areas. In this paper the partial adopter were ignored just because of the objective were not analyze the intensity of adopter of the technology. Here the research treated that those soya bean producers used ≥ 2 type of technology called adopter and those producers used ≤ 2 type of technology called non-adopter. Responses to a question in relation to choice of decision status, such as whether soya bean producer used at least more than 2 recommended soya bean technology like (improved variety, seed rate, and fertilizer rate) or not could be '1' or '0', a typical case of dichotomous variable.

The independent variables of the study, respondent’s decision to use a given selected soya bean technology is influenced by the demographic personal characteristics and accumulation of social capital of the household, the organizational and institutional support systems based on the various studies already reviewed in the literature review part. The major variables expected to have influence on the decision making to adoption of soya bean technologies is explained below;

1. Age: - age was measured as a continuous variable in terms of the respondents’ number of years of age at the time of data collection. Soya bean adoption of technology is expected to be affected by the age of the farmer. According to (Mustapha *et al,*, 2012) which indicate Households with high ages are less inclination to adopt recommended agricultural technology. It was hypothesized that, those soya bean producer increases their age of the household is negatively related to adoption and statistically significant.

2**. Frequency of extension contact:** it is measured by contacts made between farmer’s and extension workers regarding soybean production and it is treated as continuous variable.. Extension contact with the farmers is believed to increase the farmers’ probability in adopting technologies since extension agents have the required knowledge about the technology generated and they are good source of information. (Techane *et al.,* 2006) and (Olagunju *et al.,* 2010) reported the positive and significant relation. The variable hypothesized to affect adoption positively.

3. Training in soya bean production: - It measured as dummy variable which farmers who participated in the soybean production treated as a value of 1 or not 0,for at least two times per a month. Training is one of the means by which farmers acquire new knowledge and skills, it deferent from field day and demonstration that training prepared for particular knowledge gap of soya bean technology. Menyahil,(2008) found that a positive and significant relationship between adoption and participation on soya bean training. In this study participating on training of soya bean production were hypothesized to affect soybean production technology positively and significantly.

4. Membership in farmer's organization: The variable is treated as dummy variable taking value of 1, if the household head is a member and 0, if not. Belonging to soya bean production organization, primary farmer agricultural input cooperatives (maayibaasi), etc. can influence farmers' decision to adopt soya bean a technology. The organization may be formal or informal since it can help farmers get better access to information. Almaz, 2008, Vaiene *et al*. (2009) and (Nchinda; *et al*, 2010) found that membership in farmers' organization positively and significantly influence the adoption of technologies and production. In this study to be a membership of deferent formal and informal farmers organization hypothesized to increase adoption of soybean technology positively and significantly.

5. Family sizes: It is a continuous variable measured in terms of adult equivalent of persons living together in the household. Adoption of soya bean technology requires adequate labor supply to carry out the production processes. It is obvious that large families may have adequate labor that would enhance the adoption of technologies. The labor availability is positively related with the adoption of new technologies (Hassen *et al.,* 2012; Debelo, 2015). Hence, it was hypothesized that availability of labor has positively influenced the adoption of recommended soya bean technology.

6. Off-farm/Non farm income: It is a continuous variable measured in birr. It refers to annual income obtained from different agricultural activities (outside the farm) such as hired labor and income gained from other than agricultural activities and other than off farm income also, such as participating in trading non- agricultural goods. According to (Asfaw *et al.*, 1997) and (Habtemariam, 2004), this type of income increases the farmers' financial capacity and increases the probability of investing in capital-intensive agricultural practices. It is therefore, expected to affect farmers' decision to Adopt recommended soya bean technology positively.

7. Bonding: - it is dummy variable that 1 if they involved in bonding social network and 0 if not. Bonding is one of the social networks that facilitate creation of cohesion among people in a community that associated with positive technology adoption. This includes cooperation among people, extent of trust among people, and participation in technology adoption activities. According to Gintis (2002), bonding social networks affect farmers' decision to adopt soya bean technology positively; hence, it is characteristic of within-group relations, the extent to which people within the same group or community cooperate with each other. Therefore, hypothesized to affect soya bean producer decision to adopt recommended soya bean technology positively and significantly.

8. Bridging: - it is dummy variable that 1 if they involved in bridging social networks, if not o. bridging social networks implies links across groups, across communities, and with other organizations. That is expected to have a positive relationship with knowledge-intensive technologies that require sharing of information on their use, training, or visiting other farmers, research institutions, and other organizations where these technologies are developed or demonstrated. According to Kiptot, (2006) found that in Kenya, farmers shared information about adoption of technology and improved fallow seeds largely though Bridging social networks. Therefore, hypothesized to affect soya bean producers' decision to Adopt recommended soya bean technology positively and significantly.

9:- Linking: it is dummy variable that 1 if they involved in linking social networks, if not o. Linking social networks implies link of networks that the households connect groups and individuals to others in different social position. Which includes relations and interactions between a community and its leaders extends to wider relationships between the villages, the government. According to Grootaert, (2004) those involved in linking social networks are better access to inputs and information; avoiding risk and uncertainties to adopt or not to adopt a given technology. Therefore, it was hypothesized that households who involved in linking social networks are more likely to adopt soya bean technologies positively and significantly.

10. Bonding and bridging networks: it is dummy variable that 1 if they involved bonding and bridging social networks, if not o value. Respondent farmers' exercising of bonding and bridging social network have the habit of listening of discussion of shared information, procedure, guidance from Keble administrators, church leaders, friends, families for common goal. According to Gittell and Wakefield, (2005) study shows that Bonding and bridging networks play a significant role in creating awareness about new ideas and practices in a fastest possible time. Therefore, this type of networks exposure is hypothesized to have positive and significant influence on soya bean technology adoption.

11. All Bonding, Bridging, linking networks: it is dummy variable, if they involved in all social networks give one, if not zero. Membership and involvement in social activities(formal) such as in administrational groups, agricultural related groups such as cooperatives and water use associations and other civic associations ,etc or in (informal organization) such as community based organizations ('Ikub', 'Edir' Religious clubs such as 'Mahber', etc) will give higher exposure to new information. According to Habtemariam, (2004), indicated that membership and leadership in community organization assumes that farmers who have some position in peasant association and different cooperatives are more likely to be aware of new practices as they are easily exposed to information. It is therefore, hypothesized that those farmers who involved in all bonding, linking and bridging which includes social organization as member or leader are more likely to decide to adopt recommended soya bean technology positively and significantly.

4 RESULTS AND DISCUSSION

In this chapter, the results of the study were presented and discussed in detailed to address the four objectives of the research. The results are based on a household survey of 386 sample households, 4 focus group discussions, 4 key informants, 2 group interviews in sample Kebeles. The chapter is divided into four sections, namely; socio-economic and demographic characteristics of sample households; types of formal and informal social networks in the study area; effects of social networks with adopters and non-adopters using Ucinet version 6 software visualization, determinant factor of adoption of soybean technology and; effects of social networks on soybean production. The results are presents using descriptive statistics and inferential statics'. Ucinet software visualization was employed to see the relationship and its effects between social networks (bonding, bridging and linking social networks) with soybean technology adopters and non- adopters. Qualitative and quantitative data analysis methods such as a regression model, interpretation, and visualization of the diagram were also used.

4.1. Descriptive Results

4.1.1. Socio-Economic and Demographic Characteristics of Sample Households

In this sub, the section presents descriptive statistics of continuous and dummy variables. The variables include age of household, family size, total land holding, total cultivated land, and total land size for soya bean, off-farm/non-farm income, extension services. These variables are helpful to observe differences among adopters and non-adopter of soya bean technology in sampled households.

Age is a continuous explanatory variable odd to the household head. In this study, it was used to measure the age of the household head in years, which indicates Households with high ages are less inclined to adopt recommended agricultural technology. As indicated in Table 3 the mean age of the adopters was 39.53 years with the standard deviation of 6.53 and whiles it is about 38.65 years having the standard deviation of 6.86 for non-adopters. The t-value of age between adopters and non-adopters was found to be insignificant. As indicated in Table 3 the majority family size of adopters was 5.21 people and whiles it is about 5.0 persons for non-adopters. The t-value of family size between adopters and non-adopters was found to be significant. That means there is a statistical mean difference between adopters and non-adopters in terms of family size.

As indicated in Table 3 The mean total land holding, total cultivable land and land allocated for soya bean for adopters is 1.69, .652, and 0.21 hectares respectively while it is 1.20, .32, and .12 hectares for non-adopters. The t-value of total landholding and total cultivable land between adopters and non-adopters was found to be significant. That means there is the statistical mean difference between adopters and non-adopters in terms of total landholding and land allocated for soya bean but the t-value of total cultivable land between adopters and non-adopters was found to be insignificant which indicating that there is no statistical mean difference between adopters and non-adopters in terms of total cultivable land.

The frequency of extension contact refers to the number of contacts per year that the respondent made with extension agents. The effort to disseminate new agricultural technologies is within the field of communication between the change agent (extension agent) and the farmers at the grass-root level. Here, the frequency of contact between the extension agent and the farmers have been hypothesized to be the potential force, which accelerates the effective dissemination of adequate agricultural information to the farmers, thereby enhancing farmers' decision to adopt recommended soya bean technologies. The mean extension contact for adopters and non-adopters was 1.1 and 1.22 respectively. The t-value of extension contact between adopters and non-adopters is insignificant which indicating that there is no statistical mean difference between adopters and non-adopters in terms of frequency of extension contact.

Table 3:- Descriptive Statistics for Continuous Variables

variable	Adopter (N=299)		Non adopter (87)		
	Mean	Std	mean	Std	t-value
Age	40	6.53	39	6.86	.0145^{Ns}
Family size	5.2	2.3	5.0	3.1	2.45*
Total off/non-income	3046	3609	1987	3010	2.496*
Total Landholding	1.69	1.206	1.20	1.11	3.289*

Total Cultivated land	.652	.385	.32	3.1	.0678^{ns}
Total land size for soya bean	.21	.339	.37	.12	3.49*
Extension service	1.1	.34	1.22	.42	0.46^{ns}

Source: Survey result, 2019
Note: - ***, **, * are significant at 1, 5, 10% significant level respectively and

NS: Not significant,

As indicated in Table 4 Out of the total 386 interviewed soya bean producers 251 (65.0%) were from Kersa district and the remaining 135 (35.0%) were from the Omonada district. Among the sample respondents from Kersa district, 177 (70.5%) were male-headed and the remaining 74 (29.5%) were female-headed while in Omonada 104 (77.0%) and 31 (23. %) were male and female-headed producers, respectively. The chi-square test of sex distribution between the adopters and non-adopters was found to be significant

As indicated in Table 4 the majority of (83.4%) of sampled respondents were married and the rest 3.0 %, 0.6% is single and widowed respectively. The chi-square value of marital status between the adopters and non-adopters was found to be significant. That means there is a statistical mean difference between adopters and non-adopters in terms of marital status.

