BAHIR DAR UNIVERSITY

COLLEGE OFAGRICULTURE AND ENVIRONMENTAL SCIENCES

DEPARTMENNT OF RURAL DEVELOPMENT AND AGRICULTURAL EXTENSION

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EVALUATINGRESEARCH-EXTENSION -FARMERS' LINKAGE IN THE PROCESS OF AGRICULTURAL TECHNOLOGY TRANSFER: THE CASE OF DANGILA DISTRICT, ETHIOPIA

MSc. Thesis

By

Wasihun Alemnew

October, 2021

Bahir Dar

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THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN RURAL DEVELOPMENT MANAGEMENT

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THESIS APPROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by Mr. Wasihun Alemnew entitled "Evaluating research-extension -farmers linkage in the process of technology transfer: the case of Dangila district, Ethiopia". We hereby certify that; the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (M.Sc.) in Rural Development Management.

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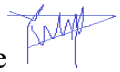
Internal Examiner: **Yenesew Sewnet (Asst prof)** Signature  Date 01/11/2021

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DECLARATION

This is to certify that this thesis entitled with " Evaluating research-extension- farmers linkage in the process of technology transfer: the case of Dangila district, Ethiopia.".Submitted in partial fulfillment of the requirements for the award of Master of Science in Rural Development Management to the Graduate Program College of Agriculture and Environmental Sciences, Bahir Dar University by Mr. Wasihun Alemnew which is an authentic work carried out by himself under our guidance. The matter embodied in this thesis work has not been submitted earlier for award of any degree or diploma to the best of our knowledge and belief.

Wasihun Alemnew  01/11/2021

Name of the Student Signature Date

Name of the Advisors:

1. Azanaw Abebe (Ass. Professor)  01/11/2021

DEDICATION

This thesis is devoted to my wife w/ro Egigayehu Wondie, my kid Blen Wasihun and friends who have been support through study process.

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ABSTRACT

The extension system in Ethiopia is used pipeline extension model, which researchers develop technology, extension workers act as technology disseminator and farmers are technology implementers/users. Such top-down approach characterized by separate involvement of actors limits the farmers' opportunity to get knowledge and skills on the technology. The overall aim of the study was to identify and describe the linkages and linkage mechanisms among research- extension-farmers and factors that influence farmers' participation on the technology demonstration.

Simple random, snowball and purposive sampling techniques were used for selecting respondents and study area for this study. The data collection tools also included interview schedules, questionnaires, and check lists. The data were analyzed through descriptive, mann-whitney U test and binary logistic regression model.

The mann-whitney U test analysis result indicated that, linkages between research-extension and farmers show that, extension workers had highly strong linkage with farmers in the process of technology transfer and there is no statistically significance on the ratings of linkages between extension workers with researchers and farmers' with researchers. The extension workers have more opportunity to participate in both farmers and research activities. The linkage mechanisms also indicated that, trainings, method demonstrations and field visit linkage mechanisms were frequently and commonly used by majority of the actors. The binary logistic regression model analysis result indicated that, Sex, education, extension advisory service and land ownership factors were significantly influence the farmers' participation on the technology demonstration.

In conclusion, the linkages between farmers with researcher and extension with research were weak that needs strengthen through joint implementation of linkage mechanisms. In general perspective role of linkages in the process of technology transfer in Ethiopia were weak. The major reasons were non/little involvement of farmers in the research system, top-down approach, poor use of linkage mechanisms and strategies

Keywords: linkage, linkage mechanisms, research-extension and farmers' linkage

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List of abbreviations

ADPLAC-agricultural development linkage advisory council

ARDPLAC- agricultural and rural development partners linkage advisory council

FRG- farmer research group

ha. – Hectare

SMS-subject matter specialist

FDRE-federal democratic republic of Ethiopia

EIAR-Ethiopian institute of agricultural research

EPID- extension program implementation department

FAO- food and agriculture organization

BMGF- Bill and Melinda Gates foundation

FTC- farmer training center

DA- development agent

EEP- Ethiopian economic development

USA- united states of America

CSA-central statistics agency

NARS- national agricultural research system

IECAMA- imperial Ethiopian college of agricultural mechanics and arts

IAR- institute of agricultural research

PADEP- participatory agricultural demonstration and extension program

RELC-research and extension liaison committee

PADETES-participatory agricultural demonstration and training extension system

FREAC- farmer-research and extension advisory council

REAC- research and extension advisory council

JICA- Japan international cooperation agency

FGD- focus group discussions

IFAD-international fund for agricultural development

SPSS- statistical package for social science

CHAPTER ONE: INTRODUCTION

1.1. Background

Agricultural production is dominated by smallholder households which produce more than 90% of agricultural output (EEP, 2015). Research, extension and farmers are the three main pillars of agriculture system and their effectiveness largely depends on the strong linkages among each other. Technology generation and transfer related to national agricultural productivity that requires effective communication among stakeholders. In Ethiopia, 960 improved varieties of crops, more than 96 improved technologies for livestock management, 45 for natural resources, 9 for agricultural tools, and 5 for forestry had been released and recommended by different research organizations (NARS, 2014).

The concept of linkage in this study is communication and work together to develop and disseminate improved agricultural technologies to farmers. Researchers and development agents are the main actors in the process of technology release and transfer and their achievement depends on strong linkages with each other. Extension system and research coordinated through information exchange and feedbacks on the technology (Havelock, 1986).Some developed countries experience implies that like, USA and Netherlands research, extension and farmers linkage were bottom-up approach that creates effective utilization of staff manpower, improve collaboration and strengthen linkages between actors(Agbamu, 2014). But in Ethiopia research, extension and farmers system were top-down that leads weak linkage, agricultural relations and little/no farmers representation on the research process (Yenesew Sewenet *et'al.,*2016).

The weak linkages between research-extension and farmers that is observable still today, efforts were made since 1986 to establish strong and functional linkages. One of the options applied was by organising committees /councils at a national level to link agricultural research and extension organizations. Accordingly, the first committee was organised in 1986 and named as Research Extension Liaison Committee (RELC). RELC was organised mainly at

national level with major purposes of providing forum for stakeholders to share information and improve the adoption of agricultural technologies. It was also commissioned to undertake diagnostic studies on weaknesses of the national research and extension systems and to study factors affecting the adoption of potentially useful technologies. However, RELC was criticized in its no involvement of farmers and in its irregular, ad-hoc and non-institutionalized meetings (Demekech Gera*et'al*, 2010;Belay Kassa, 2008).

The first linkage platform which followed RELC was called Research-Extension and Farmers Linkage Advisory Council (REFLAC). REFLAC worked from 2000 to 2008. According to Demekech et al., (2008) REFLAC had a better contribution in involving farmers and in its research problem identification than its preceded council. It also contributed in arranging demonstration of available agricultural technologies to farmers and extension workers through research site visits and discussions. However, it was dominated by research and the contribution of extension organizations and the involvement of farmers was limited (Demekech Gera*et'al.,* 2008).

Existence of an independent and able facilitating organization is key to the success of multi-stakeholder platforms. In most cases, linkage arrangements are driven by research and extension organizations with limited engagement of the private sector, including smallholder farmers. They are usually dominated by the public sector with limited representation of farmers and the private sector. As a result, participation in linkage activities has been passive with limited awareness about the purpose and functions of linkage platforms. Awareness of the importance and benefits of collaboration by actors is essential if institutional arrangements are to be established to strengthen effective linkages among different actors. When key stakeholders are convinced about the benefits of participating in stakeholder platforms, they would then assume responsibility by assigning tasks to the right stakeholders and tracking their accomplishments and expected outcomes (Tesfaye Getachew,2016).

In order to facilitate the flow of technologies from research institutions through extension organizations to farmers there is the need for links between research-extension and farmers. These links are usually brought about through linkage mechanisms. Links are about people, No linkage mechanism can succeed unless staff working on research station, on farms, and in technology transfer institutions is motivated to collaborate. To this end, the thesis was

identified, evaluate and analyze research-extension and farmers linkages mechanisms which coordinated to transfer agricultural technologies. The study based on the hypothesis which researchers, extension workers and farmers are recognized as instruments for transferring agricultural technologies and those effective linkage mechanisms and factors affecting linkage activities. Because the methods to improve links with in actors are vary from one circumstance to another and from place to place.

1.2. Statement of the Problem

In Ethiopia, agricultural research institutes have the mandate to generate and transfer improved technologies through the process of different linkage mechanisms. Technology transfer needs mutual communication and collaboration among partners. To be effective technology transfer and adoption as a result increase farm productivity requires strong linkage (Oladele, 2013). The extension advisory system in Ethiopia has top-down approach in which researchers generate the technology, extension workers transfer the technologies and farmers use technologies. Such pipeline extension approach restricts farmers and extension workers to familiarize the technology (Debella Deressa, 2015).

Released improved technology stay shelved on the research center, the case is weak relationships between researchers, extension workers and farmers in the process of linkage mechanisms implementation (Tilaye Teklewolde, 2016; Belay Kassa, 2008). In addition, once improved technologies were released, it expected to increase farming productivity. But, its demonstration and adoption process is difficult that is prior weak collaboration between researchers, extension workers and farmers. Farmers' livelihood improvement depends on strong linkages among actors (Klerkx *et'al*., 2012). Another importance of strong linkages between farmers, extension workers and researchers are easy dissemination and adoption of technologies, wise use and share resources and experts (Ashraf *et'al*., 2007).

Flow of information from research center to farmers requires continuous contact between actors. If the link is weak the agricultural productivity will not increase. These system criticisms the technical weakness, involving only big farmers, practicing top-down administration, poor dissemination of improved agricultural technologies (Fisseha Zegeye, 2009). Still the extension system in Ethiopia is limited with the consistency and quality of extension implementation, weak coordination between actors and feedback systems (Abebe & Hailemariam, 2018).

The researches have not been generally based on the real problems of farmers and they rarely took into account farmers' circumstances in terms of objectives, resources and limitations. Until recently the researches had been conducted in an environment which was totally different from that of small farmers and whatever little research outputs were disseminated to farmers had been directly given to extension workers without prior on-farm verification for

their acceptability. The lack of integration and coordination between agricultural research and extension has resulted in confusion as to who should undertake on-farm verifications and pre-extension trials before making technologies directly available to farmers. Disseminated research outputs due largely to the loose link between research and extension and/or the physical separation of researchers from farmers. Many of the farmers are not aware of the existence of technologies developed by researchers.