As indicated in Table 4, about 42.5% of Adopter farmers have no formal education .the other 36.8% of non- Adopter has no formal education. Besides, 20.1% of Adopter and 27.6 % of non-Adopter were learning primary education(able to read and write). Moreover, 31.4% of adopter and 26.4 % of non- adopter of HH heads was junior. Finally, 5.7% of the adopter and 8.0 % of non-adopter were learning secondary education. The chi-square value of education status between adopters and non-adopters is insignificant which indicating that there is no statistical mean difference between adopters and non-adopters in terms of their education status. Numerous studies indicate that there is a strong positive relationship between levels of education and adoption status, (Putnam 1995; Knack and Keefer 2000; Onyx and Bullen, 2000; Hughes *et al.*, 2000, Godquin and Agnes, 2005). Even if the educational status harms the specific adoption status of recommended soya bean technology, in the study area it does not show any significant impact in the study area. This situation might be happened due to the more educated person was, less responsive to technological changes introduced to soya bean technology, and mostly involved in an immediate cash-generating activity like the cultivation of cash crops, petty trading and also there is habit of migrating to cities to find new hire jobs.

Table 4:- Descriptive statistics for dummy variables

variable		Adopter		non adopter		Total		x^2
		N	%	N	%	N	%	
sex	Male	209	69.9	72	82.8	281	72.8	34.64*
	Female	90	30.1	15	17.2	115	27.2	
Education Status	No formal education	127	42.5	32	36.8	159	79.3	
	Primary	60	20.1	24	27.6	84	47.8	
	Junior	94	31.4	23	26.4	111	57.8	
	secondary school	17	5.7	7	8	24	29.7	2.48NS
Marital status	Married	64	73.6	258	86.3	322	83.4	
	Single	17	19.5	33	11.0	50	13.0	
	Divorced	4	4.6	8	2.7	12	3.0	
	Widow	2	2.3	1	1	1	.6	3.23*

Note: - ***, **, * are significant at 1, 5, 10% significant level respectively and

NS: Not significant,

Source: - own survey result (2019)

4.1.2 Sources of improved soya bean seed

Formal and informal organizations could be the sources of improved varieties for the farming community. However, access to these improved varieties depends on the capital (financial and social) the House Holds or individuals have. It largely depends upon the assets of the producers: whether or not the adopter has the cash (financial capital) or social networks (social capital) to access the seed. In the study area, friends and relatives within or outside the community are important sources of seed, particularly for small amounts of new varieties. As indicated in Table 4, out of respondents who used the improved varieties of soya bean, the majority (82.9. %) of adopters obtained the seed from farmers who are using the varieties through an exchange (in cash or in-kind).

As indicated in Table 5,out of 81.6% used own sources (saved from previous harvest and from neighbors exchange), 78.5%, used from traders, 71.8% of them used from research and 53.3% of used from office of Agriculture, as a source of improved soya bean seed in the last 3 years. This could imply that 82.9% of adopters use their neighbor's friends and relatives as sources of improved seed. However, 78.7% adopter solely depends on traders as a source of improved varieties. Because, if their relation left weak on their close friends, families, as a result, social networks that facilitate seed exchange collapsed. Besides, it takes relatively cost to purchase seed so having social networks help them to spend less cost.

Table 5:- Distribution of sample respondents in terms of improved soya bean seed sources.

No.	Sources of improved Soya bean	Non-Adopter N	Non-Adopter %	Adopter N	Adopter %
1	From Own Sources	18	18.4	80	81.6
2	From the research center	11	28.2	28	71.8
3	From BOA	21	46.7	24	53.3
4	From Trader	10	21.3	37	78.7
5	From Farmers	28	17.1	136	82.9

Sources: - own survey result, (2019)

4.1.3 Networks of the respondent beyond the immediate household

As discussed in the literature review, the number of close friends, relatives beyond the immediate household would be positively associated with the household propensity to accumulate organizational or group-based social networks.

In table 6 survey, the result shows that 39 % Adopter and 18 % of non-adopter s had ≥6 close friends and only 1 to 2 close friends, respectively that they can talk to about private matters or call on for help. Moreover, 42% of the adopter had 2 to 5 people in their proximity and only 0 % of them do not have any friends to help. These means those adopted recommended soya bean technology do have a large number of friends to talk t private matters or call on for help. In another case, about 15 % of the female had fewer friends to help compared to males (37 %). However, the minority 0 % of the respondent reported they have no social networks to call on for help with money, food, or labor and no one was willing to assist them. This may imply that, as compared to female households, male-headed households had a better social network beyond the immediate household. This in line with the findings of (Katungi *et al.*, 2006) where male-headed households build and maintain bigger social networks with relatives and friends nearby than female-headed households in Uganda.

In a focused group discussion with women, it had been confirmed that women have fewer close friends. They are usually confined to their homes and therefore less participate in most social gatherings, meetings, and different committees. Due to these and other socioeconomic barriers (access to a resource such as credit and time constraints), they had limited opportunities to build trust and solidarity with their colleagues.

Table 6:- Number of close friends of the household head in percentage

SEX	non-Adopter (87)		Adopter (299)		Total in %
	Number of close Friends in categories in %				
	0	1-2	3-5	≥ 6	
Female	0	10	15	2	27
Male	0	8	28	37	73
Total	0	18	42	39	100

Sources: - own sources of survey (2019)

4.2 Soya bean technology Adoption

The recommended soya bean technology (improved seed (clarks1), seed rate, fertilizer rate) can influence the production of producers. Hence, all the technology was expected to apply in a better way to improve their soya bean production practices. For the purpose of this study, soya bean producer who were using improved soya bean variety (Clark s1), seed rate and/or fertilizer at least for two years and continued using them were considered adopters of soya bean technologies. However, adoption of other related technology implement was not considered since there was no adopter of the technology observed/found in the study areas.

Table 7, survey results show that 63.7 seed rate, 39.3 dapper hectares, 70 improved seed, adopter, and 45.6 seed rate, 16.3 dapper hectares 36 improved seed, for non-adopter and the t-value of seed rate, dapper hectare and improved seed(clark1) are 7.54,8.99 and 6.698 of adopters are significant respectively which indicating that there is statistical mean difference between adopters and non-adopters in terms of using recommended soya bean technology. This means that adopter had applied all soya bean technology practices as recommended than non-adopter.

Table 7:- Proportion of recommended soya bean technology with Adopter status

Recommended technology	Adopter (N=299)		Non-adopter (87)		T-value
	Mean	Std	mean	Std	
using of improved seed, clark s1	70	12.6	36	7.5	6.698**
Seed rate per hectare	63.7	21.04	45.6	12.4	7.54*
DAP per hectare	39.3	11.4	16.36	9.62	8.99**

Note: - ***, **, * are significant at 1, 5, 10% significant level respectively and

NS: Not significant,

Source: - own survey result (2019)

4.3 Type of Social networks for soybean technology dissemination

Social networks have three different types of networks and ties, which include bonding, bridging, and linking social networks. “Bonding” occurs in relatively “alike” groups. It typically arises in connections and ties among families or specific ethnic or kinship-based groups. It might also arise within a particular social group bound together by shared identities, interests, and place of residence. "Bridging" social capital connects different types of people and groups (e.g. ethnic, social, gender, political or regional). Besides, "Linking" social capital connects groups and individuals to others in a different social position those typologies indirectly explains more their relationship of family, friends, neighbor, organization, institutions that each connection has its own weak and strong tie that will define their connection to disseminate information and technology Adoption. It has important value to spread information through each networked nodes (Woodcock, 2000).

As Table 8 indicates a majority of (82.5%) adopters and 17.5% of non-adopters involved in all types of bonding, bridging and linking networks while about 82.1% of adopters and 17.9% of non-adopters were involved in bridging network only. It means adopter of recommended soya bean technology has access to external knowledge through all bonding, bridging, linking networks, which pointed out family, friendship, soya bean producer cooperatives, traditional institutions like edier, ikub, and debo provide important opportunities for technology dissemination of soya bean. As Antonelli, (2000) argued that multi-channeled types of social networks favor access to external knowledge and information, that these pieces of information and knowledge are likely to be two or more different social networks that combined in such a way as to form a complete whole or enhance each other and additive for agricultural technology adoption.

Table 8:- Type's social network based on Adoption status

No.	Type of social Networks for Soybean Producer	Non-Adopter		Adopter	
		N	%	N	%
1	Bonding	8	61.5	5	38.5
2	Bridging	14	17.9	64	82.1
3	Linking	7	35.0	13	65.0
4	Bonding and bridging	19	26.8	52	73.2
5	Bonding and linking	2	25.0	6	75.0
6	Bridging and linking	7	28.0	18	72.0
7	All bonding, bridging, linking	30	17.5	141	82.5

Source: -field survey result, (2019)

4.3.1 Family member's participation in different social networks

As Table 9 indicates among the respondent 82.9% adopter participate in networks of friends, neighbors, acquaintances, and family. (61.9. %) of adopters participate in family networks relations, market place (58.1%) and (50.5%) in participating in church and mosques. It is also shown that relatively non-adopter households were participating informal social networks of Keble social court (38.1%), Keble cabinet (33.8%), this implies that non-adopter household has relatively linked informal social networks than adopter respondents.

Table 9:- Proportions of households' participation in different social networks

No.	Social networks	Non-Adopter(87),	Adopter(299)		
		Male %	Female %	Total	x^2
1	participate in Keble social court member	38.1	25.7	16.5	7.138*
2	HH Participate in church and mosques	57.7	50.5	28	6.274**
3	Market Place	38.1	58.1	25	.234*

4	participate in union or cooperative	35.2	36.2	18.5	.148*
5	participate Keble cabinet	33.8	31.4	16.9	.632*
6	participate in networks of friends, neighbor, and acquaintances	75	82.9	50	6.018*
7	participate in family network relation	61.9	70.8	34.4	8.896*

Note: - ***, **, * are significant at 1, 5, 10% significant level respectively and

NS: Not significant,

Sources: - own survey result (2019)

4.4 Analysis of the effects of social network on soya bean technology adoption in the study area

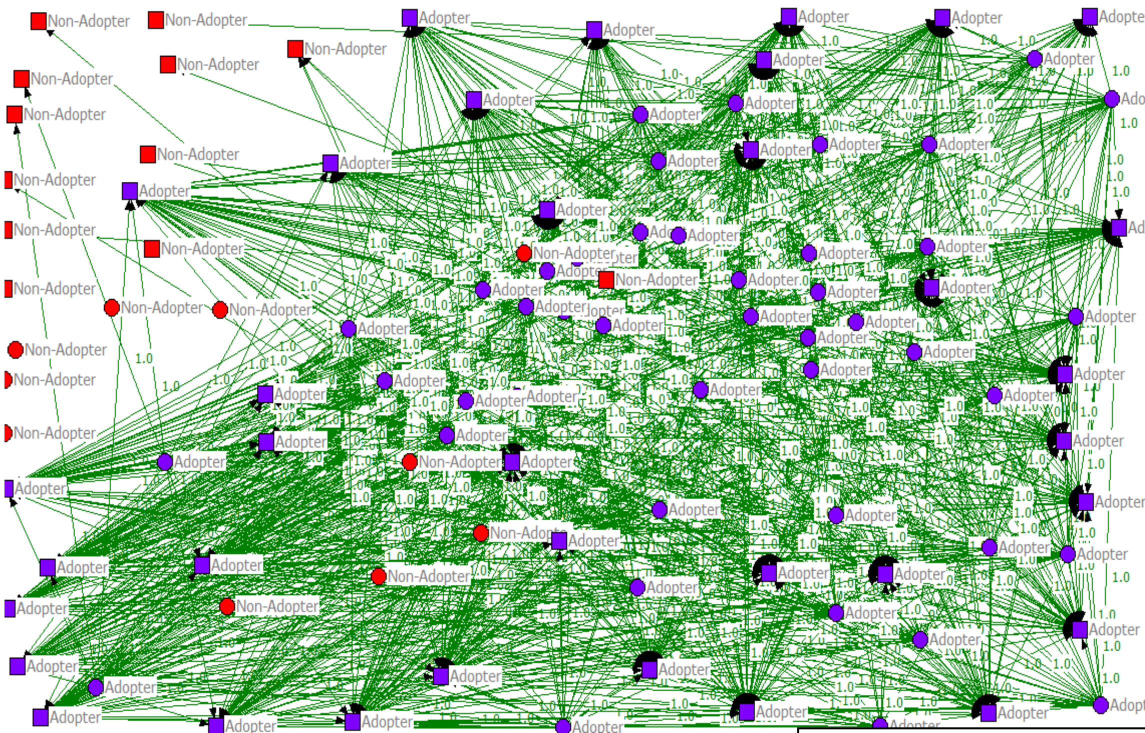
4.4.1 Analysis of social network interaction on soya bean technology adoption in the study area

Research findings show that Social Networks Analysis was used to measure social networks to map community-shared information, adoption status, market distance, friendship strengthens networks. In the case of the study area, soybean producer's farmers, it was difficult to conduct a census and determine group membership. These individuals had a different language and culture as well as agricultural production practices in their backgrounds and generally low levels of trust among themselves than with outsiders. However, the soybean producers were known easily because they produced in cluster form, as well as the common markets they served, sometimes-in competition with one another could easily identify them. There are two categories of data used for this analysis, relationship, and attribute data. The relationship data describes the ties between farmers and the attribute data describes the characteristics of farmers in the network.