Most of linkage mechanisms implemented without mutual participation of actors. As the result, the farmers and extension workers do not know how to operate the technology(Odame *et al.,* 2013). When the farmers involved on linkage mechanisms implementation through top-down approach the technologies are not adopted by the farmers. Hence, average farmers national productivity were below 2ton/ha for major crops and yield difference in research plot and farmers field remained high(CSA.,2014). Improved agricultural technologies were low impact on the farmers' livelihood and the technologies not well distributed to end users. The reasons include, among others, little/weak coordination between researchers with extension; limited feedbacks from end users; the technologies do not fit with farmers knowledge and farming conditions; lack of farmers and extension workers representation in the process of technology development; and research institutes administered separately that leads to competition on the limited resources(Teka Debele, 2019).

Research-extension-farmer linkages are main concern in many developing countries and a number of studies have been conducted internationally as well as in Ethiopia on how to enhance linkages. However, no specific studies have been conducted recently in the existing linkage and linkage mechanisms between research with extension, research with farmers and extension with farmers in western Amhara in the process of technology development and transfer. Therefore, the current study seeks to investigate linkages among research, extension and farmers with focus on Dangila District.

1.3. Objectives

1.3.1. General objective

To evaluate the research-extension-farmers linkage in the process of technology generation and transfer

1.3.2. Specific objectives

To assess the level of linkages between research, extension and farmers

To evaluate the existing linkage mechanisms between researcher, extension workers and farmers in the process of technology transfer

To analyze factors affecting farmers participation on the technology demonstration

1.4. Research questions

How was Linkages between research, extension and farmers?

What are existing Linkage mechanisms between researchers, extension workers and farmers?

Major factors affecting farmers' participation on the technology demonstration

1.5. Significance of the study

Firstly, the main objective of this research was to assess the processes that were in place to develop and disseminate agricultural technology from Amhara agricultural research institutes/Woramit research center to farmers and to examine the challenges involved in the linkage process. Such case study was important to provide on the way into how agricultural technology was transferred from the research institutes/center to farmers in Amhara region context.

Secondly, the study was planned to add to the bridging of the gap which currently exists in the technology transfer and linkage. Such bridging of the gap was accomplished by means of the provision of theoretical recommendations and suggestions for a more efficient transfer of new technology from the research institutes into end users.

Thirdly, the study identified the factors and challenges affecting the processes of linkage, in addition; it provided helpful recommendations and suggestions for minimizing these problems. .

Lastly, this thesis may be second-hand as a reference material by future researchers in this field. Agricultural research institutions will, therefore, be able to benefit from this study by learning how agricultural technology can be transferred into farmers, so that they can, in future, utilize the appropriate strategies for harnessing such linkage.

1.6. Scope and Limitations of the study

The study was conducted to identify and describe the linkage and linkage mechanisms and technology transfer process that research organizations by examining the challenges involved in the linkage process. Due to time and financial limitations, the study only focus to provide a detailed review of issues related to research-extension and farmers linkage and recommended positive improvements that should be made through its recommendations. This study is limited to Dangila district, Amhara region, Ethiopia. As the results were represent researchers, extension workers and farmers who were involved technology transfer process in Dangila district. The findings are only based on the samples of researchers, extension workers and farmers involved on the linkage activities and assessment of documents.

CHAPTER- TWO: LITERATURE REVIEW

2.1. Evolution of research-extension-farmer linkages in Ethiopia

According to Dawit Alemu and Belay Kassa (2017) agricultural extension and research work began within the early 1950s following the establishment of the Imperial Ethiopian College of Agriculture and Mechanical Arts (IECAMA now Haramya University) with the help of the us under the purpose Four Program. The tutorial program of the school was modeled on the grant College system with three fundamental but related responsibilities which are:-Training of high level manpower, promotion of agricultural research and dissemination of appropriate technologies.

In the decade following its establishment IECAMA had been active in building the national agricultural research and extension systems (NARES).But, the primary formal research-extension and farmer linkage was started with the formation of joint Institute of Agricultural Research (IAR) and therefore the Extension Project Implementation Department (EPID) outreach program in 1974. Before this era, the linkage was through personal contacts and publications of research results.

Subsequent concrete step to make functional linkages between the research and extension systems was taken in 1986, following the adoption of a replacement extension approach called the Peasant Agriculture Development Extension Program (PADEP) by the ministry of agriculture. As the poor research-extension linkage was considered to be a primordial factor affecting the efficiency of extension work, Research Extension Liaison Committees (RELCs) were formed in 1986 both at the national and zonal levels. The establishment of the national RELCs was believed to supply an appropriate forum for consultation among different stakeholders. The national RELC was responsible to supply overall policy direction and capacity building. More precisely, it had been commissioned to undertake diagnostic studies on weaknesses of the national research and extension systems also as on factors affecting the adoption of probably useful technologies developed by researchers in sight of formulating new research and extension strategies (FDRE, 1999, cited by Dawit Alemu and Belay Kassa. 2017). However, available evidence shows that both the national and zonal RELCs had

limited impact and had not lived long to be of practical use thanks to, among others, the subsequent reasons: some of the newly created agricultural development zones had no research centers and lacked the capacity to steer the extension role through staff development, support and reward; local government officials' poor technical know-how and skills in monitoring and evaluating research and extension activities, serious funding constraints to undertake linkage activities, absence of deciding power of RELCs and clear working guidelines, ad-hoc and non-institutionalized nature of meetings, lack of representation of farmers and Frequent changes within the organizational structure of the Ministry of Agriculture and therefore the resulting repeated reshuffling of RELCs members and lack of relevant technologies that were proven to supply directly measurable results or perceived benefits (Belay Kassa,2003 and FDRE, 1999).

It's also important to notice that linkage activities were totally considered as part-time work because no incentive was there for committee members. Following the change in government in 1991, a locally-adapted Training & Visit (T&V), like extension approach was adopted as a national extension system with major government financing until its replacement by the Participatory Demonstration and Training Extension System (PADETES) in 1995.

The major objectives of PADETES included increasing production and productivity of small scale farmers through research generated information and technologies, increase the availability of commercial and export crops and ensure rehabilitation and conservation of natural resources base of the country. In late 1990s the difficulty of research and extension linkage resurfaced. The linkage strategy aims at bringing together all stakeholders with in the entire process of technology generation and transfer under the umbrella of institutional setup.

Apart from the very fact that, FREAC has not been holdings its annual meetings, as planned farmers haven't been represented within the council. The council was dominated by officials of the federal and regional research institutes and bureaus of agriculture and rural development. Their activities had been limited to the establishment of Farmer Research Groups (FRGs), convening periodic meetings of researchers and extension workers and undertaking on-farm trials. At the grass roots level, the strategy adopted to

form agricultural research and extension systems responsive and relevant was to involve smallholder farmers/poor within the selection of research and extension priorities and in research planning and implementation through the establishment of farmer research groups (FDRE, 1999).

The organizational and operational weaknesses inherent within the structure of the REACs that were key for the poor performance are summarized below. All the REACs weren't institutionally anchored and there wasn't conductive ground that gave room for sufficient interaction among farmers, development agencies and researchers. Rather, as within the past, coordination of linkage activities was done on ad-hoc basis and there was lack of sustained follow-up of linkage related activities, the absence of permanent secretariats for REACs at national, regional and zonal levels. More precisely, it had been only in 2007 following the instruction from the Office of the Prime Minister that both the Federal and Regional Governments allocated allow linkage related activities.

Recognizing the weaknesses of the previous attempts (RELC and REAC), the MoA has decided in 2009 to institutionalize the linkage through allocation of normal finance and accountability institutional setup within MoA. Accordingly, the council was renamed as Agricultural and Rural Development Partners' Linkage Advisory Council (ARDPLAC) and it had been decided to determine it at federal, regional, zonal and also woreda levels. Its members were also expanded to incorporate more stakeholders including farmers' organizations, private actors, Non-governmental organization involved in agricultural development (MoA, 2011).

The ARDPLAC was later renamed as Agricultural Development Partners' Linkage Advisory Council (ADPLAC) following the name change of the Ministry. The ADPLAC, as a multi-stakeholder platform, consists of layered linkages: national, regional, zonal and district level platforms. The MoA acts as a central coordinating body that facilitates linkages and communications across the various levels. The governance of the ADPLACs at different levels is guided by the nationally approved guideline (MoA. 2010). Key functions of the ADPLACs include serving as a platform for creating stakeholder alignment on development policies and agendas, identification and

prioritization of scalable development interventions and practices, a monitoring and accountability mechanism, and sharing experiences among major stakeholders across regions and sectors within the country. The performance of ADPLAC as multi stakeholder platforms are often evaluated key performance criteria, like composition of membership, periodicity, quality and outcomes of meetings.

2.2. Theories in research-extension-farmer linkage

2.2.1. Linkages between research-extension and farmers

Links are about researchers, development agents and farmers. The term linkage as utilized in this study encompasses a broad range of collaborations and exchange of useful information among all actors of the technology generation, dissemination and utilization system. The concept of linkage utilized in this study is borrowed heavily from Havelock (1986) who emphasized that linkage may be a term wont to indicate that two systems are connected by messages so on form a greater system. He argued that if the barriers between the two systems are permeable enough for messages and responses to use of one to the opposite, then link has been created between the two. No linkage mechanism can succeed unless staff performing on demonstrations, trainings, and in technology transfer institutions is motivated to collaborate. Researchers can respond by building closer links with extension staff. Technology transfer process is more hooked in to strong linkage on researchers and extension staff.

According to Munyua et' al. (2002) agricultural research and extension are samples of two systems which will be linked by information flow and feedback. The farmer falls in between research and extension and is predicted to be the most target and beneficiary of their activities. The research-extension-farmer relationship should be viewed as an interdependent and inter-related continuum. More precisely, interdependence among the researchers, extension workers, and farmers prevents isolation, which impedes technology transfer. Close bonding among the three key players also promotes development of relevant technologies that provide directly measurable results or perceived benefits to the target population and adapted to local conditions. In traditional research and extension linkage system agricultural technology development and transfer have attended be largely supported a 'top-down' one-way communication model with

information flow from researchers to farmers. Earlier empirical studies in developing countries have identified weak links between research and extension because the major factor limiting the flow of data, knowledge, new technologies, and resources among actors within the technology-delivery-utilization system and recommend measures to minimize weakness.

2.2.2. Roles of researchers, extension workers and farmers on the linkage

Research focuses on the technical aspects for generating useful technologies, while extension focuses on the acceptance and adoption of these technologies by users (FAO. 2005). Consistent with Munyua *et'al*., (2002) agriculture research and extension are samples of two systems which will be linked by information flow and feedback. The farmer falls in between research and extension and is predicted to be the most target and benefit of their activities.