Figure 3 and 4 represents the network of farmers in Kersa and Omonada District respectively using one mode network-Attribute format type. This method shows the strongest and weaker linkages in a network to see which linkages form strong adopter cohesive communities. In this figure, each line represents a farmer and the connecting arrows show linkages between the different farmers. These linkages between farmers indicate any of the two types of relationships: adopter and non-adopter with different attribute factors.

Figure 3 shows one small and one large sub-group, which is isolates. These subgroups within the farming network can be explained in terms of the following relationships: A) green line (adopter) is farmers who have asocial networks of bonding, bridging, and linking relationship are strong adopter of recommended soybean technology and B) the red (non adopter) is farmers having only Bridging, linking and bonding separately had known adopter of recommended soybean technology. The green line or nodes have large cluster Knowledge among farmers comes from different social settings in the communities. Each sub-groups accesses different pools of knowledge and this knowledge was transferee between subgroups by farmers who are linked with more than one sub-group. All green adopter nodes are the central actor in the farming network and they exemplify this knowledge transfer. Moreover, they are participating in organizations. Through their participation, they access knowledge on the adoption of new recommended technology that they can later transmit to their family, friends, all adopters are subsequently adopted the recommended soybean technology easily.

Figure 3 kersa Woreda Adopter and Non-Adopter social network



Sources: - Ucinet output

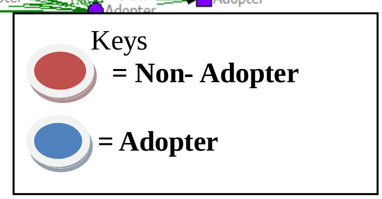
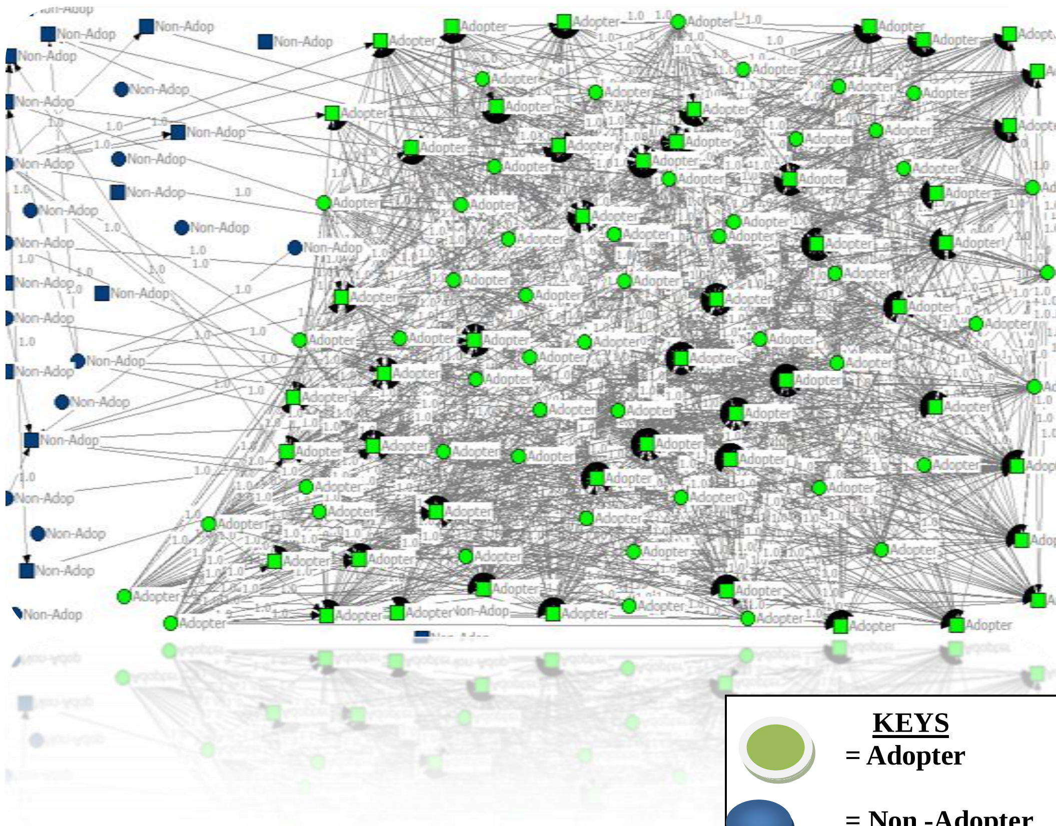


Figure 4 shows one small and larger sub-group are presented; non-adopter Group dyads are isolates and Adopter Group is condensed to each other. Soya bean technology adopter appear to be highly interrelated with overlapping kinship, friendship, and knowledge ties for common economic benefits and to soybean production. Strong ties connect similar actors and facilitate group information, whilst the non-adopter weak ties provide fewer sources of new information, friendship, and low participation in deferent formal and informal organizations. Granovetter proposed that the increased number of strong ties an actor holds in their network, the more critical their role in facilitating information flows and they adopt the technology easily (Granovetter, 2011). These means all adopter has strong relationships because of their bonding, bridging and linking network is strong.

Figure 4; - Omonada Woreda social network



Sources: - Ucinet output

KEYS

= Adopter

= Non -Adopter

The difference in social networks' relationship with the different attributes in the study area suggests that different strategies would be required to make optimum use of existing social networks for the adoption of different technology. Likely, an initiative to disseminate different technology through traditional means of social interaction, which social network of bonding, bridging, linking would have a greater likelihood of adoption of soybean technology in the study area. Further, the homogeneity of the community into subgroups would support largely the early development of farming clusters. Using a cluster management approach could build on farmer synergies, allow extension officers to provide services to the various sub-groups, reduce transaction costs, and potentially improve service availability. In contrast, for no-adopter would require a more targeted, long-term approach, including strategies to build bridging, bonding, linking social networks.

4.4.2 Analysis of effects of social networks on soya bean technology adoption in the study area

Bonding with Adopter and non-adopter

Bonding Social Network smooth's the progress of the creation of cohesion among the same kinship that has a high positive effect on each of them. This includes cooperation among people, the extent of trust among each of them and participating in different training. In the study, about 61.5 % of soya bean technology dissemination methods for non-adopter was along kinship ties rather than other social networks, however, is not surprising that the existence of bonding social network in non adopter groups was greater than adopters groups because it is significantly influenced the adoption of soya bean technology only for family member. This implies non-adopter isolates themselves from information from the research centers, NGOs, and extension staff that may lower their adopting capacity to increase soya bean productivity and expand an environment that encourages innovation. These findings agree with (Winters *et al.*, 2006) that found households with strong bonding social networks are less likely to be diversified in their adoption and use of improved innovations.

Bridging with Adopter and non-adopter

In figure 4, the result reveals that 82.1 % of adopter is involved in Bridging social network and 17.9 % of non-adopter is involved in bridging social networks. These implying that bridging ties can link heterogonous groups or networks of people into large networks, that bring deferent inherent diversity of ideas and perspectives that improve the capacity for the development of the innovative solution to a complex problem and enhance adaptive capacity to adopt soya bean technology easily. It allows access to external sources and diverse knowledge on soya bean technology adoption, which can be essential for soya bean productivity. Furthermore, it also helps actors to form bridging ties among small groups or subgroups, that may be capable of connecting and mobilizing the groups for using a given technology as recommended. This study is in line with (Putnam, 2001) that shows, those farmer involved in bridging social network have a better connection with different types of people and groups including ethnic, social, gender, political groups that help them to gather information easily about agricultural technology inputs which aid them to increase their technology adoption .

Bonding and Bridging with Adopter and non-adopter

In figure 5, the result reveals that 73.2 % of adopter is involved in Bonding and Bridging social network and 26.8 % of non-adopter is involved in Bonding and bridging social networks. These two types of social networks are expected to have a positive relationship with knowledge-intensive technologies that require sharing of information on their use, training, or visiting other farmers, research institutions, and other organizations where these technologies are developed or demonstrated. the study is line with (Leonard and Onyx, 2003) that shows using of bonding and bridging social networks is to help farmers or community members empower themselves to form groups that are organized for development, that helps them for operating defense mechanism against poverty, by promoting adopting the technology for real economic growth to take place...

Bridging and Linking with Adopter and non-adopter

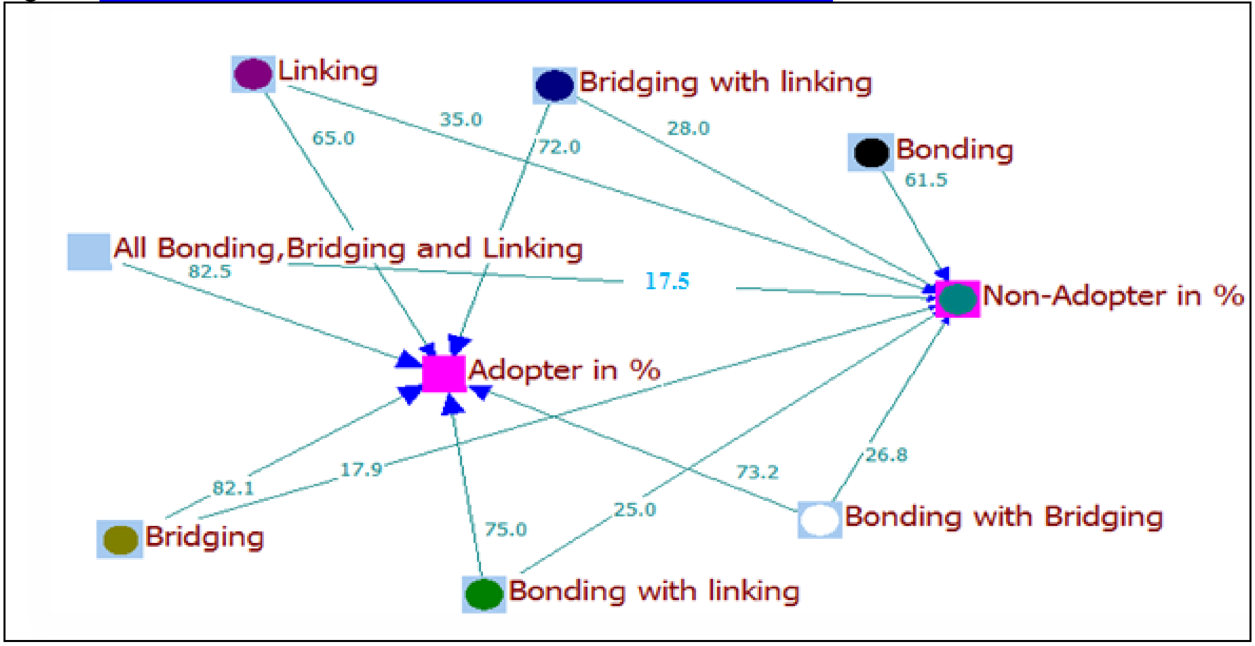
In figure 5, the result reveals that 72 % of adopter is involved in Bridging and linking social network and 28 % of non-adopter is involved in both bridging and linking social networks. these indicate that farmers with greater bridging and linking social networks likely have a greater capacity to acquire and assimilate knowledge about innovative technologies and practices coming from sources external to the farm known as absorptive capacity. Also, through the networks farmers receive timely information to cope with catastrophic events (drought, frost damage, fires, and bird attacks) Furthermore, they have a better understanding of how these new technologies and practices can resolve different kinds of issues on their farms crop management and marketing, Bridging and linking social networks 72 % significantly influenced adoption of recommended soya bean technology. the study is in line with (Micheels and Nolan, 2016)) that shows farmers with more linking and bridging social networks use different technologies more than farmers who have a single network.

Bonding, Bridging and linking social networks with Adopter and non-adopter

In figure 5, the result reveals that 82.5 % of adopter is involved in all bonding, bridging and linking social network and 17.5 % of non-adopter is involved in all bonding, bridging and linking social networks. No social networks are equal in terms of generating equal effects of the adoption of soya bean technology. Adopter is characterized by having significantly more ties between each of them and they have ties outsides. Avery high degree of bonding in densely connected networks may result in the homogenization of knowledge and experience and a lack of bridging social networks among adopters may hinder mutual learning. Similarly, when linking social networks is concentrated in a subgroup, it may privilege information that may be shared with only some members, acting as gatekeepers.

Therefore, the study area has consisted of different type of community within soya bean technology adopter groups, whose relationship were largely that of kinship through marriage, friendship, neighborhood, and other institutional linkage. That means indirectly the study area founds presence of balanced network with bonding, bridging, and linking social networks that creates substantial implication on the level and quality of information different actors receives, attitudes and belief that in turn it likely affected the potential for adopting recommended soya bean technology. The study is strongly in line with Huijboom, (2007) that exposed the adoption of various technologies had successful when social network is balanced.

Figure 5:- effects of social networks on soya bean technology adoption



Source: - Ucinet output

4.5 Analysis of determinants of soya bean technology adoption

In the Logistic regression model, the research treated as among the above technology soya bean producers used ≥ 2 type of technology called adopter and those producers used ≤ 2 type of technology called non-adopter. For the purpose of this study, soya bean producer who were using improved soya bean variety (Clark s1), seed rate and/or fertilizer at least for two years and continued using them were considered adopters of soya bean technologies. However, adoption of other related technology implement was not considered since there was no adopter of the technology observed/found in the study areas. To explain this binary variable, it is necessary to construct a model that relates the dependent variable to a vector of independent variables. The logistic regression model was employed in this study to estimate the determinants of the hypothesized independent variables on the adoption of recommended soya bean technology.

Table 9:- Logistic regression estimates on determinants of adoption of soya bean technology

	Coefficient	Odd ratio	Wald statistics	P>z(sig)
Constant	-6.927	3.812	9.459	0.069
Family size	0.207	0.813	6.45	0.005***
Total non/off-farm Income	0.000	1.000	9.65	0.035**
Training for soya bean	1.145	3.142	11.87	0.032**
Production in quintal	0.271	1.312	12.34	0.000***
Bonding	3.112	22.46	12.98	0.023**
Bridging	3.225	25.148	9.56	0.001***
Linking	2.195	8.978	11.39	0.039**
Bonding and bridging	2.718	15.149	7.99	0.003***
Bridging and linking	2.580	13.195	9.47	0.011**
All bonding, bridging, linking	2.397	10.990	12.87	0.008***
$\chi 2$	140.0			
-2 Log likelihood	34.241			
Correct prediction of all samples (%)	94.0			
Correct prediction of adopters (%)	88.5			
Correct prediction of non-adopters (%)	97.5			

Sources: - Model Output

Note: - ***, **, * are significant at 1, 5, 10% significant level respectively

Among eleven independent variables used in the model, nine variables were found to be statistically significant at 5 % significant level. This implies that the nine variables do have a significant effect on the adoption of recommended soya bean technology. These variables include family size, off/non-farm income, bonding, bridging, linking, bonding and bridging, bridging and linking, all bonding, bridging and linking.

Family size

Family size: Family size is found to be negative and significant at 1 % impacted to determine the adoption of recommended soya bean technology in the study area (Table 10), implying that the probability of adopting recommended soya bean technology decreases with an increase in household size. When the family member increases by one unit' then the likelihood of adopting soya bean technology decreases by 0.813 %. Large families may have their working interests that would determine the adoption of technologies. The study was in line with (Hassen *et al.,* 2012) that labor availability are negatively related and significantly determined with the adoption of improved new technologies.

Bonding social networks

Bonding social networks were found to determine the adoption of recommended soya bean technology positively and significantly (at 1 %). As shown in table (10), When soya bean producers participates in Bonding social networks the likelihood of adopting soya bean technology increases by 22.11 %. Therefore, Bonding Social Networks variables that facilitate the creation of cohesion among people in a community have high positive loadings. This includes cooperation among people, the extent of trust among people, and participation in community activities. This finding agrees with studies by (Bowles and Gintis 2002), who found that those farmers involving in bonding social networks are in trust and a willingness to live by norms and bylaws of the community. Bonding social networks enhance the characteristic of people within-group relations, the extent to which people within the same group or community cooperates had participated in the adoption of agricultural technology activities.

Bridging social network

Bridging social networks is found to be positively related and significantly associated with 1 % to determine the adoption of recommended soya bean technology in the study area (Table 10), implying that the probability of adopting recommended soya bean technology increases with an increase in the involvement of bridging social networks. Those soya bean producers who participate in bridging social networks have likelihood of 25 .148 % times than non-participants to adopt soya bean technology. This shows respondents who have the number of family and group friendships have easily adopt recommended soya bean technology. This study is in line with (Putnam, 2001) that shows, those farmer involved in bridging social network have better connection with different types of people and groups including ethnic, social, gender, political groups that help them to gather information easily about agricultural technology inputs which aid them to increase their technology adoption and productivity.

Linking network type

Linking social networks was found to determine the adoption of recommended soya bean technology positively and significantly (at 1 %). As shown in table (10), When soya bean producers participates in Linking social networks the likelihood of adopting soya bean technology increases by 8.978 %. Therefore, those involved in linking social networks assist to have a better connection within groups, individuals and to each other's in different social positions, which includes relations, interactions between a community and its leaders extend to wider relationships between the village, the government, and the marketplace. This helps them to gather agricultural information more than those did not involved in linking social networks. The study is in line with (Grootaert, 2004) that shows, farmers participated in linking social network had adopted agricultural technology; due to better access of gaining inputs and information that avoid risk and uncertainties to adopt a given technology.

Bonding and Bridging network type

Bonding and Bridging are mixed types of social networks that were founded to determine the adoption of recommended soya bean technology positively and significantly (at 1 %). As shown in table (10), Those soya bean producers who participate in Bonding and bridging social networks have likelihood of 15.145 % times than non participants to adopt soya bean technology. Therefore, involving in mixed social networks is more significant than involving in single social network for access of information in soya bean farming, because soya bean technology information dissemination runs through informal channels, for example, kin networks, neighbors, friends for a common economic benefits and arise from relationship among "alike" members of a network. Kinship networks are vital in accessing information, with networks of neighbors playing a key role in disseminating technological innovation.

Here what makes positive with highly significant is that associations of kinship with other friends and organization position interaction play a role in information sharing and technology adoption. Hence, the study is in line with (Bandiera & Rasul, 2006; Van de Broeck & Dercon's, 2011) that indicates group's characteristics including cohesiveness, motivation, kin networks, friend, and family relationship has promoted technology adoption.

All bonding, bridging and linking social networks type

Bonding, Bridging, and linking are mixed type of social networks were founded to determine adoption of recommended soya bean technology positively and most significantly (at 5 %). As shown in table (10), those soya bean producers who participate in all bonding, bridging and linking social networks have likelihood of 10.990 % times than non-participants to adopt soya bean technology. For that reason, those adopter who used only bonding social networks isolates themselves from knowledge brokers (such as advisors and extension staff), that may translate into lower capacity to make changes on the farm and develop an atmosphere that encourages innovation. Thus, when farmers' networks are based primarily on bonding social networks, this may cause the development of homogeneous and redundant knowledge within the network; this could prevent the acquisition of new knowledge obtained from other social network types.

Even though adopters constituted only in bridging social networks can allow for accessing new sources of knowledge, a lack of bridging social networks among farmers may hinder mutual learning and implementation of new knowledge, potentially leading to limited success in adapting technology and practices. Similarly, when linking social networks is concentrated in a few individuals, this may have access to privileged information that may be shared with only some members, acting as gatekeepers.

Therefore, the benefits of accessing knowledge and adopting technology by a broader support network emerge through what has been referred to as a balanced network with bonding, bridging, and linking social networks. The study is strongly in line with (Grootaert, 2003; Martínez-Pérez *et al*., 2016 and Tiwana, 2008) that publicized being able to use all social networks equally well and having a balanced network facilitates the exploration of new opportunities and their successful implementation to adopt a given technology.