Agricultural research identifies produces, analyzes and interprets innovative ideas to resolve the challenges being faced by the farmers. Extension officers educate farming communities about the actual innovation trough demonstration, specific trainings and group meetings (Aremu *et'al.,* 2015). The extension officers are mainly liable for dissemination of data, providing institutional support and facilitating farmers (Maponya and Mpandeli, 2013).

For successful operation, it needs an independent interaction between research and extension. Extension needs research findings as production recommendations to supply solutions to the technical problems of the farmers. Extension should function a main source of research to develop an orientation to take care of an awareness of actual farmers‟ problems. Research focuses on the technical aspects for generating useful technologies, while extension focuses on the acceptance and adoption of these technologies by users (FAO, 2005).

2.2.3. Linkage mechanisms between research-extension and farmers

Linkage mechanisms ask the structured working relationships established between two or more organizations to bridge the gap between components of the system and permit regular information flow and feedback to reinforce productivity (Kaur and Kaur,

2013; Sah *et'al.,* 2014). A careful adaptation of formal and informal mechanisms may be a prerequisite for the dissemination and utilization of technology (World Bank, 2014)

2.2.3.1 On-farm trail

Trials and experiment which are conducted on farmers' field and it's an effort to check technical options under real farmers' condition. Make sure that research is acceptable to field conditions and extensionist to check and disseminate findings rapidly. Enables researchers to know farmers and extension needs and Help farmers improve their own experiments by providing some military training and guidelines (the experimental agenda and therefore the process are completely in farmers' hands); or help farmers evaluate new technologies and practices selected jointly by farmers and researchers. Until recently researches had been conducted in an environment which was totally different from that of small farmers and whatever little research outputs were disseminated to farmers had been directly given to extension workers without prior on- farm verification for his or her acceptability. The researches haven't been generally supported the important problems of farmers and that they rarely took under consideration farmers' circumstances in terms of objectives, resources and limitations. The shortage of integration and coordination between agricultural research and extension has resulted in confusion on who should undertake on-farm verifications and pre-extension trials before making technologies directly available to farmers (EIAR,2007).

2.2.3.2.Trainings

Farmer training is one among the important components of the FRG approach. Training is supposed to introduce a replacement way of doing things and/or to fill observed gaps in performance or undertaking some agricultural activity. Training is additionally given to farmers and extension workers when some basic knowledge and skills is required to hold out planned trials. Training is often given at different times within the course of FRG research activities. Farmer training is one among the important components within the technologies pre-extension demonstration. It's meant to introduce a replacement way of doing things and/or to fill observed gaps in performance or undertaking some research activities. within the course of demonstration, farmer participants, development agents and experts working for the agricultural and natural resources development offices were participated on theoretical and

practical trainings on benefit, utilization and general aspects of managing the technology at different time in FTC.

2.2.3.3.**Method demonstrations**

Demonstration provides a chance of getting sizable amount of varietal choices to farmers, enhances farmer's access to crop varieties and increase in diversity, increases production and ensures food security, helps to disseminate the adoption of pre and released varieties in larger areas, allows doing varietal demonstration in targeted areas at cost-effective way and also during a lesser time and helps seed production at community level. one among the most consequences is that an outsized amount of breeding material is discarded without knowing whether it could are useful within the real conditions of farmers' fields and therefore the one that demonstrated is probably going to perform well in environments almost like the research stations and should not perform also within the fields of the poorest farmers. Expose farmers to new technologies, like varieties, practices, and inputs, and obtain farmers' feedback on the new technologies. Rationale: If scientists, extension agents, or another external agent would really like farmers to gauge or adopt new technologies, farmers got to get familiar with these technologies during a way that costs them little money, time, and risk.

2.2.3.4.**Field days**

Field day can exhibit good technologies side by side with local practices to relatively sizable amount of individuals. By observing the technology with the way it's being managed, interacting with hosting farmers and among participants, it's expected to realize the subsequent output. Farming practice is open for people to go to and learn. the sector days also can give scientists and extension workers information during a systematic way about farmers' perceptions of latest technologies. Researchers, extension agents and non-governmental organizations) establish one or several demonstration fields, which can be located on farmers' fields or on experiment stations. The demonstrations could also be established and managed exclusively by the researcher/extension worker or along side farmers. The demonstration field is split into plots containing the set of technologies to be shown to farmers. The technologies should be presented during a way that distinguishes them from each other as clearly as possible (for example, by partitioning the plots in order that each technology is clear to observers.

2.2.3.5.Farmer research group

FRG approach may be a research approach by which a multi-disciplinary research team, extension workers and groups of farmers jointly conduct research on selected topics supported farmers' needs on the farmers' field. Researchers facilitate the involvement of extension workers and farmer groups altogether the method of the research from planning through to implementation and from monitoring to evaluation and sharing of outputs or results (JICA. 2015). a group of farmers involved in joint problem identification, experiment/trial designing/planning, execution and monitoring and evaluation within the process of technology generation, evaluation and transfer. There had been little or no feedback from farmers to research institutes about disseminated research outputs largely thanks to the loose link between research and extension and/or the physical separation of researchers from farmers. Many of the farmers aren't conscious of the existence of technologies developed by researchers.

2.2.3.6.Use of extension materials

Extension materials Present research leads to simple, easy-to understand form, Contain current information and function "first-aid" tools for extensionist who encounters problems in farmers' fields. Like, Newsletters, brochures, folders and booklets. Leaflets, posters, manuals, samples and audio visuals are wont to disseminate information on agricultural technologies.

2.2.3.7.ADPLAC and review meetings

Allow extensionist and researchers to share experiences and answer questions and immediate feedback. A platform for planning, monitoring and evaluation of agricultural research and development activities administered (more or less) in one administrative zone and district. There also are ADPLACs at national and regional levels. ADPLAC is that the outcome of successive changes which reflect changing priorities and therefore the shift to the mixing of farmers and other stakeholders to what were previously purely research-led and technology oriented linkage mechanisms (MoA, 2012b).

In Ethiopia, public agricultural extension services are in action for about half a century. Studies show that Ethiopia has the most important agricultural extension system in Sub-Saharan Africa, and third largest within the world after China and India (Swanson and Rajalahti, 2010). Consistent with the Bill and Melinda Gates Foundation report (BMGF,

2010), a complete of 8,500 farmer training centers (FTCs) are established and 63,000 field extension workers (known as development agents-DAs) are trained.

2.3. Empirical evidence of research-extension-farmers linkage in Ethiopia

In 2008, under the leadership of the MoA, Agriculture Development Partners Linkage Advisory Councils (ADPLACs) have been established at different levels to promote alignment and collaboration among the major stakeholders in the agricultural sector. The MoA acts as a central coordinating body that facilitates linkages & communications across the different levels. The major functions of ADPLAC is creating stakeholder alignment on development policies, identification and prioritization of scalable development interventions and sharing experience among stakeholders. Extension workers facilitate as bridge researchers and farmers at FTCs through active participation of community and capacity building. Farmers training centers enhance agricultural knowledge and information services to stakeholders.

2.4. Conceptual framework of the study

The conceptual framework utilized in this study is specializing in technology developers and technology users. Linkage is communication and collaboration between researcher, extension workers and farmers (Klerkx and Leeuwis, 2009). The concept of linkage implies the communication and dealing relationship established between two or more organizations pursuing commonly shared objectives so as to possess regular contact and improved productivity(Sadighi,2005).The conventional argument for linkages is that by working together actors stand better chances for establishing the institutional relationships which will facilitate access to technology, information, capital and marketing arrangements, which may successively enable farmers to be competitive.

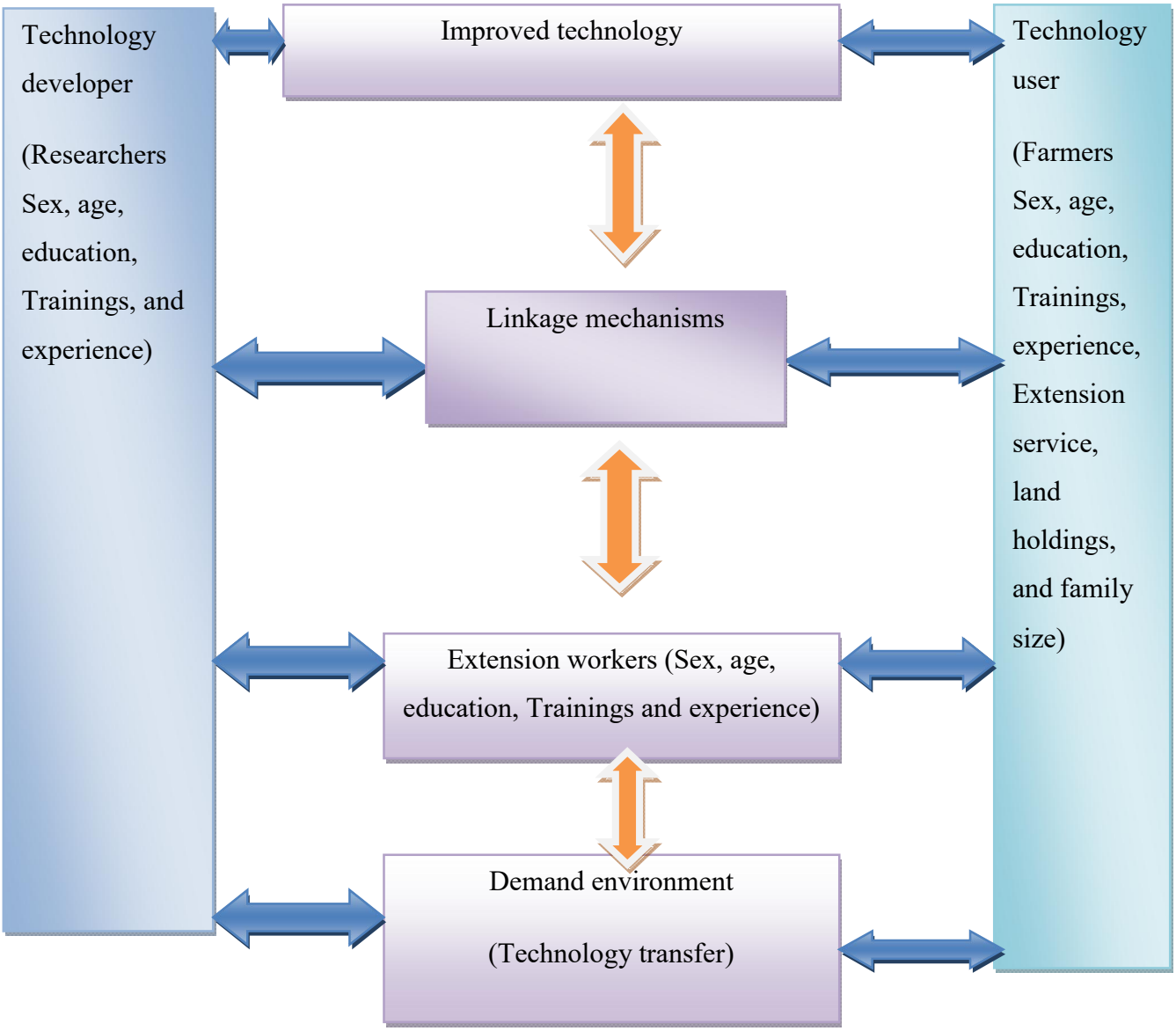


Figure 1: conceptual framework

Adopted from: technology dissemination from the European Institute of Innovation and Technology

CHAPTER-THREE: RESEARCH METHODOLOGY

3.1. Description of the study area

The study was conducted in three Kebeles of Dangila district namely: Dengeshta, Gayita and Gisa mariam. Dangila is one of the 12districts found in the Awi zone. It is characterized by mid altitude agro ecology with mixed farming system. The district has a 1 1°16′N latitude and longitude of 36°50′E.The total farming land area is 55,213 ha. The current land use pattern includes 78 % cultivated land, 15.84 % pasture land, 2.95% forest land and the rest for others.