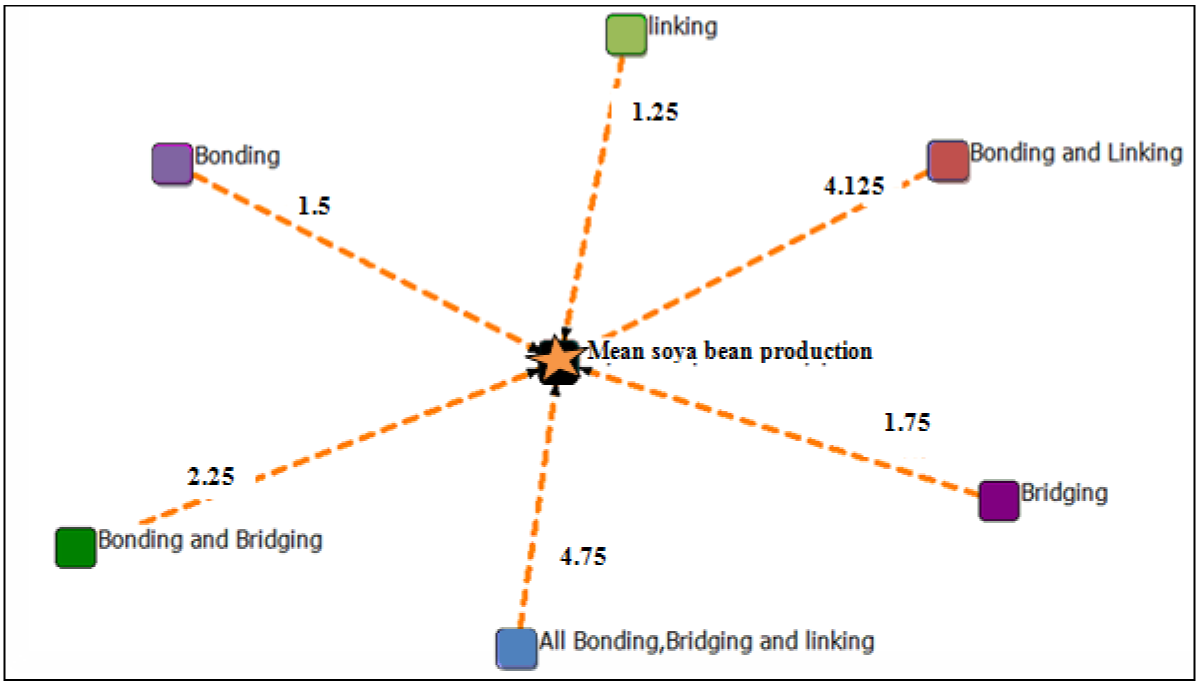
4.6 Analysis of the effects of social networks on soya bean production

Using survey results of Woredas on yield production in the ratio of output/input or (production per household) were mapped the soya bean production with bonding, bridging and linking social networks for the harvest period of 2010/2011 in the study area. For the creation of the soya bean production mapping, the study used matrix and graphical analysis of the data provided to look at the relationship between the soya bean production and typology of social networks in the network. For this, the study was used social network analysis software (Ucinet). The total mean land holding of soya bean producers are 0.25h.

In Figure 6, the analysis results indicate that those involved in all bonding, bridging, linking had the highest level of output (4.75 quintal/household) of soya bean production and those involved in Bonding and Linking social networks had the second-highest level of output (4.125 quintal/household) of soya bean production. Moreover, those involved in Bonding and Bridging social networks had the third level of output with, (2.25 quintals/household) of soya bean production. These show that when soya bean technology adopter increase in involving all bonding, bridging and linking social networks had increased the production of soya bean. For instance, when farmers involved in more than one social networks soya bean production increases, again when farmers involved in single social networks production had decreased. All bonding, bridging, linking social networks, and mean soya bean production have a direct relationship. In Table 3 page 43 indicate that those have all type of networks were adopt soya bean technology easily at 82.5 %, these are because producers had seen as a set of connected actors, who interact constantly, seeking to negotiate and create opportunities to fulfill their needs and pursue their interests.

The study revealed that a mixed type of social networks influenced the rate of soya bean production of soya bean producers. They also facilitate the flow of information, reduce the information asymmetry, as well as provide access to resources to implement farm innovations. Moreover, these networks provide the opportunity for farmers to gather updated information about technologies from each other. These networks had often seen as an important mechanism for smallholders to access agricultural information and innovation. The study is in line with (Osaki and Batalha, 2014.) that shows the spread of technology within more than a single social network had a relative advantage for soya bean production.

Figure 6:- Representation of effects of social networks on soya bean production



Sources: - Ucinet, draw-net output.

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Imperfect soya bean production and adoption problem in the Woreda can be the result of absence of awareness on the expansion of social network variable to the deferent household level. Problem of imperfect soya bean production has implication on human nutrition and productivity in general. It is often essential to measure the severity of social network as well as determine its effects across household members to find appropriate solution and precisely address problem of adoption and production of soya bean technology. The major findings concluded as follow.

The study was identified three types of social networks, which include bonding, bridging, and linking social networks for dissemination and adoption of soya bean technology. Likewise, soya bean producers who mainly involved only in a single social network separately had to be non-adopter of soybean technology whereas, those soya bean producers involved in all type of social networks together were adopter of soybean technology. Therefore, involving in multi-channeled types of social networks enhance additive for soya bean technology adoption that favor access to extra knowledge and information. Additionally, practicing mixed type of social networks increase the rate of soya bean production and facilitates the flow of information by reducing the information asymmetry that provide access to resources to implement soya bean technology innovations. In general, social networks (bonding, bridging, and linking) were found to have positive and significant effect on dissemination and adoption of soya bean technologies. Moreover, publicized being able to use all social networks equally well and having a balanced network facilitates the exploration of new opportunities and successful implementation to adopt soya bean technology.

5.2 Recommendation

The study showed that all bonding, bridging, linking, relatives, friends and neighbors were the most important nodes of information and seed sources; influential networks in the adoption recommended soya bean technology and for dissemination of technology information process of the study area. Hence, organizing and empowering these networks in to community based Farmers Research and Extension Groups and strengthening the existing informal as well as formal networks will have a great importance in the process of technology generation, adoption, and diffusion process.

- Therefore, efforts should be made to organize new groups, strengthening the existing indigenous networks at village, Woreda, and Woreda levels and strengthening the existing groups through different capacity building strategies. Besides, in order to strengthen the bridging and linking social capital of these groups, the village level groups should have representatives at PA and Woreda level groups. So that, information flows, experience sharing from the formal organizations to the groups as well as the informal social networks will be easy and effective. Research, BoARD and NGOs have to work together to achieve this objective.
- Research and BoARD have to lead the initiative jointly, because they do have the capacity to implement such participatory approaches, which were proven elsewhere in the country. On the other hand, NGOs could support financially, technically through their capacity-building program on social capital strengthen strategy.
- In addition, government needs to mainstream to their annual plan to give technical training on social capital asset. The concerned bodies such as governments, Keble administrations, should make efforts, community leader has to device scaling up mechanisms to expand balanced social networks. Finally Community based policing, creating awareness among community members, community training should have to be implemented regarding to social network importance for agricultural technology adoption and its production.

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APPENDIX

Group Statistics

	Adopter Status	N	Mean	Std. Deviation	Std. Error Mean
age of hh in a year	Non-Adopter	87	38.6552	6.86723	.73624
	Adopter	299	38.5385	6.53907	.37816
fsize of hh	Non-Adopter	87	5.2184	3.11943	.33444
	Adopter	299	5.0167	2.34801	.13579
Dependency Ratio	Non-Adopter	87	.4137	.34836	.03735
	Adopter	299	.6711	4.38251	.25345
edu status of hh	Non-Adopter	87	3.3908	3.27200	.35079
	Adopter	299	3.3144	3.27306	.18929
Total off-farm and non-farm income	Non-Adopter	87	1987.3563	3010.68078	322.77886
	Adopter	299	3046.8963	3609.44629	208.73967
close friends of HH	Non-Adopter	87	2.8046	2.16117	.23170
	Adopter	299	3.3010	2.12599	.12295
Time taken to reach the main market	Non-Adopter	87	38.5862	12.43733	1.33342
	Adopter	299	43.2308	12.54376	.72542
total land size of HH	Non-Adopter	87	1.2010	1.11508	.11955
	Adopter	299	1.6937	1.26081	.07291
total land size for soyabean production	Non-Adopter	87	.3756	.38816	.04162
	Adopter	299	.5028	.33980	.01965
Shares of land allocated for soyabean production	Non-Adopter	87	.4210	.30938	.03317
	Adopter	299	.4070	.26755	.01547
seed rate	Non-Adopter	87	24.2241	21.53928	2.30925
	Adopter	299	30.8411	23.76152	1.37416
seed rate per hectar	Non-Adopter	87	70.2543	15.28333	1.63854
	Adopter	299	63.7281	21.04373	1.21699
DAP applied on soyabean	Non-Adopter	87	16.1207	15.58957	1.67138
	Adopter	299	19.3662	13.27960	.76798
land for fertilizer	Non-Adopter	87	.7237	2.94692	.31594
	Adopter	299	.5012	.34252	.01981
DAP per hectar	Non-Adopter	87	16.1207	15.58957	1.67138
	Adopter	299	19.3662	13.27960	.76798
frqeuncy of weeding	Non-Adopter	87	1.8046	.83303	.08931
	Adopter	299	2.4415	.81043	.04687
how many kuntal do you get from last year production	Non-Adopter	87	3.1379	3.46552	.37154
	Adopter	299	7.7734	6.63804	.38389

T-test result

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
age of hh in a year	Equal variances assumed	2.016	.156	.145	384	.885	.11671	.80568	-1.46738	1.70080
	Equal variances not assumed			.141	134.659	.888	.11671	.82769	-1.52023	1.75366
fsize of hh	Equal variances assumed	11.117	.001	.651	384	.515	.20167	.30956	-.40697	.81030
	Equal variances not assumed			.559	115.784	.577	.20167	.36095	-.51326	.91660
Dependency Ratio	Equal variances assumed	.252	.616	-.547	384	.585	-.25741	.47072	-1.18292	.66809
	Equal variances not assumed			-1.005	310.575	.316	-.25741	.25618	-.76149	.24666
edu status of hh	Equal variances assumed	.367	.545	.192	384	.848	.07642	.39868	-.70744	.86029
	Equal variances not assumed			.192	139.946	.848	.07642	.39861	-.71164	.86449
Total off-farm and non-farm income	Equal variances assumed	3.848	.051	2.496	384	.013	-1059.54000	424.43784	-1894.05311	-225.02689
	Equal variances not assumed			-2.756	164.663	.007	-1059.54000	384.39360	-1818.51573	-300.56426
close friends of HH	Equal variances assumed	3.932	.048	-1.910	384	.057	-.49641	.25994	-1.00749	.01468
	Equal variances not assumed			-1.892	138.089	.061	-.49641	.26230	-1.01505	.02224
Time taken to reach the main market	Equal variances assumed	.388	.534	-3.045	384	.002	-4.64456	1.52512	-7.64319	-1.64594
	Equal variances not assumed			-3.060	140.879	.003	-4.64456	1.51798	-7.64552	-1.64360
total land size of	Equal variances	8.403	.004	-3.289	384	.001	-.49271	.14979	-.78723	-.19820

HH	assumed									
	Equal variances not assumed			-3.519	155.667	.001	-.49271	.14003	-.76932	-.21611
total land size for soyabean production	Equal variances assumed	.720	.397	-2.973	384	.003	-.12721	.04278	-.21133	-.04309
	Equal variances not assumed			-2.764	126.809	.007	-.12721	.04602	-.21828	-.03614
Shares of land allocated for soyabean production	Equal variances assumed	3.030	.083	.415	384	.678	.01404	.03380	-.05242	.08050
	Equal variances not assumed			.384	125.783	.702	.01404	.03660	-.05839	.08647
seed rate	Equal variances assumed	9.569	.002	-2.333	384	.020	-6.61700	2.83611	-12.19326	-1.04074
	Equal variances not assumed			-2.462	152.183	.015	-6.61700	2.68719	-11.92601	-1.30799
seed rate per hectar	Equal variances assumed	7.073	.008	2.692	384	.007	6.52628	2.42399	1.76032	11.29224
	Equal variances not assumed			3.198	190.338	.002	6.52628	2.04105	2.50029	10.55227
DAP applied on soyabean	Equal variances assumed	.083	.773	-1.926	384	.055	-3.24553	1.68475	-6.55803	.06697
	Equal variances not assumed			-1.764	124.546	.080	-3.24553	1.83937	-6.88601	.39495
land for fertilizer	Equal variances assumed	11.921	.001	1.280	384	.201	.22253	.17381	-.11922	.56427
	Equal variances not assumed			.703	86.677	.484	.22253	.31656	-.40671	.85176
DAP per hectar	Equal variances assumed	.083	.773	-1.926	384	.055	-3.24553	1.68475	-6.55803	.06697
	Equal variances not assumed			-1.764	124.546	.080	-3.24553	1.83937	-6.88601	.39495
frqeuncy of weeding	Equal variances assumed	.262	.609	-6.411	384	.000	-.63687	.09935	-.83220	-.44155
	Equal variances not assumed			-6.314	136.895	.000	-.63687	.10086	-.83632	-.43743
how many	Equal variances	49.664	.000	-6.266	384	.000	-4.6354	.73981	-6.0900	-3.1808

kuntal do	assumed						8		7	9
you get from last year production	Equal variances not assumed			-8.677	276.644	.000	-4.63548	.53424	-5.68718	-3.58379

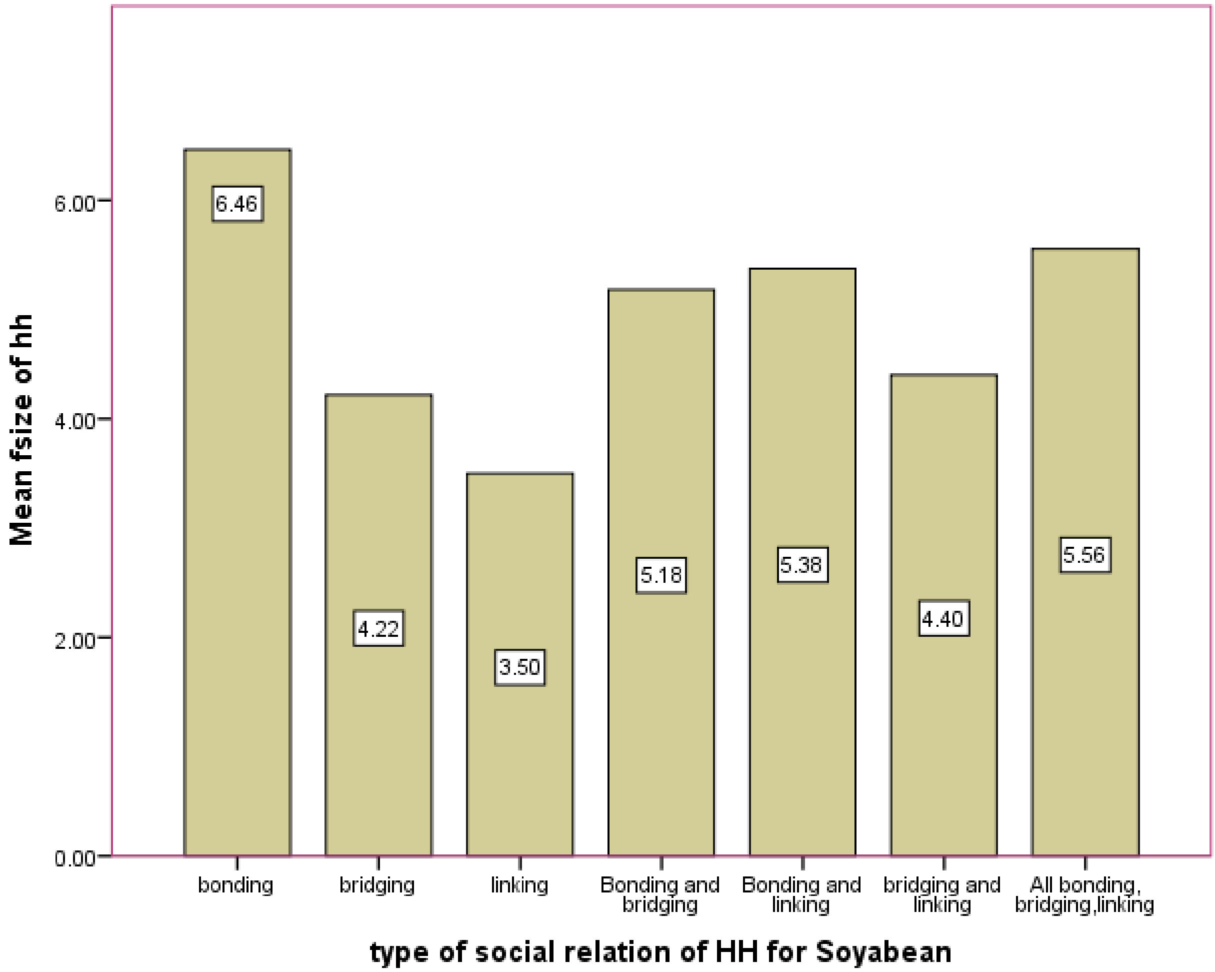
Descriptive results

Marital of households

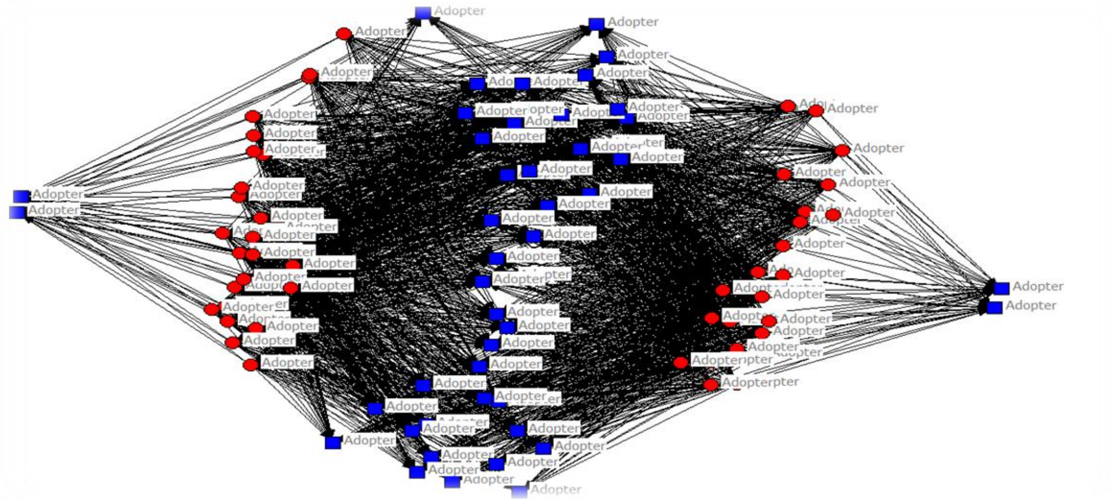
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	married	322	83.4	83.4	83.4
	single	50	13.0	13.0	96.4
	divorced	12	3.1	3.1	99.5
	widow	2	.5	.5	100.0
	Total	386	100.0	100.0	

Shared information among soya producers

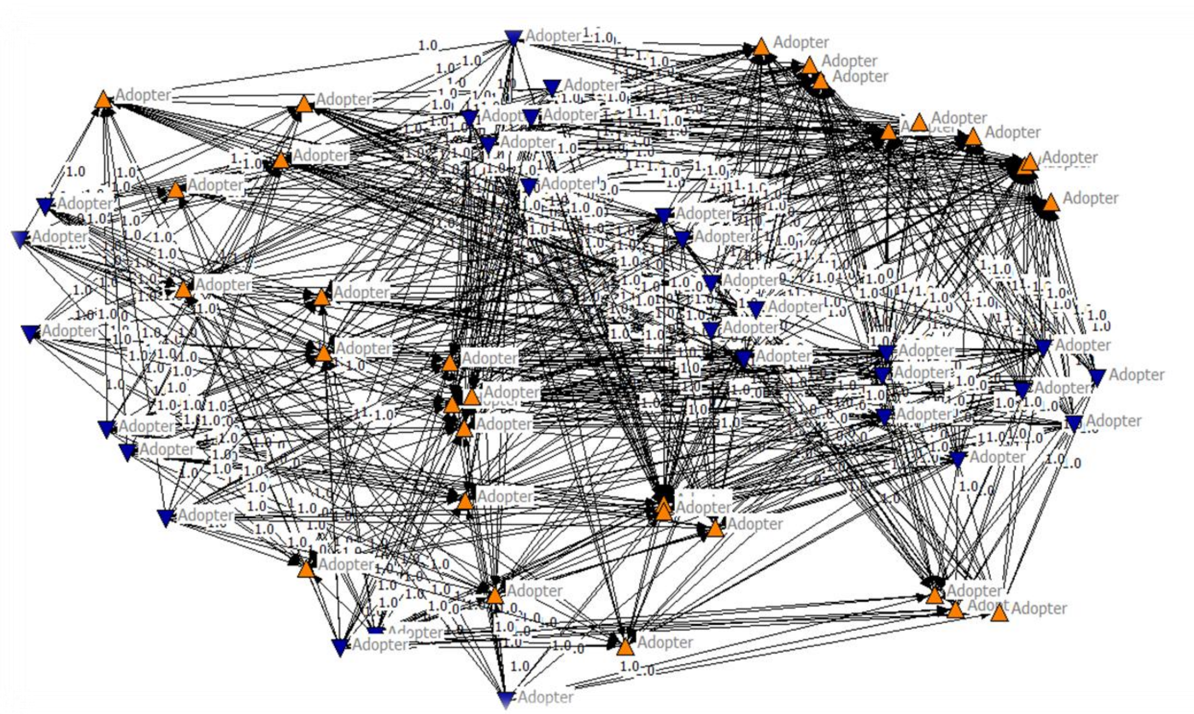
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Always	187	48.4	48.4	48.4
	often	59	15.3	15.3	63.7
	Neither often nor seldom	98	25.4	25.4	89.1
	seldom	39	10.1	10.1	99.2
	very seldom	3	.8	.8	100.0
	Total	386	100.0	100.0	


6.46
4.22
3.50
5.18
5.38
4.40
5.56
6.00
4.00
2.00
0.00
Mean fsize of hh
bonding
bridging
linking
Bonding and bridging
Bonding and linking
bridging and linking
All bonding, bridging,linking
type of social relation of HH for Soyabean

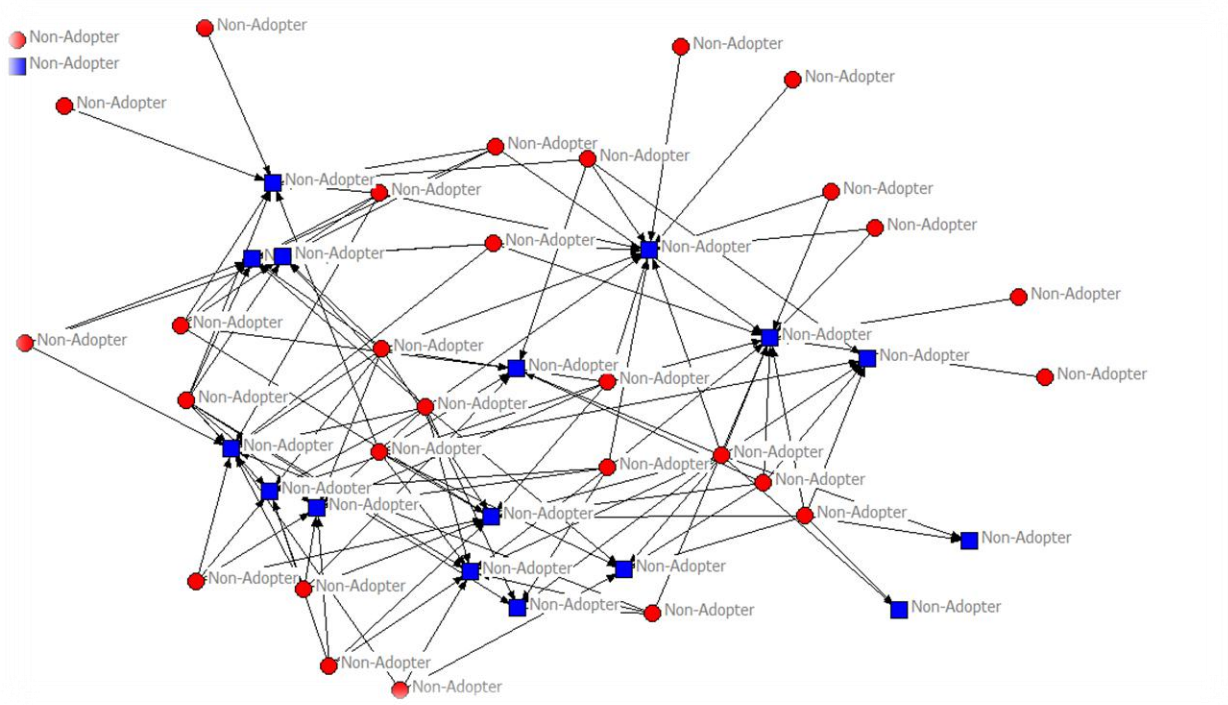
Kitinbela Keble (kersa Woreda) Adopter network relation visualization