The mean annual rainfall is 1200-1400 mm, with Belg and Meher cropping seasons. Its altitude ranges from 1980 up to 2150masl allowing a favorable opportunity for wider crop production and better livestock is rearing. Most of the farm land was allocated for annual crops where cereals covered 11,572.5 ha. Pulses cover 22,667 ha. Oil seeds 2,761 hectares; root crops 1,034.29 ha and vegetables 3,733 ha. The major crops include maize, teff, finger millet and pulse crops, in order of area coverage (Dangila agricultural office,2013).

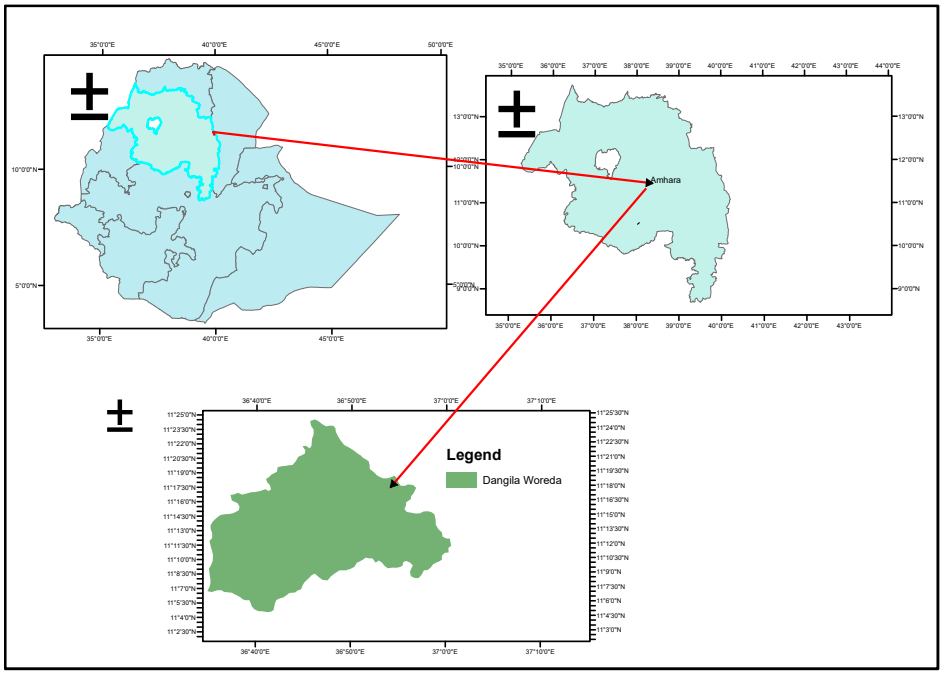


Figure 2: location map of Dangila district(Google Earth, 2021)

3.1. Research design

3.1.1. Sampling unit

This thesis applies cross-sectional research which uses collection of data from representative sample from the population at a single point in time (Babbie,1994, cited by Chiligati,2010).The sampling units of this study were farmers and extension workers from Dangila districts and agricultural researchers who had been participating at least one of linkage mechanisms for a minimum of three years before to this study. These criteria are important to guarantee that respondents had the essential information and awareness on the study.

3.1.2. **Sampling method**

Simple random sampling, snowball (respondents assisted sampling) and purposive sampling techniques were used for selecting respondents and study area for this study. The Dangila district was selected purposively for this study because it is one of frequently technology verification and demonstration sites of Adiet research and Fogera rice research centers, Bahir Dar and Injibara Universities. Three Kebeles namely: - Gayita, Gisa Mariam and Dengeshta were selected from the district purposively based on their prior implementation of linkage

mechanisms with researcher. Key informant farmers, researchers and extension workers were selected by using snowball sampling method. Because research unit requires the respondents implemented at least one of linkage mechanisms collaboratively, detail information and subject matter and had known their partners. The farmers were selected by using simple random sampling who was implemented one of linkage mechanisms with researchers at the selected Kebeles within three years prior to this study.

3.1.3. **Sample size determination**

The sampling frame was prepared from the selected kebeles to select the farmers and select 165farmer respondents randomly. Extension workers selected who were conducted linkage mechanisms with agricultural research in three years prior to this study. Hence, 30 extension workers and 15 researchers were selected by using snowball sampling technique.

The sampling size was determined by using Yemane formula (Yemane,1967) due to its simplicity and predetermined population.

N=460 and 0.05 precision level was decided

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

Where,

n= minimum returned sample size

N = the population size

e = precision level

Table 1: **Sample size of the respondents**

Sample unit	Total number of population involved in linkage process in the study area		Number of sampled actors selected for interview
Farmers	Gayita	172	83
	G/mariam	118	57
	Dengeshta	52	25
	Total	342	165
Extension workers (D.A, SMS)	80		30
Researchers	38		15
Total population	460		210

3.2. Method of data collection

Interview schedules, questionnaires, and check lists were used as data collection tool. Interview schedule methods were used to collect data from the farmers interviewed by enumerator, questionnaires prepared to collect data from extension workers and researchers filled by them and checklists also used to collect qualitative data through focus group discussions. Three focus group discussions were conducted; one discussion with extension workers and two FGD were implemented with farmers. The questionnaires and interview schedules were prepared to collect primary data like socio-demographic characteristics of respondents, linkages and linkage mechanisms between research with extension, research with farmers and extension workers with farmers. The interview schedule also contains additional data that is factors affecting farmers' participation on the linkage mechanisms Checklists used to gather qualitative data by using focus group discussions. The qualitative data also collected by face to face interview and group discussions with the selected key informant respondents who were voluntary to provide valuable information.

3.2.1. Type and source of data

Primary quantitative data such as linkages and linkage mechanisms between researches with extension, research with farmer and extension with farmer and factors affecting farmers' participation on linkage mechanisms were types of the data that were collected on this study. Primary qualitative data like, weakness and strength of the current linkage, effectiveness of linkage mechanisms and the major challenges limiting the actors' participation on the linkage mechanism also the type of data. Secondary data: linkage experience, evolution of research, extension and farmers linkage in Ethiopia, related literatures and documents were collected. Reports of the agricultural office and research organization were reviewed.

3.3. Method of data analysis

The data were verified, coded and entered into a computer and were analyzed using SPSS software package version 20.0.Descriptive data analysis was analyzed frequencies, percentage, minimum, maximum, mean and standard deviation. Inferential statistics also analyzes ordinal data by using mann-whitney U test in which non-parametric statistical tool. The tool analyses the linkages of two independent samples which is research with extension, research with farmer and extension with farmer. The inferential statistics also analyze the factors affecting farmers' participation on linkage mechanisms by using binary logistic model. Qualitative data was analyzed through the narrative content analysis.

3.3.1. Mann-Whitney U test

The mann-whitney U test is a non-parametric statistical test which analyzes the medians of two independent populations. The dependent variable is ordinal data and the null hypothesis is not normally distributed (median of distribution is zero).

Assume, sample of n_x observations (x_1, $x_2 \ldots x_n$) from one population and sample size of n_y observations (y_1, $y_2 \ldots yn$) are another populations. The test compares every x_i first sample observation with y_i second sample observation and the total pair wise comparison result is $n_x * n_y$. The data from both samples are shared and the rank also from one to-n. An observation of the tied rank is an average of equivalent raw ranks (Mann and Whitney, 1947).

To calculate the value of mann-whitney U test used the formula:

$$U = \mathrm{n1}n2 + \frac{n2(n2+1)}{2} - \sum_{i=n1+1}^{n2} Ri$$

U= Mann-Whitney U test

N_1= sample size of the first sample

N_2= sample size of the second sample

R_i= rank of the sample size

3.3.2. Binary logit model

Factors influencing farmers' participation on technology demonstration were also analyzed through binary logit model. Binary logit model is used to analyze factors affecting independent variables on the dependent variables which the dependent variable is dichotomous like the value of 1 if independent variable influenced and 0 other wise. The farmers' decision to participate on the technology demonstration based on binary option and the independent variables may as dummy, categorical or ordinal.

Farmers' decision related to participation on the technology demonstration is chosen by dummy variable:

$$\mathrm{Di} = \int \begin{matrix} 1\ \mathrm{ifthefarmerparticipateonthetechnology\ demonstration} \\ 0\ \mathrm{ifthefarrmernotparticipateonthetechnology\ demonstration} \end{matrix}$$

To determine the factors affecting farmers' decision on whether participate or not, the binary logistic model is constructed as follows (Cremades *et'al*., 2015):

$$1n\frac{pi}{1-pi} = \alpha + \sum_{n=1}^{n} \beta nxni$$

Where:

P_i =probability of farmers participation

α =the intercept variable

β = vector of regression coefficient

X_{ni}= vector of n independent variable

1n = natural log of logit model

As a result, for this data logistic regression is appropriate model to measure how independent variables affect farmers' participation likelihood of being participated or not. The Logit function can be derived from odds ratios:

Log odds ratio = $log\frac{success}{failure} = log\frac{y=1}{y=0} = \beta 0 + Xi\beta ------(1)$

Where, y_i=1 represents an individual "i" is being participated (success), and y_i=0 represents an individual "i" is being not participated (failure), xi is column vector of independent variables.