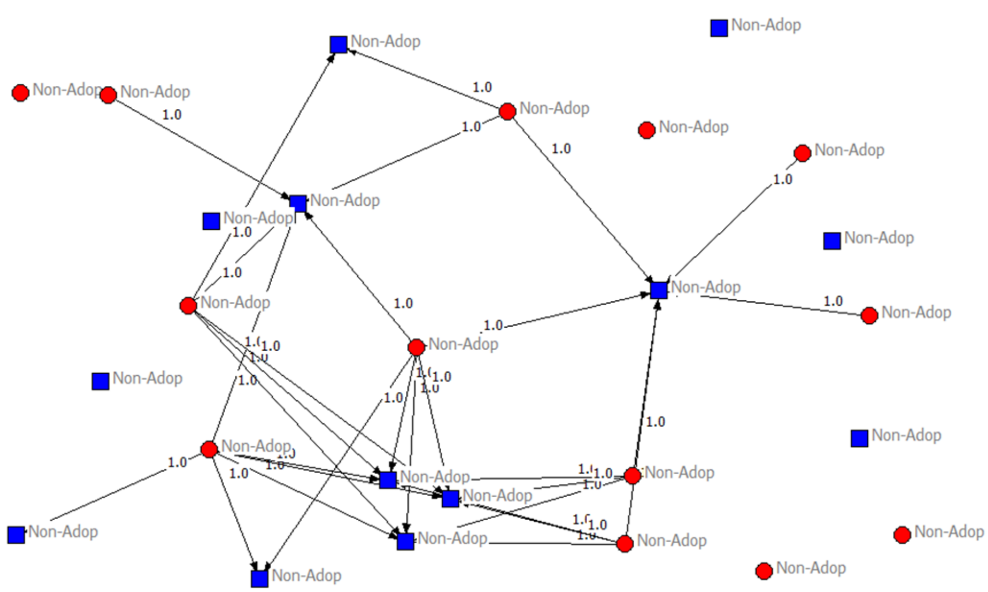
Tikurbalto Keble (kersa Woreda) Adopter network visualization



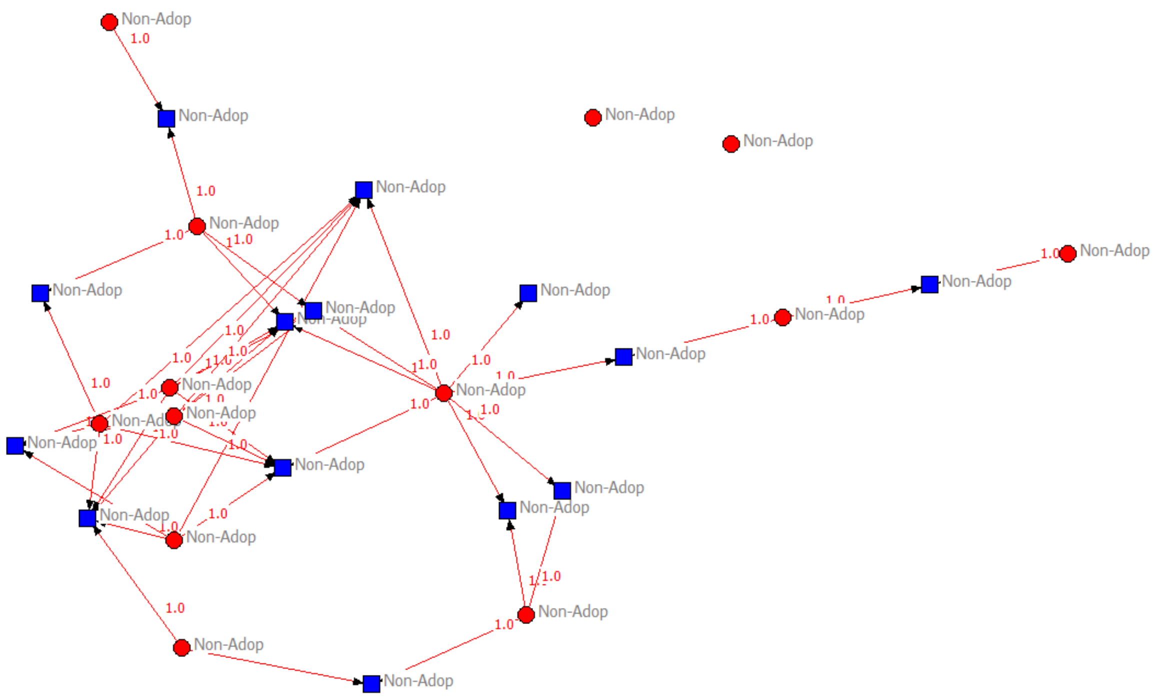
Kitinbela Keble (kersa Woreda) non- adopter network relation visualization



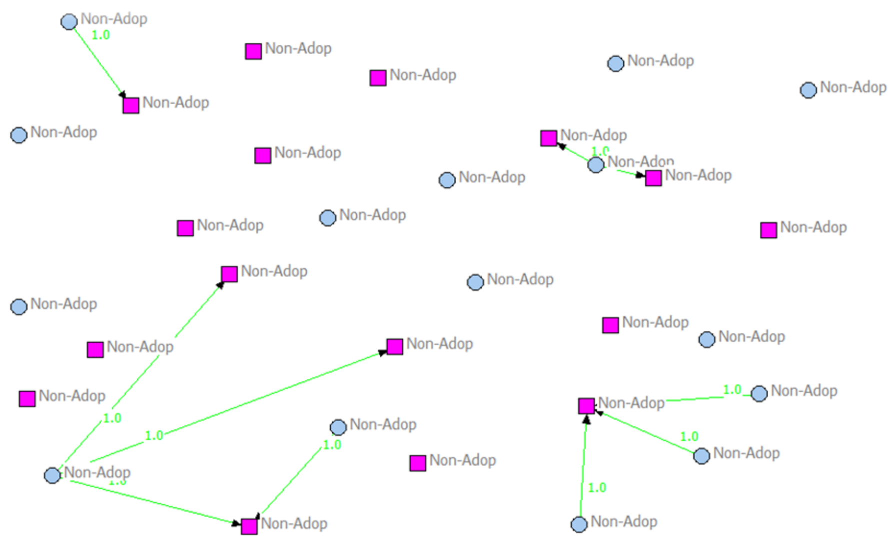
Tikurbalto Keble (kersa Woreda) non-Adopter network relation visualization



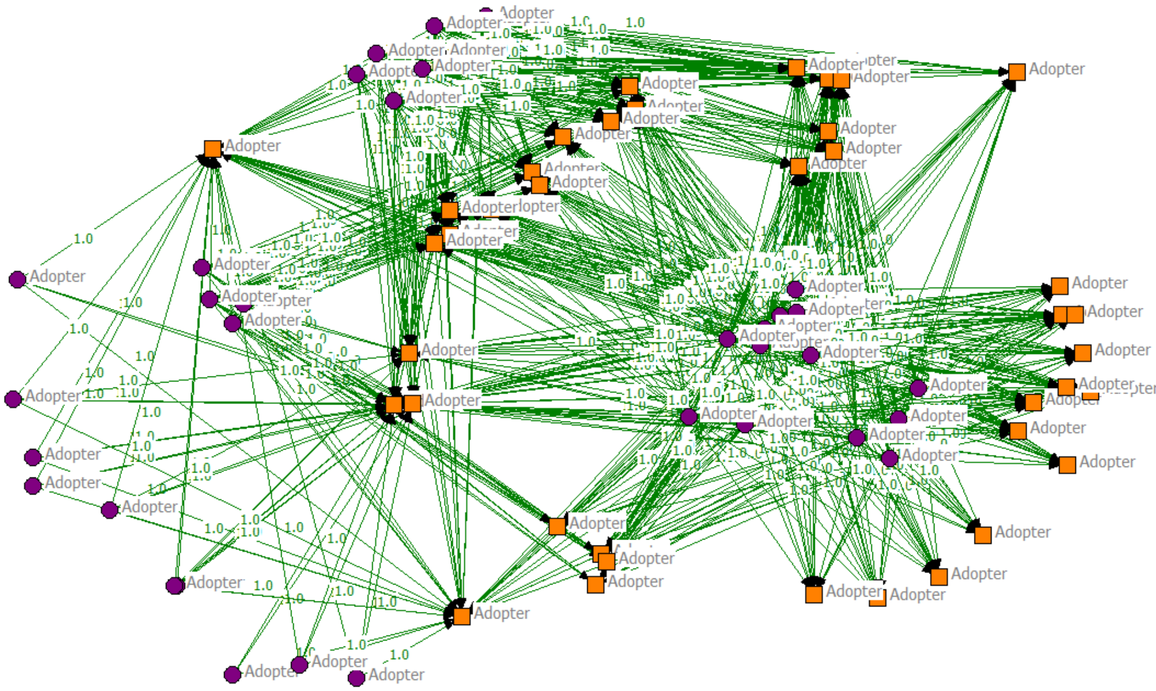
Bisogonbo Keble (omonada Woreda) Non-Adopter network visualization



Seyoadem Keble (omonada Woreda) Non Adopter network visualization



Seyoadem Keble (omonada Woreda) Adopter network relationship visualization



Survey Questionnaire

<u>Jimma University College of agriculture and veterinary medicine</u>

Date ------------------

Dear Respondent

Subject:-<u>Request for Response to Questionnaire</u>

these research is done by Jimma university college of agriculture and veterinary medicine with in titled called ***"effects of Social Networks On Soybean Adoption of recommended technology in the case of Jimma Zone, Oromiya Region"*** You have been selected as one of the respondents to supply the required information for This study. I therefore solicit for your cooperation to respond as objective as possible to the questions. It is purely academic work and all information supplied by you will be strictly treated in confidence.

Thank you for your patience and cooperation.

Yours faithfully,

Ashenafi Girma .

Interview schedule used for data collection (For Household survey)

Instruction: - Introduce yourself before starting the interview. Inform the respondent politely to whom you are working for and explain the purpose of the interview. Fill the responses in the space provided or circle alternative responses in the space provided or circle alternative response (s) where appropriate.