3.4. Definitions of variables and working hypothesis

Variables:- are represent the measurable characters that can change over the way of a research. In this section the researcher includes dependent variables, independent variables and different operational definitions

Actors: are researchers, extension workers and farmers involved in the process of technology transfer.

Technology transfer: the process of implementing linkage mechanisms

Linkage: -researchers, extension workers and farmers connected by technology and information exchange.

Linkage mechanisms: -working relationship activities established between researchers, extension workers and farmers to disseminate improved agricultural technologies. In this study 8 linkage mechanisms were selected which include review meetings, trainings, on-farm trails, method demonstrations, field days, FRG, extension materials and ADPLAC.

Dependent variables: - linkage and linkage mechanisms between research-extension-farmers

Independent variables:- For this study, seven independent variables were selected to influence the dependent variable. The selection of these independent variables was based on the past research and published literature related to this study including family size ,age, educational level, household land size, access to extension service, ,training, experience of farmers.

Operational definitions of independent variables

1. **Gender: -**is sex of respondents. It is dummy variable and measured if, male= 1 and female=2.
2. **Age: -**number of years of respondents at the time of data collection (30-40, 41-50, 51-60 and >60)
3. **Family size: -**the total number of agricultural labor lives with the respondent and measure by numbers.

4. **Land holdings: -**is the farming land ownership by respondent farmers. It is the continuous variable and measured in the hectares.
5. **Access to extension service: -** the farmers' access to advice and support by the extension workers related to research and extension linkages. Measured1 if, they get extension service and 0, otherwise
6. **Educational status:-**the highest acquired qualification of the respondents. It is categorical variable and the variable is measured through if the farmers can't read and write =1, and other wise=0,for researchers and extension workers1=diploma,2=BSc., 3=MSc., and 4=PhD
7. **Experience related to linkage:-**for researchers and extension workers1-5, 6-10, 11-15 and >15 and farmers experience measured in times
8. **Training access related to linkage:-**1 if the respondent get training and 0 otherwise

Table 2: Definition and measurement of variables

No	Variables	Definition	Variable type	Unit of measurement
	Independent variable			
1	Sex	Sex of respondents	Dummy	1=male and 2= female
2	Age	Number of year	Categorical	1=30-40, 41-50, 51-60 and >60
3	Education	Highest educational level of respondents	Categorical	- For the farmers, 1=can't read and write,2=read and write,3= primary and =4 secondary, 5= graduate - for researchers and extension workers1=diploma,2 =Bsc, 3=Msc, and

				4=PhD
4	Experience	Working experience related to linkage	Categorical/continues	- For researchers and extension workers 1-5, 6-10, 11-15 and >15 - For farmers measured in times
5	Training	Access to training related to linkage mechanisms	Dummy	1 if the respondent get training and 0 otherwise
6	Family size	No. of family members providing labor	Continuous	Number of labor who can support farming, live with the respondent farmer
7	Land holdings	Number of hectares used for farming	Categorical	.Measured in hectares
8	extension service	1 if the farmer access to advice from extension workers ; 0, otherwise	Categorical	1 If accessed, 0 otherwise
9	Factors affecting farmers participation	Determinates of farmers participation on the technology demonstration	Dummy	1, if the variable influenced and 0 otherwise
	Dependent variable			
1	Linkages between	Respondent	Ordinal	strong(3), moderate(2),

	R-E-F	involved on planning, implementation and evaluation		weak(1), and absent (0)
2	Linkages mechanisms between R-E-F	Frequency of use of linkage mechanisms	Ordinal	Measured in terms of frequency of use very much use(4), much use(3), little use(2), very little use(1) and not use at all(0)

CHAPTER –FOUR: RESULTS AND DISCUSSION

The results presented the mann-whitney analysis indicating the linkages and linkage mechanisms between research with extension, research with farmers and extension with farmers and binary logistic analysis identifying factors affecting farmers' participation on the linkage mechanisms.

4.1. Demographic and socio economic characteristics of farmers

Sex: 89.7% of sample farmers were men and 10.3 % of farmers' respondents' women (table-4). In the study area in most linkage mechanisms men farmers were involved and the women farmers decision dominated by men.

Age: an average sample farmer respondent's age was 41 years old.67 years were the maximum age and 30 years was minimum age of respondents in the study area.

Trainings experience:69.7% of farmers were received trainings related to the importance of linkages and linkage mechanisms for technology transfer. The training mostly given by researchers and extension workers participate on the training with farmers. But, 10.3 % of sample farmers confirmed, they were not received training related to linkage mechanisms. In the study area, there were number of trainings conducted by different non-governmental projects. However, the content of training was not including linkage related topics.

Extension service:table-4 result indicated that,70.9 % of farmers accessed extension services by development agents where as 29.1% of farmers were not get extension advisory service regarding to linkages and linkage activities in the study area. The current extension advisory system focus of seasonal activities that slow down the linkage related extension service. In general, majority of extension workers provide linkage and linkage mechanisms related extension service was in needs of researchers and collaborative activities with researchers.

Land: The assumption's of researcher on the land variable in this study was the main determinant to participate the farmers on the linkage activities. To this regard, greater land ownership increase farmer's interaction with researchers and extension workers. In the study area the maximum land holding was 2ha and minimum 0.25ha.The average land holdings of the sampled farmers in the study area were 0.99ha.

Family size: The average active agricultural labor in the household was 4.32(~4) and the maximum and minimum numbers of active labor on the household were 9 and 2 respectively in the study area. The number of family size increase within the household related to farmers participation on the linkage mechanism which supports as labor on the technology demonstration.

Literacy: The other data collected on the farmers was weather read and write or not that expected to improve the farmers' capacity to search information and use extension materials to know how to operate the technologies. It is therefore likely to increase the farmers' ability to identify and prioritize their problems on their own situation towards increasing technology transfer. The result shown that from the table-4, 65.5% of farmers can read and write and 34.5%cannot read and write. As observed during the field visits and discussions this has helped the farmers to be easy to access improved technologies and appropriate to use extension materials to operate the technology and improve their participation on linkage activities.

Experience: as indicated in the table-4, the farmers having maximum four times experienced and minimum one times experienced on the linkage activities, with an average experience of 1.79 (~2)times in linkage activities in the study area .

Table 3: Demographic and socio-economic characteristics of farmers

No.	Variables		Descriptive	Mean	Standard deviation
	Continuous variables				
1.	**Age**	Maximum	67	41.38	8.646
		Minimum	30		
		Average	41.38		
2.	Land holding	Maximum	2.000	0.996	0.436
		Minimum	.250		
		Average	.99697		
3.	Family size	Maximum	9	4.32	1.505
		Minimum	2		
		Average	4.32		
4.	Experience	Maximum	4	1.79	0.854
		Minimum	1		
		Average	1.79		
	Dummy variables		Percent		
4.	Sex	Men	89.7	1.10	0.305
		Women	10.3		
5.	Training	Yes	69.7	0.70	0.461
		No	30.3		
6.	Education	Read and write	65.5	0.65	0.477
		Not read &write	34.5		
7.	Extension service	Yes	70.9	0.71	0.456
		No	29.1		

Source: own survey, 2021

4.2. General background of Extension workers and researchers

Sex: 86.7% of researchers and 63.3% extension workers involved on the linkage activities were men where as 13.3% of researchers and 36.7% were women (see table-5). In all groups of samples, the majority of participants on the linkage mechanisms were men.

Age: Overall, the 30-40 of extension workers and 41-50 researchers' age groups categorized the largest proportion. The higher age expected to more experience on the involvement of linkage mechanisms.

Trainings: 80% of extension workers received trainings from researcher and provide to farmers. 86.7 % of researchers also received and provide trainings related to linkage mechanisms. This implies that, the majority of linkage mechanisms between researchers, extension workers and farmers were training.

Educational level: Regarding the level of education, 90% of extension workers had bachelor degree holders, while the majority of the researchers (80%) had master's degree, and 13.3% of researchers obtained PhD holders. The results on the level of education indicate that researchers were equipped with a higher level of education than extension workers.

Experience: 40% of extension workers and 20% researchers had been involved on linkage activities by 11-15 times respectively. While 13.3% of extension workers experienced on linkage activities 1-5 times but, 16.7% and 53.3% extension workers and researchers respectively implemented linkage activities more than 15 times. As indicated on the table-5, the researchers were more experienced to implement linkage mechanisms and extension workers and researchers were an average experience of 2.60 and 3.27 times respectively on linkage activities.

Table 4: Backgrounds of Extension workers and researchers

		Extension workers				Researchers		
No.	Variables	Values	Percent	Mean	Standard deviations	Percent	mean	Standard deviations
1.	Sex	Men	63.3	1.37	.490	86.7	1.13	.352
		Women	36.7			13.3		
2.	Age	30-40	56.7	1.57	.728	26.7	1.93	.704
		41-50	30.0			53.3		
		51-60	13.3			20.0		
		>60	-			-		
3.	Education	Diploma	10.0	1.90	.305	-	3.07	.458
		BSc	90.0			6.7		
		MSc	-			80.0		
		PhD	-			13.3		
4.	Training	Yes	80.0	1.20	.407	86.7	1.13	.352
		No	20.0			13.3		
5.	Experience	1-5	13.3	2.60	.932	-	3.27	.884
		6-10	30.0			26.7		
		11-15	40.0			20.0		
		>15	16.7			53.3		

Source: own survey, 2021

4.3. Linkages between research-extension- farmers

The first objective of this study was analyzed degree of strength of linkages between research, extension and farmers in the process of technology transfer. The linkage participant actors should be awareness about linkage activities before this interview. This objective has an assumption to understand the degree of strength between researchers, extension workers and farmers.

The measurement of degree of linkages between researchers, extension workers and farmers are uses the parameter of planning, implementation and evaluation of linkage activities (Gupta,1998). It is naturally intangible which measuring is difficult. Based on this, the strength of linkage between researchers with extension, researcher with farmers and extension with farmers measured as follows; planning (review meetings, and ADPLAC, implementation(training, on-farm trail, method demonstration, FRG, use of extension materials) and evaluations (field day, farm visit, ADPLAC).

When the actors participated or implemented in all parameters respondents rate strong, that involved at two rate moderate, participate only one of the above rate weak and while the respondents not participated at all of research and extension activities give absent. The actors were asked to rate the level of strength (strong (3), moderate (2), weak (1) and absent (0)) of each other based on the above parameter.

Accordingly, the mann-whitney U test result analysis indicated that, there is statistically significant on the ratings of level of extension workers linkage with farmers. The findings of the level of linkage show that, extension workers had highly strong collaboration with farmers in the study area. This shows that farmers have accessed extension advisory service regularly. The finding was in agreement with the work of Oladele (2017) in his study in South Africa.

4.3.1. Linkages between researchers with extension workers

The descriptive analysis result indicated that, 53.3% of researchers rated moderate their degree of linkage with extension workers and 50% of extension workers also rated as moderate on the degree of linkages with researchers. The interaction of research with extension is based on technical information exchange and feedbacks on the technology.

The result of mann-whitney U test analysis result showed that, there is no significant difference between researchers (mean rank of 21.60) with extension workers (mean rank 23.70). Based on the results indicated table-6, it needs improvement on their communication and coordination to generate and transfer agricultural technologies. In most cases extension workers desire to get incentives to work with researchers which were they think the collaborative activities were not their obligation.

In time of FGD, the participant extension workers reflect the means of communication with researchers were personal contacts and cell phone and their collaboration based on the researchers need. This finding is mentioned by Demekech Gera*et'al.* 2010;Tesfaye Getachew. 2013) personal communication and phone calls were used as information exchange between researchers, extension workers and farmers.

Table 5: Mann-whitney U-test result of linkages between research with extension

Linkages	actor	Strength of linkages between researchers with extension workers				N	Mean rank	Mann Whitney U test	Exact sig.(2-tailed)
		Strong	Moderate	Weak	Absent				
Researcher with extension	R	13.3	53.3	26.7	6.7	15	21.60	204.000	.577^{NS}
Extension with research	E	20.0	50.0	30.0		30	23.70		

Source: own survey, 2021, Note: NS- not significant at P<0.05

4.3.2. Linkages between researchers with farmers

Researchers support farmers in the form of capacity building and technology supply where as the farmers also provide land to demonstration, labor for agronomic practice and give feedbacks on the technology.

The findings on the table-7 confirmed that, 66.7 % researchers rated their degree of linkage with farmers as weak and 40% farmers also rated as weak their degree of linkage with researchers. The mann-whitney result indicated there was no significant difference between researchers with farmers and farmers with researchers with mean rank of researcher (106.00) and extension (89.09).

The reasons for weak linkage and insignificance between researchers and farmers were as follows; limited resources to research organizations to address the mandate districts of the surroundings (Klerkx *et' al*. 2012). Another reason was insufficient number of researchers to mobilize large number of farmers; this was in line with the findings of (Debella Deressa, 2015 and Belay Kassa, 2008) and Farmers not participate on the on-station research process which researchers conduct the research separately (Teka Debele, 2019).

One focus group discussion was conducted within researchers. During FGD, researchers discus about how was communicate with farmers. Hence they were communicating only when researchers had new technologies to transfer.

Table 6: Mann-whitney U-test result of linkage between research with farmers

Linkages	Actor	Strength of linkage				N	Mean rank	Mann Whitney U test	Exact sig.(2-tailed)
		Strong	Moderate	Weak	Absent				
Researchers	R	-	33.3	66.7	-	15	106.00	1005.000	.198^{NS}
Farmers	F	-	32.7	40.0	27.3	165	89.09		

Source: own survey, 2021, ,Note: NS- not significant at P<0.05

4.3.3. Linkages between extension workers and farmers

The table.8, result implies that more of extension workers (50%) rated their strength of linkage with farmers as strong with a mean rank of 120.25 and majority of farmers (36.4%) also rated as strong their link with extension workers with a mean rank of 93.95. The mann-whitney analysis indicated that there is significant difference between extension workers collaboration with farmers and farmers' collaboration with extension workers. This implies extension workers provide regular and effective extension service and the farmers participated on the linkage mechanisms with extension workers. Hence, farmers are active participants on the extension advisory service in the study area. According to the key informant interviews, the existing form of linkage between extension workers and farmers are appropriate to transfer new technologies. Similar finding was reported by Leta Gerba (2018) in Ethiopia.

Table 7: Mann-whitney U-test result of linkages between extension with farmers

Linkages	Actor	Linkages between				N	Mean rank	Mann Whitney U test	Exact sig.(2-tailed)
		Strong	Moderate	Weak	Absent				
Extension with farmers	E	50.0	50.0	-	-	30	120.25	1807.500	.012^{S}
Farmers with extension	F	36.4	37.0	26.7	-	165	93.95		

Source: own survey, 2021, Note: S- significant at P<0.05

4.4. Linkage mechanisms between research-extension-farmers

In this study, Linkage mechanisms which are the major factors of agricultural technology transfer consist of eight linkage mechanisms through which technology disseminates along the research institute to end users. Linkage mechanism referred to as "the specific organizational steps used to continue technology transfer process(Kaimowitz *et'al.*1989).The 8 linkage mechanisms selected to this investigation were review meetings (planning), on-farm trails, trainings, method demonstrations, field visits, membership of farmer research groups, use of extension materials and active participation of actors on ADPLAC (joint problem identification and activity evaluation). It allows actors (i.e. researchers, extension workers and farmers) to disseminate improved agricultural technology to end users. The linkage mechanisms that actors come together should be identified to enhance exchange of ideas, technology and information about farming. The farmers concerned in the linkage were interviewed to identify which linkage mechanisms were more used to exchange information to the researchers and extension workers and capacitate them in the process of technology transfer.

The assumption is there are differences on the use of linkage mechanisms. The criterion is based on the researcher's assumption that the research variable linkage mechanisms between research-extension and farmers was operatsonalized and measured as the degree to which those personnel's were using linkage mechanisms to communicate with one another, and also as the degree of their mutual participation in planning, implementation and evaluation of research and extension activities.. On the basis of these criteria's, frequently implemented and involved linkage mechanisms was rated as very much use. To analyze the degree of use of linkage mechanisms between research institute, agricultural offices (extension) and farmers and the study used eight well-known linkage mechanisms which were frequently implemented by the actors (researchers, extension workers and farmers) to develop, transfer and adopt improved agricultural technologies (Kumar*et'al*,2009).

To analyze the actors have frequently applied linkage mechanisms given to score in 5-point Likert scale:(not use at all(0), very little use(1), little use(2), much use(3) and very much use(4)) on each linkage mechanisms. As findings indicated that, training, method demonstration and field visit linkage mechanisms were frequently and commonly used by

majority of the respondents which supports the work of Mamusha Lemma and Bamlaek Tesfaye (2016) in Ethiopia.

4.4.1. Linkage mechanisms between researchers and extension workers

The findings of linkage mechanisms between researchers with extension workers indicated that, 46.7% of researcher confirmed the use of method demonstrations and field visits on their research system with extension workers, as very much use and trainings (20%), extension materials (13.3%).The mann-whitney U test result implies that, there was statistically significant between use of trainings, field days, method demonstrations and use extension materials as technology transfer techniques.

Training: 20% of linkage mechanisms between researchers with extension workers confirmed, trainings as very much use and 50% of extension workers also linked with researchers by trainings as very much use. Most of extension workers get trainings from researchers about characteristics of improved technologies in the study area. Training is one of the most important methods of transferring technology to extension workers and farmers regarding the characteristics of technology, and facilitates scaling up of technology dissemination. Extension workers had received two days theoretical training from researchers. Similar findings reported by Chiligati, (2010) in Tanzania.

Field day: 46.7% of researchers rated field days as very much use with extension workers whereas 63.3% extension workers rate field days as much use with researchers. Joint field trials play a major role in research-extension relations in the more advanced systems.

Method demonstrations: 46.7% of researchers use demonstrations as very much use with extension workers and linkage mechanisms of 80% of extension workers was also demonstrations rated as very much use. This result is support the work of Okoedo-okojie and Okon, (2013)in Nigeria on joint field demonstration and field trips/visits were major linkage mechanisms between researchers with extension workers

Use of extension materials: 13.3 % of researchers rated use of extension materials as very much use with extension workers whereas 30% extension workers rate use of extension materials as much use with researchers.

There was no significant difference between researchers communicate with extension workers in the conduct of review meetings, on-farm trails, formation of farmer research groups, involvement of in ADPLAC as tool to transfer the technologies and participation of in the ADPLAC meetings by their technology experiment and extension advisory service applied as linkage mechanism.

Qualitative results: So far, researchers not invite extension workers and farmers on review and ADPLAC meetings and on technology trails.

Table 8: Mann-whitney U-test results of linkage mechanisms between research with extension

Linkage mechanisms	**Actors**	**Degree of use of linkage mechanisms**					Mean rank	Mann Whitney U test	Exact sig. (2-tailed
		4	**3**	**2**	**1**	**0**			
R.meetings	**1**	-	-	33.3	40.0	26.7	25.87	182.00	0.284^{NS}
	2			20.0	26.7	53.3	21.57		
Trainings	**1**	20.0	33.3	33.3	13.3	-	17.60	158.500	0.002^{S}
	2	50	50				25.70		
on-farm trail	**1**			20	40	40	30.40	114.000	0.068^{NS}
	2				20	80	19.30		
Demonstrations	**1**	46.7	40.0	13.3	-	-	16.00	144.000	0.022^{S}
	2	80	20				26.50		
Field visits	**1**	46.7	40.0	13.3	-	-	27.43	120.000	0.005^{S}
	2	16.7	63.3	20			20.78		
FRG	**1**		13.3	33.3	40.0	13.3	22.50	217.500	0.855^{NS}
	2		10.0	40.	26.7	23.3	23.25		
Exn. Materials	**1**	13.3	26.7	33.3	13.3	13.3	28.67	140.00	0.034^{S}
	2		30.0	30.0	26.7	13.3	20.17		
ADPLAC	**1**	13.3	13.3	26.7	33.3	13..3	27.43	158.500	0.100^{NS}
	2		16.7	26.7	43.3	13.3	20.78		

Source: own survey, 2021. Note: NS- not significant at P<0.05 and S-significant at P<0.05

*1=researcher and 2= extension worker

*very much use (4), much use (3), little use (2), very little use (1)and not use at all (0)

4.4.2. Linkage mechanisms between researchers and farmers

The mann-whitney U test result indicated there was no significance difference between means ranks of researchers and farmers on six linkage mechanisms but, there is statistically significant on the field visits and demonstrations between researchers with farmers. The finding is similar with the work of Ironkwe, (2010) in Nigeria. Majority of farmers also pointed out field days and demonstrations were most frequent means of collaboration with researchers. The farmers were rated as little use on, membership of FRG and use of extension materials and they were not participated at all on-farm trails, review meetings and ADPLAC with researchers.