1. General Information

1.1 Name of enumerator______________________________ Signature_____________

1.2 Dateof interview:-_______________________________

1.3. Woreda Name:

kersa o a

1.4. G P S Coordinates of each kebele: Latitude____ Longitude_________Elevation__________

1.5 Respondent code:-__________________

1.6. Sex:-_________________

1.7. Religion_____________________ , Household head Yes ☐ No ☐

1.8. How many years did you live in this kebele? ______________

1.9. Ethnicity ☐

No.	2.1.1 List names of all in individuals in your family (*List household head first, use first names only)* Name	2.1.2 what is "______" relationship to Household head? *(Use code box)* Code	2.1.3 Sex *Male--- 1* *Female--2*	2.1.4 How old is"______" years	2.1.5 what is "______" 's Marital status? Married……….1 Common-low…2 Divorced………3 Widow(er)…….4 Never married….5	2.1.6 Completed education Level? *(Use code box*	2.1.7 How long have you lived in this community ?	Rem ark
1								
2								
3								
4								
5								
6								
7								
8								
9								

Code box for Question 2.1.2

Head……………………01Uncle/Aunt……………..…..08

Wife/husband…………..02 Cousin…..……..................09

Son/daughter…………...03 Grand Parent.................10

Father/mother…..04 Children from anotherfamily…..11

Sister/brother…………...05 Other non-Relative……...12

Stepson/stepdaughter…...06 Other relative……..……..13

Stepfather/stepmother…..07 Renter ………………..…14

Code box for Question 2.1.6

no schooling…………………..……1

How grade are you………………4

Other (Religion)..……… ………5

2.2 **<u>If you are a household head]</u>**what is your social role other than a household head in the Community?

1. Priest/ sheka/traditional healer
2. Kebele Cabinee", Administrator, militia, "
3. Committee member of ________________
4. Others (specify) ______________________
5. What advantages do you get from this social role?

----

6. Did the household participate in off/non-farm activity? 1. Yes ☐ No ☐

7. If yes what type? ________

8. How much money did the HH get from off farm activities in 2010/2011 EC? ______________

9. How much money did the HH get from non-farm activities in 2010/2011 EC? _____________

SOYBEAN PRODUCTION TECHNOLOGY

1. When did you start to cultivate soybean? ___________

2. Have you ever used improved soybean variety? 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 ☐

5. Have you ever interrupted growing improved varieties since your start? 1) Yes ☐ 2) No ☐

6. If yes, why?

1) Seed not available 2) Seed too expensive 3) not adaptable

4) Susceptible to diseases 5) Poor quality of seed 6) other specify

7. Do you have a plan to plant soybean in future? 1) Yes 2) no

8. If no, why not? 1) Seed not available 2.) Lack of cash to buy seed 3) Low yielding variety 4) Lack of access to credit (seed) 5) other……

9. Is there production risk in soybean farming? 1) Yes 2) no

10. What are your problems in soybean farming? 1) ______________ 2)_______________ 3) ______________

17. Do you think that there is risk regarding market value? 1) Yes 2) no

18. Which risk is significant in soybean production? 1) Price 2) production

19. How do you perceive the production cost of soybean 1) low 2) moderate 3) high?

MEMBERSHIP AND LEADERSHIP PARTICIPATION

1. How many members participate as member and leader in the following organizations?

organization			**Member**		**leader**	
	yes	**no**	**Male**	**Female**	**Male**	**Female**
Idir /Iqub						
Cooperatives / union						
PA council						
Saving &credit group						
Other (Specify						

MARKETAND CREDIT

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

2. If yes what is the average market price of soybean? (Birr/kg) ______________________

Price at farm gate	Price at market	To whom did you sell at farm? (Codes A)	To whom did you sell at market? (Codes A)

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

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

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

5. Which months of the year had the higher price for soya bean? ___________

6. Compare price of soya bean with alternative crops that you can grow? 1) Motivated_________ 2)demotivated:- _________________

7. How long do you store soybean? _______months,

8. Time taken to reach the main market? _____min,

9. Is credit service available in the area? 1) Yes __________ 2) No _______

10. Have you received credit during 2010/2011 cropping calendar? 1) Yes_______ 2) no _______

11. If yes, which category? 1) Cash________ 2) kind ____________

12. From whom did you get credit? 1) Bank_______ 2) NGO_____ 3) Friends \relatives________ 4) Local organizations_____________ 5) Cooperative______ 6) saving and credit________ 7) Others, specify ______________________

13. If yes, what is the amount of credit you got? ________________

14. Conditions for getting credit? 1) __________________ 2) ________________ 3)_________________ 15. If no to Q No 10, why? 1) I didn't need it ____________2) it was inaccessible _______________3) no financial institutions________________

CONTACT WITH EXTENSION

1. Did you get advisory services from extension agents in 2010/2011? 1) Yes_____ 2) No ______

2. If yes, have you received advice in soya bean production? 1) Yes______ 2) no _______

3. How frequently did the extension agents visit you?

1) Once in a year_____ 2) twice a year _____ 3) Monthly __ 4)bi-weekly _ 5)Weekly____ 6) not at all__

4. During which farm operation extension agent visit you? 1) Land preparation 2) During input provision 3)during sowing 4) Whenever disease/pest occur 5) during credit collection 6) any time 7) others, __

5. Did you visit extension agents by yourself? 1) Yes _____ 2)No_

6. When you did first heard of improved variety of soybean? _______year

7. from who/, which source? 1) Fellow farmers_____ 2)DA ______ 3)Research __ 4) NGO _____ 5) relatives___ 6) Others

8. Have you participated in farmers' field day? 1) Yes _____ 2)No__

9. If yes, how many times------------------and who arranged for you?

1) BoA ______ 2) Research __ 4)NGO _____ 5)Others, Specify------

10. Have you ever received training in soybean production? 1) Yes______ 2)No _______

11. If yes, how many times--------and who arranged for you?

12. Have you hosted demonstration in the last five years? 1) Yes_________ 2) No ______

13. If yes, how many times-----------and with whom you conducted demonstration?

1) BoA ______ 2) Research __ 3) NGO_____ 4) Others, Specify

LEVEL OFADOPTION

Subject	**Local seed**	**Improved variety**
Total area allocated for soybean		
Frequency of weeding		
Seed rate		
DAP applied on soybean land		
Area of soybean applied with fertilizer		

KNOWLEDGE OF IMPROVED SOYBEAN PRODUCTION

Practices	**Answer**
List two recommended variety of soybean	
Recommended seed rate per hectare	
Soybean land cultivated	
Fertilizer rate per hectare	
Soybean production	

2. SOCIAL networks

Now I would like to ask you some questions about how you feel about this village/neighborhood, and how you take part in the community activities.

2.1 Household membership in different groups and associations

2.1.1 What type of social relation do you have

1. Bonding networks ☐
2. Bridging networks ☐
3. Linking networks ☐
4. Bonding and bridging ☐
5. Bonding and linking ☐
6. Bridging and linking ☐
7. all of them used ☐

2.1 Are you or is someone in your household a member of any groups, organizations or associations? , household belongs to which Group? ____

____

2.2 Are there any other groups or informal associations that you or someone in your household belongs to? [*Ifthe household is not a member in any group, go to section 2.B*

____

2.3 Do you consider yourself/household member to be active in the group, such as by attending meetings or volunteering your time in other ways, or are you relatively inactive? Are you/household member a leader in the group?

Household Member in Latter	Name of Organization/ association	Type of Organization *(use codes below)*	Degree of participation *(Use code below)*

		Type of Organization Farmers group…………………………..1 Cooperative/cooperative Union..……...2 Credit/finance group(Eg. Equb.............3 Religious group or spiritual group (e.g. church, mosque, temple, informal..4 Mutual support association (Edir).........5 Political group(Cabinee/ Mlitia) …........6 Labor exchange group(Debo, Wonfel)...7 Women's group(womens Edir)....…….8 Ethnic-based community group….…....9 Others ………..………..……..…...10	*Degrees of participation* Leader…………….01 Very active……….02 Somewhat active…03 Not active………..04 Only member…….05

2.4 Which of these groups/associations in which you are a member is the most important to

Your household? *(List up to three by name and in order of importance.)*

Group 1: ____ [ ]

Group 2: ________________________ _______________[ ]

Group 3: ____ [ ]

2B. Social Networks

2B0:- **<u>Shared information each other through soybean producer(open ended)</u>**

1. How often you share information with each of the other on soybean adoption technology

1. (Very Often or Always,

2. Often,

3. Neither __________Seldom

4. Seldom

5. Very Seldom

3B.1 about how many close friends do you have these days? These are people you feel at

Ease with, can talk to about private matters, or call on for help.

3B.2 If you suddenly had to go away for a day or two, could you count on your neighbors to Take care of your children?

A. Definitely
B. Probably
C. Probably not
D. Definitely not

3B.4 Who do you talk to, here in the village "______"[*Here the enumerator should site the* *village name*] when you have a big decision to make in your life, or when you need adviceabout a problem, exchange of resources, seek information? can you name three peopleName Their relationship with the household

1.____________________ _________________________

2.____________________ _________________________

3.____________________ _________________________

3B.5 did you/your family members participate in the following social networks?

No.	Social networks	Yes	no
1	1. Kebele social Courts	[ ]	[ ]
2	2. Local Cabinet member	[ ]	[ ]
3	3. Education (Family-Teacher committee)	[ ]	[ ]
4	4. Church/Mosque (As a priest, sheka)	[ ]	[ ]
5	5. Market place (who frequently go to market)	[ ]	[ ]
6	6. Unions (cooperatives)	[ ]	[ ]
7	7. Clubs & societies [ ] [ ]	[ ]	[ ]
8	8. Networks of neighbors, friends & acquaintances	[ ]	[ ]
9	9. Families	[ ]	[ ]

3B.6 Do these social networks have trans-generational continuity (like from father to son) Within the community?

1. Yes 2. No

3B.7 If No, what are the reasons? ---

4. Information and Communication

4.1 What are the three most important (in order of importance) sources of information about what the government is doing (such as agricultural extension, workfare, family planning, etc.)?

1. Relatives, friends and neighbors
2. Spiritual places (like Church, mosque)
3. Local market
4. Radio

5. Television

6. Political leaders

7. Community leaders

8. An agent of the government (Like DAs)

9. NGOs

10. Others (specify)

4.2 What are the three most important (in order of importance) sources of seed exchange Mechanisms (such as improved seed of soybean,)?

1. Relatives, friends and neighbors
2. own seed selected from previous harvest
3. Local market
4. Cooperatives

5. Bureau of Agriculture and Rural development(BoARD)
6. Research centers
7. Investors

4.3 What is/are the reasons for these (selected above) sources being the best source of seed Exchange?

1. Terms of exchange is favorable/flexible/simple
2. Variety choice is adapted, appropriate and wide
3. Reciprocity and trust: we know them and they are related to us
4. Easily accessible

5.4 In general, compared to five years ago, has access to information improved, deteriorated, or Stayed about the same?

1. Improved
2. Deteriorated
3. Stayed about the same

5.5 When you want to adopt or use any soybean technology that is new to the community (like improved seed,) who is/are primarily to follow? --

5.6 Through which channels technological or institutional innovations channeled to the community or social system? List 3 important channels

Formal informal

1.______________________________ 1.______________________

2.______________________________2._________________

3.________________________________ 3.______________________

5.6 Among these social networks, which are crucial for the diffusions of technology within and outside the community?

1.______________________________ 2.____

3.____

<u>Thank you for your collaboration</u>