Field visit: 46.7% of researchers use field days as linkage mechanism with farmers. Extension workers involved on field visits to seek more information and strength their linkage with researchers. The field days in the study area was prepared by research center and by financial support of IFAD project. After demonstration and continuous follow up one day field visit and variety evaluation were conducted at vegetative stage. The institutions which was initiated the existing technology was Adiet agricultural research center specially Woramit sub fruit research center.

Demonstrations: 60% of researchers' linkage mechanisms with farmers were method demonstrations that rated as very much use. All selected and trained farmers were planted on their filed through practical support of researchers' and regular monitoring of development agents. Woramit research centers should carry out a number of method demonstrations on farmers' fields to show the potential of new technology and train extension workers and chosen farmers step-by-step in how to apply it. Crop types demonstrated in the study area were onion, tomato and Banana new improved varieties. Researchers indicated all the linkage mechanisms as major methods for improve linkages with extension workers and farmers except ADPLAC. This linkage mechanism is dominated by politicians and not reflects the problems of farming.

Table 9: Mann-whitney U-test result of linkage mechanisms between research with farmers

Linkage mechanisms	**Actors**	**Degree of use of linkage mechanisms**					Mean rank	Mann Whitney U test	Exact sig. (2-tailed
		4	**3**	**2**	**1**	**0**			
R.meetings	**1**	-	13.3	20.0	26.7	40.0	93.30	1195.500	0.818^{NS}
	3	-	1.8	24.8	35.2	38.2	90.25		
Trainings	**1**	40	40	20	-	-	87.70	1195.500	0.814^{NS}
	3	40.6	41.2	16.4	1.8	-	90.75		
on-farm trail	**1**	-	-	6.7	26.7	66.7	75.47	1012.000	0.198^{NS}
	3	-	-	21.2	26.1	52.7	91.87		
Demonstrations	**1**	60.0	33.3	6.7	-	-	100.63	815.000	0.017^{S}
	3	46.7	37.0	14.5	1.8	-	89.58		
Field visits	**1**	46.7	40.0	13.3	-	-	137.17	537.500	0.000^{S}
	3	7.3	38.2	35.2	19.4		86.26		
FRG	**1**	13.3	46.7	40.0	-	-	92.33	1210.000	0.883^{NS}
	3	-	24.2	32.1	25.5	18.2	90.33		
Exn. Materials	**1**	13.3	13.3	53.3	20.0	-	106.93	991.000	0.182^{NS}
	3	4.2	18.8	35.8	23.0	18.2	89.01		
ADPLAC	**1**	-	6.7	33.3	33.3	26.7	118.67	1085.500	0.385^{NS}
	3	-	-	17.6	31.5	50.9	87.94		

Source: own survey, 2021, Note: NS=not significant at P<0.05 and S=significant at P<0.05

*Actors: 1=researcher and 3= farmers

*very much use (4), much use (3), little use (2), very little use (1) and not use at all (0)

4.4.3. Linkage mechanisms between extension workers and farmers

The mann-Whitney result indicated that, there was significant difference on the meetings/planning, trainings, field visit and demonstrations, where as there was no statistically difference on the on farm trail, ADPLAC, use of extension materials and FRG of extension workers with farmer and farmers with extension workers. This shows that majority

of extension workers had not been invite the farmers on the linkage activities without researchers need and horticultural technologies were transferred to the farmers through regular contact of researchers. The high connection of extension workers with farmers in linkage indicates that when extension services are the center and directive, funds are expected to be use successfully in conducting demonstration and scaling up.

Qualitative findings by focus group discussion: Approaches extension workers use to share and transfer the technologies to the farmers are by training, demonstrations at FTC and at model farmers' farm, teaching the farmers orally in the churches and preparing field days to scaling up new technologies. Adiet research center was implemented different linkage mechanisms to transfer newly generated agricultural technologies to the farmers. The key informants agreed a choice of linkage mechanisms in which the research center participates in the process of method demonstration, trainings and field days. Furthermore, there is little farmer research groups' linkage mechanism. From the choices provided demonstration, trainings and field days were ranked from one to three respectively. Tomato and onion producer farmers were organized in the form of farmer research Group, but it was not functional.

Review meetings (planning):13.3% of linkage mechanisms between extension workers with farmers confirmed planning's as very much use and 10.9% of farmers also participated with extension workers rated planning's as much use.

Trainings: 73.3% of linkage mechanisms between extension workers with farmers confirmed trainings as very much use and 52.7% of farmers also linked with extension workers rated trainings as very much use. Extension workers provide trainings to farmers with technical aspects to make sure appropriate implementation of technology demonstrations. Similar report was indicated by (Gerba Leta *et'al*.,2017a).

Field visit:16.7% of linkage mechanisms between extension workers with farmers confirmed field days as very much use and 10.9% of farmers also involved with extension workers confirmed trainings as very much use.

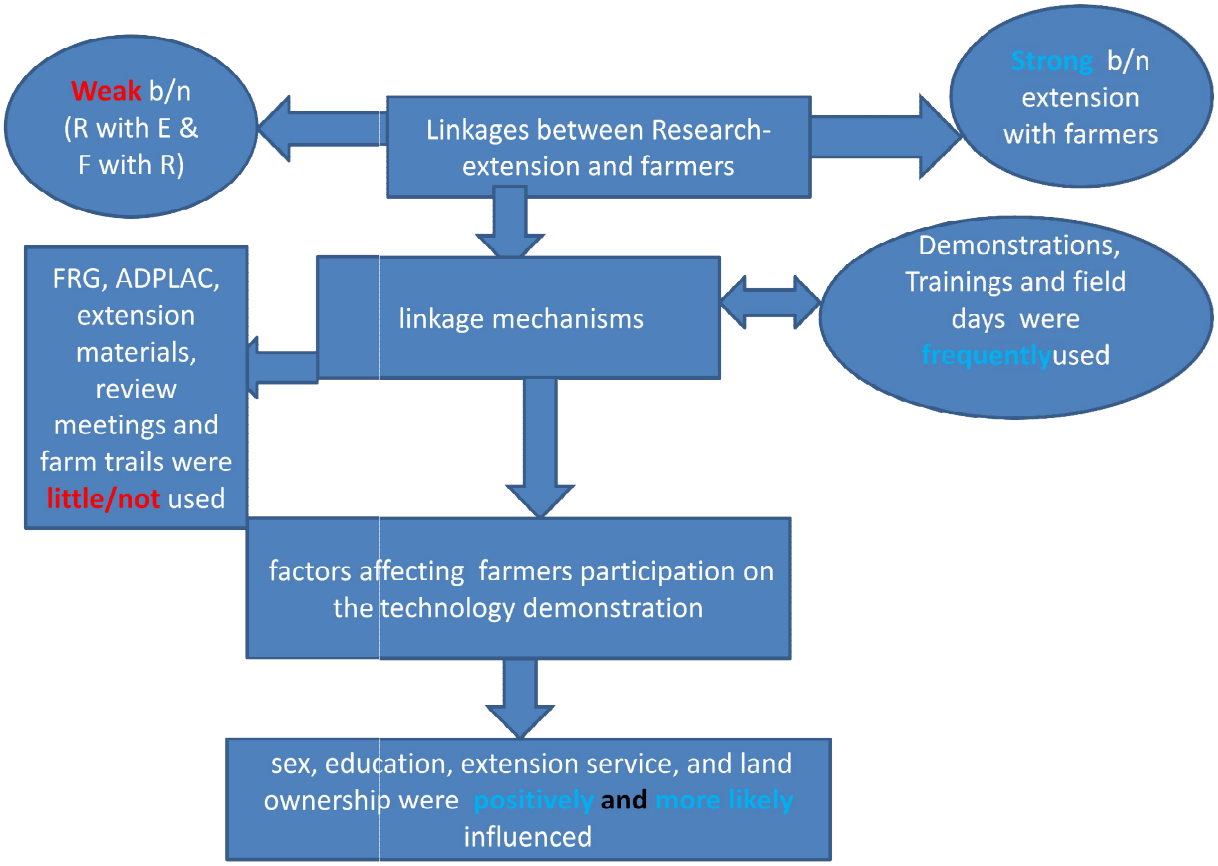
Demonstration: 53.3% of linkage mechanisms between extension workers with farmers confirmed, demonstrations as very much use and 51.5% of farmers also collaborated with extension workers rated demonstrations as very much use.

Table 10: Mann-whitney U-test result of linkage mechanisms between extension with farmers

Linkage mechanisms	**Actors**	**Degree of use of linkage mechanisms**					Mean rank	Mann Whitney U test	Exact sig. (2-tailed
		4	**3**	**2**	**1**	**0**			
R.meetings	2	13.3	23.3	36.7	26.7	-	137.42	1292.500	0.000^{S}
	3	-	10.9	32.1	26.1	30.9	90.83		
Trainings	2	73.3	26.7	-	-	-	118.37	1864.000	0.016^{S}
	3	52.7	29.1	17.6	0.6	-	94.30		
on-farm trail	2	-	-	-	30.0	70.0	91.40	2277.000	0.404^{NS}
	3	-	-	11.5	23.0	65.5	99.20		
Demonstrations	2	53.3	23.3	23.3	-	-	94.53	2371.000	0.024^{S}
	3	51.5	35.2	12.1	1.2	-	98.63		
Field visits	2	16.7	36.7	43.3	3.3	-	104.85	1435.500	0.000^{S}
	3	10.9	38.2	43.6	7.3	-	96.75		
FRG	2	-	10.0	40.0	36.7	13.3	105.60	2247.000	0.398^{NS}
	3	0.6	7.9	35.2	35.2	21.2	96.62		
Exn. Materials	2	-	26.7	40.0	30.0	3.3	132.65	2269.500	0.436^{NS}
	3	1.8	7.3	28.5	27.9	34.5	91.70		
ADPLAC	2	-	-	-	26.7	73.3	79.13	1909.000	0.685^{NS}
	3		0.6	17.0	27.3	55.2	101.43		

Source: own survey, 2021**Note**: NS- not significant at P<0.05 and S-significant at P<0.05, ***Actors**:2=extension worker and 3= farmers*very much use (4), much use (3), little use (2), very little use (1) and not use at all (0)

4.5. Schematic diagram of linkages among actors in the process of technology transfer



4.6. Factors affecting farmers participation on the technology demonstration

The third objective of this study is factors affecting farmers' participation on the technology demonstration which analyzed through binary logistic regression model. The model analyzes influence of independent variables on the dependent variables. The selected variables were fit with the model well. Additionally, considering the tolerance and the variance inflation factor values, there was no collinearity among the independent variables of the estimated model. Results indicated that sex, literacy level, extension advisory service and land ownership had positive coefficient and was significant at 5% of probability level (table-12). As a result, the odds ration also use to see the strength of influences and significant influence is more likely to participate on the technology demonstration.

Sex: Gender had positive coefficient (1.895) and significant factor on the farmers' participation on the linkage activities at 5% probability level. The odds ratio result indicated that, men are 6.653 times more likely to participate on the linkage activities than women. Men have more decision making power and control of household's resource than women that creates interaction and communication with researchers and extension workers. Researchers and extension workers are limiting women participation on the meetings, demonstrations, field days, membership of FRG and trainings in the study area. Similar findings reported by Charatsari *et'al*.(2013a) due to gender equality not fulfilled.

Education: the result of logistic regression analysis on the table-12 indicated that, literacy level of the farmer influence positively and significant at the 5% level of probability with positive coefficient of 1.535. One unit literacy rate increase is 4.643 times more likely to farmers participate on the linkage mechanisms. In this study farmers who can read and write were more likely participate on the linkage mechanisms. The farmers who can read and write and better educated improve farmers' capacity to search and use information from researchers and extension workers, easy to adopt the technology and effectively use extension materials as linkage mechanisms.

Extension service: advisory extension service had positive coefficient (0.230) and was significant at 5% probability level. The odds ratio indicated that, farmers had accessed to extension service are 1.259 times more likely to participate on the linkage mechanisms. This indicated that higher frequency of extension contact increase probability of farmer's

interaction with researchers and extension workers. Farmers get regular extension service related to linkage is more likely to participate on the linkage mechanisms. This finding is similar with the work of (Birhanu Megerssa and Getachew Wolde Michael, 2014) in Ethiopia. The linkage mechanisms used as extension method in the study area were method demonstrations and trainings at FTC, experience sharing.

Land holdings: land ownership had positive coefficient (1.918) and statistically significant at 5% probability level. The farmers who have large size of land are 6.804 times more likely to participate on the research activities. In the study area, the maximum land holding by sample respondents was 2 ha and the minimum was 0.25 ha. The average land holding of the sample farmers were 0.89 ha. Thus, farmers participate more in the linkage mechanisms when they feel they have the land tenure security. This implies that farmers have more land size increase their probability of participation on the linkage activities. The result confirms the work of Yahaya *et'al*.,(2013) his studied in Nigeria and Sithole *et'al.* (2014).

Table 11: binary logistic regression model result of factors influencing farmers' participation on technology demonstration

No.	Variables	Co-efficient	S.E	Significance	odds ratio
1.	Sex	1.895	.768	.014**	6.653
2	Education	1.535	.574	.008**	4.643
3.	Training	.845	.609	.166	2.327
4.	Experience	-1.182	.264	.382	.307
5.	Family size	-.137	.163	.401	.872
6.	Land	1.918	.697	.006**	6.804
7.	Extension service	.230	.555	.033**	1.259
	Constant	-2.895	1.180	.014**	.055
	Model Chi-square	62.060			
	Hosmer-Lemeshow test				
	Chi-square	10.139			
	Significance	.255			
	Cox and Snell R2	.313			
	Nagelkerke R2	.454			

**significant at p<0.05

CHAPTER –FIVE: CONCLUSION AND RECOMMENDATION

5.1. Conclusions

The objectives of the study are identified and describe linkages and linkage mechanisms between research-extension and farmers and factors influencing farmer's participation on the technology demonstration to transfer improved agricultural technologies. The study used mann-whitney U test and binary logit model to evaluate linkages and linkage mechanisms between research-extension and farmers participation on the technology demonstration. The overall findings indicated that, the linkages between researchers, extension workers and farmers were weak and require being strengthened.

The agricultural research in Ethiopian generated many improved technologies. However, these technologies had low impact on the farmers livelihood; due to lack of coordination and integration between research, extension and farmers, inappropriate technologies and lack of farmers participation in research process. Those weak linkage systems bring, low adoption rates and decreased farming productivity. Research and extension organizations should use linkage mechanisms to enable them perform their role in agricultural research-extension-linkage more effectively.

In general perspective role of linkages in the process of technology transfer in Ethiopia were weak. The major reasons were non/little involvement of farmers in the research system, top-down approach, poor use of linkage mechanisms and strategies. However, all of these can be reversed if policy makers and programme implementers understand the role of linkage in agriculture and apply them to promote agricultural technology transfer and adoption.

Considering challenges to research-extension-farmers linkages globally especially in developing countries, capacity building for personnel and agencies saddled with extension service delivery should be given priority by government at all levels. There is need for government and agricultural agencies to organize and explore opportunities for staff exchange training across research and extension institutions and across countries to promote global dimension ideas, knowledge and lessons to enhance research-extension-farmers role performance in agricultural linkages.

5.2. Recommendations

On the basis of results indentified by the research the following recommendations were suggested:

- Researchers in the process of technology generation and demonstration be invite extension workers and farmers effectively to easy technology dissemination and adoption.
- As much as possible, actors involve and implement in all linkage mechanisms identified by this study.
- Positive factors to influence farmers' participation on the linkage mechanisms were promoted and secured.
- Adult education is important to the farmers as increase farmers' literacy level to seek agricultural information and use of extension materials as linkage mechanism.
- Regular and frequent contact of farmers improve extension advisory service which have more informed about the use of agricultural technologies
- Land owner ship and land tenure security assure farmers interaction with researchers and extension workers
- Gender equality is another issue to guarantee sustainable farmers participation on the technology demonstration.
- To enhancing linkage and role performance for extension delivery, a multidimensional and integrated approach is recommended to government, agencies and other partners in the agricultural sector.
- In general, researchers consider farmers and extension workers as primary partners in the process of technology generation and transfer. So far, conduct linkage mechanisms and the research process jointly.

5.3. Future work suggestions: future research needs to be the effectiveness of linkage mechanisms in the process of technology development and dissemination will be clearly studied. The impact of strong linkages between researchers, extension workers and farmers on the technology adoption and farming productivity will be investigated**.**

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APPENDICES

Study on Research-Extension-Farmer linkage in the process of technology transfer: the case of Dangila district, Ethiopia.

Description of the Study Area

1. Names of Region_____Zone _____ Woreda _____ Kebele _____
2. GPS reading (if available) N/S _____E/W _____Altitude(m) _____
3. Agro ecology 1. Weyena dega 2. Dega 3. Kola 4. Bereha
4. Land use classification of the study Kebele: Forest _____(ha)

Cropland __(ha), Grazing land_____(ha), irrigation land__(ha),

watt land _____(ha) other ____(ha) Total land (ha) _____

5. Household size of the study Kebele MHHH_____FHHH_____Total_____
6. Name of interviewer _____Signature _____Date _____

Socio-demographic characteristics of respondents

Only for *Farmers*

Socio- demographic information

1. What is your **sex**? 1. Female 2. Male
2. What is your **age** in years (1=30-40, 2=41-50, 51-60 and >60)
3. **Family** size ----------
4. What is your **education level**? 1. Cannot read and write 2. Read and write3. Primary 4. Secondary 5. Graduate
5. **Land** holdings of farmers----------ha.
6. **Experience** of the farmer involvement in linkage activities in years/times
7. **Training** access related to linkage (1. Yes, 0. no)
8. Access to **extension service** (1=yes, 0 =no)

9. **Distance** from residence of farmers to demo site----------km.

Only for extension workers and researchers

1. What is your **sex**? 1. Female 2. Male
2. What is your **age** in years (1=30-40, 2=41-50, 51-60 and >60)
3. Your highest **educational** qualification 4. Doctorate 3. Master 2. Bachelor 1. Diploma
4. Experience involved on linkage activities in Years. (1.1-5, 2. 6-10, 3. 11-15 4.>15)
5. Training access related to linkage (1. Yes, 2. no)

I -Questionnaire for researchers, extension workers and farmers

Linkages between Research – extension and farmers

1. What are the current linkages between **researchers and extension**

   3. Strong 2. Moderate 1. Weak 0. Absent

2. What are the current linkages between **researchers and farmers**

   3. Strong 2. Moderate1. Weak 0. Absent

3. What are the current linkages between **farmers and extension workers**
4. Strong 2. Moderate 1. Weak 0. Absent
5. linkage mechanisms between **research –extension and farmers**

Appendix table 1: Linkage mechanisms between research with extension

No.	Linkage mechanisms	Not use at all	Very little use	Little use	Much use	Very much use
1	Review meetings					
2	Trainings					
3	On-farm trials					
4	Method Demonstrations					
5	Field day					

6	FRG					
7	Extension materials					
8	ADPLAC					

Note: very much use (4), much use(3), little use(2), very little use(1) and not use at all(0)

Appendix table 2: Linkages mechanisms between research with farmers

No.	Linkage mechanisms	Not use at all	Very little use	Little use	Much use	Very much use
1	Review meetings					
2	Trainings					
3	On-farm trials					
4	Method Demonstrations					
5	Field day					
6	FRG					
7	Extension materials					
8	ADPLAC					

Note: very much use (4), much use(3), little use(2), very little use(1) and not use at all(0)

Appendix table 3: Linkages mechanisms between extension with farmers

No.	Linkage mechanisms	Not use at all	Very little use	Little use	Much use	Very much use
1	Review meetings					
2	Trainings					
3	On-farm trials					
4	Method Demonstrations					
5	Field day					
6	FRG					
7	Extension materials					
8	ADPLAC					

Note: very much use (4), much use(3), little use(2), very little use(1) and not use at all(0)

6. Are you currently involved on technology demonstration? (1, yes and 0, otherwise)

II - A Checklist for focus group Discussions

1. Which linkage mechanism wasfrequently used by actors?
2. What are the major challenges to involve on the linkage
3. Suggestions for strengthening the above linkages
4. Whose actor were more strongly linked with you

Bibliography

I was born on February 19, 1990 G.c in Adiskidam town, Awi zone which is 90 km away from Bahir Dar. I learned school education at Dikuna primary and Ankesha secondary school. I was also educated at Alage ATVET College on September 2000 E.c and certified with Diploma in Animal health science and also work on at Dangila district as kebele animal health service provider.

I was also joined on September, 2006 E.c at Bahir Dar university through support of SG.2000 (sasakawa Africa project) midcareer program Degree in agricultural extension on April, 05/2008 E.c. after this graduation, I was worked Dangila agricultural office with gender expert and Currently, until, I started a post graduate study progamme at Bahir Dar University. Now a day, I was working on Ethiopian agricultural research institute at wondo genet agricultural research center.